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Hugo Câmara-Costa

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# Université Paris Descartes

**Ecole doctorale 261 Cognition, Comportement, Conduites Humaines**

*INSERM U669 Troubles du comportement alimentaire de l'adolescent*

Cognitive, behavioral and familial associations of  
reading acquisition and academic achievement:

*A population-based longitudinal study from  
kindergarten to middle school*

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PhD Thesis - Psychology

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**Title:** Cognitive, behavioral and familial associations of reading acquisition and academic achievement: A population-based longitudinal study from kindergarten to middle school.

**Abstract:** Longitudinal studies starting during kindergarten provide an appropriate method to investigate the child- and environmental-level factors that account for children's reading and academic achievement later in their educational trajectories. In France, studies designed to follow-up children longitudinally from kindergarten onwards remain scarce. An epidemiological study started in 2001 in the Urban Community of Creusot Montceau (Saône-et-Loire, France) sought initially to identify the factors associated with children's reading acquisition and academic achievement from preschool (3-6 years) to the middle of elementary school (Grade 3, 8-9 years). The PhD project reported here aimed to extend the original design of data collection to the end of middle school (Grade 9, 14-15 years) spanning a 10-year follow-up period in the general population.

This work aimed to investigate the specific contributions of child-level factors (cognitive-academic skills, behavior problems) and environment-level factors (sociodemographic and family characteristics) for children's subsequent reading acquisition at the end of elementary school (Grade 5), as well as academic achievement at the end of middle school (Grade 9).

The samples of analysis comprised 829 kindergarteners in the 2001-2002 school year (Cohort 1, 90% of the initial sample) followed through the end of middle school (Cohort 1, 2010-2011 school year) and 812 kindergarteners in the 2003-2004 school year (Cohort 3), from which a sub-sample of 154 participants was followed through the end of elementary school (2008-2009 school year). At kindergarten, assessment included measures of children's cognitive-academic and behavioral skills, as well as family background characteristics. Outcome measures were composed of children's results in the national evaluations performed at the end of middle school for Cohort 1 ("*Diplôme National du Brevet*") and of children's scores in standardized measures of word reading achievement at the end of elementary school for Cohort 3 (*ODEDYS*, Jacquier-Roux, Valdois & Zorman, 2002).

The results indicated that children's phonological processing skills, letter knowledge and attentive behavior were the most robust predictors of word reading achievement at Grade 5. In addition, parental reports of familial antecedents of reading difficulties also contributed to predict word reading at Grade 5 and were specifically associated with both reading difficulties and inattention behavior at this grade level. At Grade 9, children's oral language skills, letter knowledge, short-term verbal memory, perceptual reasoning (non-verbal cognitive ability) and attentive behavior at kindergarten predicted significantly the outcome measure of general academic achievement at Grade 9, together with parental educational level and family structure. Moreover, results indicated the influence of several family characteristics referring to father's nationality, type of early childcare, language-based bedtime routines and familial antecedents of reading difficulties as risk factors for children's subsequent academic underachievement.

The present work contributes to the extant literature regarding the child- and family-level factors associated with subsequent reading acquisition and academic achievement from kindergarten to elementary and middle school. Importantly, these results allowed the identification of novel familial risk factors that influence negatively children's subsequent academic trajectories. These findings have important implications regarding the child and family factors that should be targeted during kindergarten in order to prevent children's subsequent reading and academic difficulties and to promote adequate intervention strategies early in children's educational trajectories.

**Keywords:** Kindergarten, elementary school, middle school, longitudinal study, school entry readiness, cognitive-academic skills, emergent literacy skills, behavior problems, family-related characteristics, early risk factors, familial antecedents of reading difficulties, language-based bedtime routines, reading acquisition, academic achievement.



**Titre :** Facteurs cognitifs, comportementaux et familiaux associés à l'acquisition de la lecture et à la réussite scolaire : une étude longitudinale de la maternelle au collège dans la population générale.

**Résumé :** Les études longitudinales en milieu scolaire débutant en maternelle permettent une analyse des facteurs propres à l'enfant et à son environnement impliqués dans le développement de la lecture et de la réussite scolaire. Cependant, les études visant à analyser l'influence longitudinale de ces facteurs dès l'école maternelle restent exceptionnelles en France. Une étude épidémiologique initiée en 2001 dans la Communauté Urbaine de Creusot Montceau (Saône-et-Loire, France) avait comme objectif l'examen des contributions des facteurs propres à l'enfant et des variables environnementales dans l'acquisition de la lecture et la réussite scolaire dès la maternelle (3-6 ans) jusqu'au milieu de l'école élémentaire (CE2, 8-9 ans). Le travail de thèse présenté a permis le prolongement de la période de recueil de données jusqu'à la fin du collège (3<sup>ème</sup>, 14-15 ans) représentant une période de suivi de 10 ans dans la population générale.

L'objectif principal de ce travail est d'identifier les facteurs propres à l'enfant (cognitifs, académiques et comportementaux) et des variables environnementales (facteurs sociodémographiques et caractéristiques familiales) dans le développement de la lecture à la fin de l'école primaire (CM2) et la réussite scolaire à la fin du collège (3<sup>ème</sup>).

Les échantillons comprenaient 829 enfant inscrits en Grande Section de Maternelle pendant l'année scolaire 2001-2001 (Cohorte 1, 90% de l'échantillon initial) suivis jusqu'à la fin du collège (année scolaire 2010-2011) et 812 enfants de Grande Section de Maternelle durant l'année 2003-2004 (Cohorte 3) suivis jusqu'à la fin de l'école élémentaire (Cours Moyen 2, année scolaire 2008-2009). En Grande Section de Maternelle, le recueil de données a compris l'évaluation des compétences cognitives, académiques et comportementales des enfants, ainsi que le recueil des informations concernant le contexte familial. Les mesures de réussite scolaire ont compris les résultats des enfants dans les évaluations nationales réalisées à la fin du collège pour la Cohorte 1, (*Diplôme National du Brevet*) et les performances des enfants dans une mesure standardisée de lecture de mots à la fin de l'école élémentaire pour la Cohorte 3 (*ODEDYS*, Jacquier-Roux, Valdois & Zorman, 2002).

Les compétences de traitement phonologique, la connaissance de lettres et le comportement attentif étaient les prédicteurs le plus significatifs de la lecture de mots au Cours Moyen 2. Le signalement par les parents d'antécédents familiaux de difficultés de lecture était associé simultanément avec des difficultés de lecture et le comportement inattentif à la fin de l'école élémentaire. En 3<sup>ème</sup> année du collège, les compétences de langage oral, la connaissance de lettres, la mémoire verbal à court terme, le raisonnement perceptif (facteur non-verbal) et le comportement attentif des enfants en maternelle, ainsi que le niveau d'éducation des parents et le type de famille, ont prédit significativement la mesure de réussite scolaire générale à la fin du collège. En outre, les résultats ont montré l'influence de plusieurs caractéristiques familiales dont la nationalité du père, le mode de garde avant la scolarisation, les rituels d'endormissement et les antécédents familiaux de difficultés de lecture. Ces caractéristiques renvoient à des facteurs qui mettent un enfant en risque d'échec scolaire à la fin du collège.

Ce travail contribue à la littérature scientifique existante concernant les facteurs propres à l'enfant et à son environnement familial liés à l'acquisition de la lecture et à la réussite scolaire. Les résultats permettent l'identification des facteurs familiaux mettant un enfant à risque d'échec scolaire. Il ont des implications importantes pour repérer le plus précocement possible les enfants à risque de développer des difficultés de lecture et d'échec scolaire et pour mettre en place des programmes d'intervention adéquats à ses difficultés dès le début des trajectoires académiques des enfants.

**Mots clés :** Grande Section de Maternelle, école élémentaire, collège, étude longitudinale, maturité à l'entrée à l'école, compétences académiques et cognitifs, alphabétisation émergente, troubles de comportement, caractéristiques familiales, facteurs de risque précoces, antécédents familiaux de difficultés de lecture, rituel d'endormissement, acquisition de la lecture, réussite scolaire.



*Aos meus avôs, pais e irmãos,*





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## Introduction

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Academic achievement is a central developmental task for children who must bring to bear all their cognitive, language, social, emotional and physical competencies to successfully perform in the school setting (Cicchetti & Toth, 1997). Children's academic trajectories are largely influenced by the linguistic, cognitive and behavioral resources they exhibit before school entry, as well as by the environmental contexts in which these resources arise. Converging evidence from independent fields of research have pointed to the cumulative impact of early life experiences in multiple domains of competence and to its lasting effects throughout life-long course (Shonkoff & Phillips, 2000). The development of the neural pathways underlying the formation of the skills essential to academic achievement follows hierarchical rules in a bottom-up sequence, in which more recent acquisitions add up to a predictable developmental sequence; in addition, the favorable plasticity of the brain during infancy allows the neural circuits to be more optimally receptive to environmental influences during this sensitive period (Knudsen, Heckman, Cameron & Shonkoff, 2006).

The cumulative nature of the achievement trajectories entails that children's cognitive-academic and behavioral skills before school entry represent foundational scaffolds for later educational success. In addition, these skills are largely influenced by environmental conditions that incite or hinder the development of children's early competence. Recent research has focused in examining the child and environmental factors that promote, protect or place a child at risk of subsequent academic underachievement. Importantly, longitudinal studies have consistently demonstrated that several child- and environmental-level factors before school entry are robust predictors of children's later academic achievement (Boyle, Georgiades, Racine & Mustard, 2007; Burchinal, Peisner-Feinberg, Pianta & Howes, 2002; Campbell, Pungello, Miller-Johnson, Burchinal & Ramey, 2001; Duncan et al., 2007).

Framed within this conceptual perspective, the study here presented aims to contribute to the identification of the early factors before elementary school that influence children's subsequent achievement trajectories. To achieve this objective, the current work was based in a prospective longitudinal study conducted in France with four community-based cohorts followed from preschool to the end of elementary and middle school.

In the first chapter (I), we present a review of the studies that analyzed the cross-sectional and longitudinal contributions of child- and family-level factors to children's subsequent reading and academic achievement. We describe the empirical evidence reported in the scientific literature that allowed the formulation of the research questions underlying the present work. Moreover, we present a brief summary of the structure, curricular aims and national indicators of the French educational system.

The second chapter (II) is dedicated to the description of the longitudinal study from which the present work was derived. We recapitulate the initial objectives, methods and the main findings issued from the original longitudinal study.

In the third chapter (III) we report the work that constituted the PhD project. In this section, we present a description of the objectives, participants and methodology, and we indicate the results obtained from the analyses performed in the present research.

In the last chapters of this report, we discuss the main findings of the current work, as well as its strengths and limitations (Chapter IV), and we conclude by presenting the educational implications of the findings here reported (Chapter V).

## I. Literature review

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### Academic achievement

#### Theoretical models and conceptualization

Academic achievement is a central challenge in children's developmental trajectories with significant implications in multiple domains of competence and psychopathology (Masten, Burt & Coatsworth, 2006). The pathway to educational success involves the adaptive development of a set of competencies, behaviors and attitudes that lay the foundations for children's future academic achievement. The scientific literature has underlined that children's academic trajectories are launched early in life before the beginning of formal schooling (La Paro & Pianta, 2000, for a review) and remain remarkably stable after the first years in school (Entwisle, Alexander & Olson, 2005; Hecht, Burgess, Torgesen, Wagner & Rashotte, 2000). The stability of children's achievement trajectories from the beginning of formal schooling onwards has led investigators to focus in the analysis of the early factors before school entry that allow explaining the variability of children's later academic achievement.

There is general consensus among researchers that children's longitudinal trajectories of academic achievement can be accurately traced back to the preschool years prior to children's entry in formal schooling. Indeed, longitudinal research has recurrently demonstrated that children's cognitive-academic skills before school entry constitute the cornerstones of later academic achievement during elementary school and through adolescence and young adulthood (Campbell et al., 2001; Duncan et al., 2007, for a review, Entwisle et al., 2005). The findings from a large body of studies have evidenced the substantial inter-individual variability of children's initial levels of cognitive-academic skills before school entry. Importantly, these findings have emphasized that, without intervention, students exhibiting inadequate levels of cognitive-academic skills at school entry tend to stay behind their peers in the primary grades and may never close this gap during formal schooling (Hecht et al., 2000; La Paro & Pianta, 2000). The effects of the achievement gap related with the inequality of children's cognitive-academic resources at school entry remain an international concern

because of the lasting implications and costs both to individuals and to societies (Heckman, 2006; Schweinhart, 2004). The persistency of academic difficulties from childhood through adulthood has led researchers to focus on the identification of the early factors influencing children's subsequent academic achievement in order to improve the efficient screening of children who might be at risk of academic underachievement and to identify the critical dimensions of cognitive-academic development that should be targeted in intervention programs. As suggested by Heckman (2006), the return rates of investing early in children's educational pathways are notoriously superior at the individual, societal and economical levels, when compared with the benefits associated with interventions during later stages of the academic trajectories.

The kindergarten period encompasses a sensitive period where children's cognitive, social and emotional skills must converge to respond efficiently to the challenging demands of the transition into elementary school. In the comprehensive meta-analysis performed by Duncan and colleagues (2007), the authors analyzed six nationally-representative longitudinal data sets in order to examine the predictive power of behavioral and cognitive-academic skills before school entry (age 5 to 6 years) on children's later achievement at middle school (ages 11 to 13 years). The authors concluded that the strongest predictors of later achievement were mathematical, reading and attention skills at school entry. Importantly, these findings have been replicated extensively (Grimm, Steele, Mashburn, Burchinal & Pianta, 2010; Grissmer, Grimm, Aiyer, Murrah & Steele, 2010; Hooper, Roberts, Sideris, Burchinal & Zeisel, 2010; Pagani, Fitzpatrick, Archambault & Janosz, 2010; Romano, Babchishin, Pagani & Kohen, 2010) and highlight the critical importance of longitudinal studies initiated during preschool in unraveling the factors associated with subsequent academic achievement.

The comprehensive work by Duncan et al. (2007) and its extensive re-analysis (Foster, 2010) have contributed greatly to the state of the art regarding the factors that contribute the most for children's achievement from kindergarten to middle school. Notwithstanding the contribution of Duncan's meta-analysis, this exhaustive work adopted a child-centered model for school transitions and, as pointed out by Rimm-Kaufman and Pianta (2000), a model based primarily on child-level factors might account for only a reduced proportion of the variance. Hence, these authors proposed the Direct effects model, which takes into account not only the impact of child-related characteristics, but also the effects of environmental contexts such as schools, neighborhoods and families. This broadened perspective is in line

with theoretical models of human development that underline the importance of children's early environments, such as the bio-ecological model of development (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2006) and the transactional model (Sameroff, Seifer, Baldwin & Baldwin, 1993). Both these models acknowledge that the characteristics of the children and of the contexts influence one another over time through interactive and dynamic processes that significantly shape the course of development.

An ecological model posits development as the result of bidirectional processes involving person-context interactions through the course of time (Bronfenbrenner, 1979). On this point, Bronfenbrenner and Morris (2006) highlight the primordial role of proximal processes, i.e. children's experiences and interactions with their immediate environments (e.g. family), as powerful mechanisms in human development. In this sense, the individual differences observed in children's developmental outcomes emerge as a result of the multiple pathways shaped by the ongoing interplay between children and their environments (Rutter, Kim-Cohen & Maughan, 2006). Importantly, this model laid the groundwork for the notion that children play an active role in these person-context interactions. The characteristics of children, caregivers and the environments influence one another dynamically, and the processes whereby these elements interact over time change as a function of intervening events. In the same vein, the transactional model underlines the importance of considering a broader perspective that recognizes the influence of numerous environmental factors affecting children's development (Sameroff & Seiffer, 1983). These authors proposed the multiple risk model in order to capture the extent to which family-related factors impact children's developmental outcomes. This model is based on the assumption that the relation between any single risk factor and subsequent developmental outcomes is weak, and that, in general, other contextual influences interact simultaneously in determining the outcome (Sameroff et al., 1993). Thus, the impact of risk factors is cumulative since it is the concentration of risk factors, regardless of the individual risk, that is related to an increased probability of negative outcomes (Gutman, Sameroff & Cole, 2003). Several longitudinal studies have demonstrated the strong association between the number of early familial risk factors and lower academic outcomes from childhood to early adulthood (Pungello et al., 2010; Schoon et al., 2002).

The work reported here draws its conceptual framework from the ecological and transactional developmental theories by recognizing the importance of considering a broader perspective that acknowledges the influence of environment-level factors affecting child development.



Framed within the ecological-transactional model, academic achievement is conceptualized as one of children's developmental outcomes emerging as a result of the interactions established between children and their living environments, in particular the family context.

Academic achievement is an umbrella term used typically to designate the outcomes from participation in formal schooling and can be categorized in several ways. In research, operationally-derived measures aimed to represent academic achievement rang from global indicators, such as educational attainment and school marks, to more specific measures, such as standardized test scores in specific academic area (e.g., reading, math). As a result of the data available to conduct this research and because variability in the factors associated with academic achievement might occur depending on the type of outcome used to represent this construct (Pagani et al., 2010), the present study focused on two often cited measures of achievement: word-reading at the end of elementary school and general academic achievement at the end of middle school (Duncan et al., 2007, for a review).

The overgrowing demand in industrialized societies for reading proficiency has led researchers to focus in reading acquisition as a significant indicator of academic achievement. Reading skills play a central role to academic achievement since they represent pre-requisites to most academic tasks in school. Extant research has evidenced that there is developmental continuity in school success or failure base on children's reading achievement in the primary grades of elementary school (Paris & Cunningham, 1996). Indeed, reading ability have been shown to be a good measure of school achievement and a key to overall educational attainment early in elementary school and beyond (Duncan et al., 2007; Stanovich, 1986; Whitehurst & Lonigan, 1998). In the present work, we assessed reading achievement at the end of elementary school through a composite measure of word reading obtained through an age-appropriate standardized measure with established reliability and validity in the evaluation of reading achievement during elementary school ("*Outil de dépistage des dyslexies*" (ODEDYS), Jacquier-Roux, Valdois & Zorman, 2002). In addition, because extant research has systematically shown that deficits in word identification constitute the basic source of poor reading, notably in the case of specific reading disability or dyslexia, and that measures of word reading are typically used in the study of clinically significant reading difficulties (Landerl et al., 2013; Vellutino, Fletcher, Snowling, & Scanlon, 2004, for a review), we focused in the present study on difficulties in learning to read associated with inadequate word reading efficiency.

At the end of middle school, the outcome measure used in the work here reported was constituted of the results of the national diploma attributed to the students enrolled in the final year of middle school (“*Diplôme National du Brevet*”). In France, it is a standard procedure of the French Department of National Education to calculate a general measure of academic achievement for each student enrolled in the final year of middle school. The computation of this general measure is based on several indicators such as student’s performances in three written exams (French, Mathematics and History), grade point averages of the student’s in the curriculum subjects taught in the final year of middle school and teachers’ evaluations of classroom engagement. Because each of the indicators included in the this general measure have been reported to represent adequate measures of academic achievement (Duncan et al., 2007, for a review; Pagani et al., 2010) and because this general measure included an indicator of reading achievement, i.e., a robust correlate of general academic achievement, we considered appropriate to use it as an outcome measure of children’s general academic achievement at the end of middle school. Moreover, this general measure represents the most important indicator for the French Department of National Education regarding children’s general academic achievement at the end of compulsory education, and constitutes a nationally-representative measure of academic achievement in typically-developing students enrolled in the final year of middle school.

As mentioned above, the present work focused on reading achievement at the end of elementary school and on general academic achievement at the end of middle school. For this reason, the literature reviewed for the present research and described subsequently will focus on the factors associated with reading achievement from kindergarten to elementary school and on the longitudinal correlates of general academic achievement from kindergarten to the end of middle school. We begin the following section by summarizing the concurrent studies that examined the associations of children’s cognitive-academic skills and behavioral problems with later reading and academic achievement. Moreover, we describe extant research that analysed the influence of family background characteristics on children’s subsequent academic achievement in elementary school and beyond. Whenever it was considered justified, appropriate distinctions were made between the factors specific to reading or specific to academic achievement. We conclude the following section by describing the research questions aroused by the literature review and specifying the expected contributions of the present study to the extant scientific literature.

## Child-level factors and academic achievement

Before school entry, at kindergarten, children exhibit a set of cognitive-academic skills described in the scientific literature as the developmental precursors of later academic achievement. The pivotal work of Duncan and colleagues (2007) represents to date one of the most comprehensive meta-analyses examining the contribution of children's cognitive-academic skills before school entry on their subsequent academic achievement. As stated earlier, these authors concluded that children's early math, pre-reading and attention skills at school entry were the most robust predictors of children's later academic achievement at elementary and middle school (ages 11 to 13 years). These dimensions of children's cognitive-academic and behavioral competency contributed significantly to predict children's subsequent performances on measures of reading and math achievement, as well as composite measures regrouping both outcomes.

Importantly, the results advanced by Duncan and colleagues (2007) have been re-examined by several researchers, which provided wide support for the same pattern of associations between these specific set of cognitive-academic and behavioral skills at school and later academic achievement (Grimm et al., 2010; Grissmer et al., 2010; Hooper et al., 2010; Pagani et al., 2010; Romano et al., 2010). Duncan's findings and its extensive replications summarize remarkably the findings from an extensive body of literature examining the effects of early math, pre-reading skills and attentive behavior on children's subsequent achievement. Although early mathematic skills have emerged as a significant predictor of later academic achievement and an increasing number of studies has started considering its role on later achievement, the present work lacked a specific measure representing mathematical skills and, thus, these skills were not considered in the literature review exposed in this section.

The school entry predictors underlined in Duncan's work (2007) refer above all to oral language (vocabulary and comprehension), phonemic awareness, letter knowledge, short-term verbal memory and attention skills. These results resemble substantially the findings reported in previous studies examining the powerful influence of early pre-reading skills (Cunningham & Stanovich, 1997; Whitehurst & Lonigan, 1998) and attentive behavior (Hinshaw, 1992; Rabiner & Coie, 2000; Spira & Fischel, 2005, for a review) on later reading and academic achievement. Importantly, previous research has indicated that this gamut of school readiness skills is associated with successful transitions in the early years of schooling and forecasts

later academic achievement into adolescence and adulthood (Campbell et al., 2001; Entwisle & Alexander, 1998, Entwisle et al., 2005). Because children's cognitive-academic skills and behavior have been shown to play a significant role on children's subsequent achievement, we present below a summary of the results described in the extant literature regarding the influence of children's cognitive-academic skills, i.e. pre-reading skills (referred hereafter as emergent literacy skills) and cognitive abilities, and behavior on later reading and academic achievement.

### Emergent literacy skills

In the comprehensive review of the literature performed by Whitehurst and Lonigan (1998), the authors advanced the notion of emergent literacy skills referring to the conceptualization that learning to read is strongly associated with the skills, knowledge and attitudes children evidence before the beginning of formal reading and writing instruction, as well as the environments that support the development of these early abilities. This conceptual framework acknowledges literacy acquisition as a developmental continuum in which children's developing skills and knowledge before school entry constitute the precursors of subsequent conventional forms of reading and writing during elementary school. Hence, this perspective of a developmental continuity from emergent literacy skills to conventional reading and writing ability emphasizes the importance of the preschool period in the development of the early reading-related skills that will promote later reading acquisition, as well as of the environmental contexts where the development of these skills occurs.

Whitehurst and Lonigan (1998) proposed the emergent literacy model organized in two interdependent domains of skills and processes: the *outside-in* and the *inside-out* processes. On one hand, the *outside-in* processes represent children's understanding of the concepts and contexts where reading and writing take place. These processes concern children's oral language and comprehension (syntactic and semantic knowledge) as well as understanding of print conventions (e.g. knowing that reading is oriented from left-to-right, top-to-bottom, front-to-back, recognize punctuation marks). On the other hand, the *inside-out* processes pertain to children's understanding of the rules that allow them to decode and convert printed material into their component sounds (or converting sounds into print, as in the case of writing). These processes refer to children's phonological sensitivity, such as phonological awareness and verbal memory, knowledge of letters and understanding of the correspondence

between letters and sounds (letter-sound knowledge). Research framed within an emergent literacy perspective has demonstrated the interdependence among these competencies and the significant role that this variety of skills exhibited before school entry play on children's subsequent reading performance in elementary school (Dickinson, McCabe, Anastasopoulos, Peisner-Feiberg & Poe, 2003).

Among the diversity of skills described in Whitehurst and Lonigan's review (1998), an extensive body of scientific literature has demonstrated the major role that three domain-specific skills play on children's later decoding and reading ability. These skills refer to children's oral language, namely vocabulary and oral comprehension, letter knowledge and phonological awareness. An extensive body of research has supported the predictive power of this set of skills on kindergartener's later reading achievement during elementary school (Jordan, Snow & Porche, 2000; Leal, Gamelas, Cadima & Silva, 2005; Lonigan, Burgess & Anthony, 2000; National Institute of Child Health and Human Development (NICHD), 2000; Wagner et al., 1997). Importantly, extant longitudinal analyses have shown that individual differences in these early literacy skills are relatively stable from kindergarten onwards and contribute to later discrepancies in reading ability throughout elementary school and beyond (Cunningham & Stanovich, 1997; Hecht et al., 2000; for studies performed in France see Billard et al., 2009; Watier, Dellatolas & Chevrie-Muller, 2006).

Children's *oral language* during the preschool period, which refers to the range of their vocabulary and oral comprehension, plays a crucial role during reading development. As mentioned by Whitehurst and Lonigan (1998), reading is largely impelled by the search of meaning of print, and children's vocabulary and comprehension abilities allow children to derive meaning from words and text, which facilitates the reading process. The work developed by Dickinson and colleagues (2003) based on the Comprehensive Language Approach has highlighted the significant role that preschooler's oral language skills play on initial reading acquisition and later development. The results obtained with a representative sample of preschooler's, who had been evaluated on measures of receptive vocabulary, print knowledge and phonological awareness, demonstrated that children's vocabulary was predictive of concurrent emergent literacy skills, even after controlling for the effects of sociodemographic factors and concurrent emergent literacy skills. Moreover, the results indicated that children with low performances on the measures of receptive vocabulary also exhibited lower performances on the tasks aimed to evaluate emergent literacy skills, and that

these performances were comparable to the ones of children that exhibited lower performances on other emergent literacy skills, namely phonological awareness. The authors concluded that oral language skills play a unique role during the initial stages of reading development and that these skills are closely related with the development of print knowledge and phonological awareness during the preschool period.

Furthermore, the study developed by Walley, Metsala e Garlock (2003) adds to the abovementioned results regarding the unique contribution of children's vocabulary to the development of emergent literacy skills during preschool. In this study, oral vocabulary, phonological awareness, recognition of orally-presented words and word-reading were evaluated in a sample of preschoolers. Children's vocabulary contributed to predict the study's outcome measure of word reading and, most importantly, the measure of children's ability to recognize orally-presented words, i.e. a measure of the children's lexicon size, contributed to the proportion of variance explained of children's performances in the tasks evaluating phonological awareness. The results demonstrated that the remarkable growth of vocabulary observed during the preschool period contributed to children's ability to segment explicitly lexical units, which represents the core characteristic of phonological awareness skills. The authors concluded that children's vocabulary growth during the preschool period represented a developmental precursor of phonological awareness skills, which underlines the decisive role of oral language skills during the initial stages of reading development.

Other the important role that oral language skills play in the beginning of reading acquisition, several studies have reported that its importance for reading development increases during elementary school. Longitudinal research has demonstrated the influence and predictive power of children's vocabulary and oral comprehension in their later success in learning to read (Muter, Hulme, Snowling & Stevenson, 2004; Storch & Whitehurst, 2002; for studies performed in France see Watier, Dellatolas & Chevrie-Muller, 2006). As children progress in their educational trajectories during elementary school, they are called to invest progressively in reading materials of increasing complexity. Therefore, children must progress from reading oriented mainly to word decoding, as required in the initial steps of reading acquisition, to reading for meaning. At later stages of reading development, children are expected to be proficient in word decoding and, therefore, their ability to derive meanings from words and to understand text becomes pivotal for a child's success in reading efficiently (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998).

Print knowledge, which refers to children's understanding of the conventions of prints (e.g., knowing that writing goes from left to right and top to bottom across a page), letter names and print to sound correspondences, was shown to explain a substantial proportion of variability in the growth of reading outcomes (Hecht et al., 2000, Wagner et al., 1997). However, letter knowledge, which implies children's understanding of grapheme-phoneme correspondences, has been pointed as the most powerful single predictor of short and long-term literacy success, when compared with other aspects of print knowledge. Several longitudinal studies have consistently reported the importance of letter knowledge in reading development during the beginning of formal schooling by demonstrating its unique and robust predictive power of children's later reading acquisition, even when the effects of other emergent literacy skills are taken into account (Lonigan et al., 2000; Muter et al., 2004; Storch & Whitehurst, 2002, Whitehurst & Lonigan, 1998). Moreover, several researchers have presented evidence that letter knowledge is strongly associated with preschoolers concurrent vocabulary and oral language (Dickinson et al., 2003) and that its association with phonological awareness is bi-directional, in which letter knowledge promotes the development of phonological awareness and vice-versa (Lonigan et al., 2000; Wagner et al., 1997).

Finally, *phonological awareness*, which pertains to children's ability to explicitly manipulate the distinct sounds that constitute language, is considered the most important developmental precursor of reading development and its influence has been often cited in several studies (Hulme, Snowling, Caravolas & Carroll, 2005; Wagner & Torgesen, 1987, for a review). Children with specific reading difficulties have been frequently reported to exhibited lower performance in tasks evaluating phonological awareness, when compared with proficient readers (Hecht et al., 2000; Shaywitz et al., 1999), and compelling evidence has supported this phonological deficit as the cognitive basis of specific reading disabilities (Ramus, 2001). Importantly, a large array of longitudinal studies has demonstrated its unique contribution to children's initial progress in reading development (Spira, Bracken & Fischel., 2005; Storch & Whitehurst, 2002; Torgesen, Wagner, Rashotte, Burgess & Hecht, 1997; Wagner et al., 1997; for studies performed in France, see Billard et al., 2008, 2010; Sprenger-Charolles, Colé, Béchennec & Kipffer-Piquard, 2005; Sprenger-Charolles, Siegel, Béchennec & Serniclaes, 2003). The development of phonological awareness skills follows a developmental continuum regarding children's sensibility to discriminate the linguistic units that compose reading and writing. Although children's sensibility to recognize rhymes and syllables precedes the ability to identify phonemes (Carroll, Snowling, Hulme & Stevenson, 2003; Courcy, Beland &

Pitchford, 2000), the development of phonological sensitivity follows a quasi-parallel progression such that children appear to be sensitive to multiple levels of word structure concurrently (Anthony, Lonigan, Driscoll, Phillips, & Burgess, 2003; Lonigan, Burgess, Anthony & Barker, 1998). In addition, the association between phonological awareness skills and learning to read is reciprocal: phonological awareness promotes reading development, which in turn improves the ability to segment words into their constituent sounds (de Santos Loureiro et al., 2004; Dellatolas et al., 2003).

Taken together, an extensive body of literature has highlighted that reading development is strongly influenced by the emergent literacy skills children exhibit and develop during preschool. These studies have recurrently demonstrated the robust predictive power of children's vocabulary and oral comprehension, letter knowledge and phonological awareness in explaining subsequent reading acquisition in elementary school (Jordan et al., 2000; Lonigan et al., 2000; Lervåg, Bråten, & Hulme, 2009; Spira et al., 2005; Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998).

Importantly, the scientific literature has underlined that the individual differences in the development of these emergent literacy skills tend to remain stable from preschool onwards (Sénéchal & LeFevre, 2002; Stanovich, 1986; Wagner et al., 1997) and contribute to the widening discrepancies of children's reading performances later in elementary school (Foster & Miller, 2007; Hecht et al., 2000; Storch & Whitehurst, 2002, Whitehurst & Lonigan, 1998). As a consequence, preschoolers who struggle to develop proficient levels of emergent literacy skills during preschool are at increased risk of manifesting reading difficulties later in elementary school (Lonigan et al., 2000; Storch & Whitehurst, 2002; Wagner et al., 1997; Watier et al., 2006), adolescence and mid-life (Maughan et al., 2009; Shaywitz et al., 1999). Without appropriate intervention targeted to their individual needs, an important percentage of these children will tend to perform significantly lower in reading-related activities resulting in persistent difficulties in reading throughout their educational trajectories and, ultimately, in an increased risk of developing Reading Disabilities [RD] (Lipka, Lesaux & Siegel, 2006). In this sense, the study of emergent literacy skills during the preschool period is of particular relevance due to its potential to identify the early factors that might allow identifying children at increased risk of subsequent reading difficulties and academic underachievement.



## Cognitive abilities

During kindergarten, children exhibit an array of cognitive skills considered pre-requisites for subsequent educational success. These skills refer typically to children's *perceptual* and *visual-spatial ability*, *working memory*, *verbal ability* and *processing speed*. The studies examining the early factors that influence children's academic achievement frequently include these skills as control variables aimed to represent children's levels of cognitive ability. Moreover, these skills are widely used by researchers to create a composite score of children's general cognitive ability, commonly referred to as Intellectual Quotient (IQ), which, in turn, is usually subdivided in verbal and nonverbal ability or, more recently, in Verbal comprehension, Perceptual reasoning, Processing speed and Working memory (Wechsler Intelligence Scale for Children, 4<sup>th</sup> edition, 2003).

General cognitive ability is amongst the most important predictors of children's academic achievement (Campbell et al., 2001; Duncan et al., 2007, for a review). Experimental studies have showed that intervention programs aimed at promoting children's cognitive development during preschool accounted for children's increases in cognitive ability and academic achievement during elementary school and beyond, compared with children that did not participate in the intervention programs (Campbell & Ramey, 1994, Vandell, Belsky, Burchinal, Steinberg & Vandergrift, 2010). Furthermore, scientific evidence has highlighted the strong association between the development of children's cognitive abilities and changes in academic achievement over time. Ferrer and colleagues (2004, 2007) have clearly demonstrated the mutual interrelations of children's cognitive competence with reading and academic achievement from childhood to early adulthood. In two longitudinal studies following children from Grade 1 to 12, the levels of cognitive ability (Full Scale IQ, Nonverbal IQ and Verbal IQ) were positively related to changes over time in reading and academic achievement. Likewise, the levels of reading and academic achievement were associated with changes in cognitive abilities from Grade 1 to 12. The authors concluded that the symbiotic dynamics of cognition and achievement reflected coupled developmental sequences underlying cognitive development and reading and academic achievement.

Hence, the analysis of the contribution of child-level factors for later reading and academic achievement must take into account the influence of verbal and nonverbal cognitive abilities described in the literature as robust longitudinal correlates of subsequent achievement.

## Behavior problems

In order to increase understanding of the factors that influence academic achievement, researchers have called for a broader perspective that recognizes the importance of behavioral correlates in subsequent academic achievement (Duncan et al., 2007; Entwisle & Alexander, 1998). For instance, Duncan and colleagues (2007) have clearly demonstrated that attention-related skills at school entry add to the prediction of later academic achievement. In the same vein, La Paro and Pianta (2000) concluded that children's behavior contributed to the prediction of subsequent academic outcomes independently of children's cognitive-academic skills, such as early literacy skills. These authors conducted an extensive meta-analysis aimed to summarize the longitudinal studies evaluating the predictive power of child-related factors before school entry in explaining children's later achievement at the beginning of elementary school. La Paro and Pianta (2000) concluded that children's social skills and socio-emotional behavior, such as externalizing and internalizing problems, represented significant predictors of children's later achievement at the beginning of elementary school, even though their influence was smaller when compared with children's cognitive-academic skills. Due to the documented influence of children's behavior on reading and academic achievement, the effects of children's behaviors must be considered in the study of the child-related factors impacting their academic achievement.

The association between reading achievement and behavior problems during early and middle childhood has been well documented. The notable work conducted by Hinshaw (1992), for a review) represents an often cited comprehensive review of the literature dedicated to the analysis of the co-occurrence between behavior problems and academic underachievement. This author concluded that a large array of longitudinal studies has consistently demonstrated that the association between behavior problems and academic achievement occurs more often than what is expected by chance and that this association is established early in children's development, well before school entry. The frequent association observed between behavior problems and cognitive-academic development draws attention to the argument that children's behavioral characteristics before school entry need to be taken into account in studies examining the contributions of child-level characteristics to subsequent academic achievement.

Behavior problems are commonly conceptualized by researchers into two distinct behavioral patterns: a) externalizing behavior and b) internalizing behavior. Externalizing behavior problems are characterized by inattention, impulsivity and hyperactivity, aggression, as well as by disruptive and antisocial behavior. Internalizing problems refer to behaviors characterized by withdrawal, isolation, anxiety and dysphoria. It is important to notice that the data available to conduct the analyses here reported comprised exclusively externalizing behavior problems and, thus, the literature reviewed in the present work refers only to the influence of externalizing behavior problems on children's academic achievement. Moreover, for the purposes of clarification of the terminology employed hereafter, we use the designation behavior problems or externalizing behavior problems interchangeably.

Similarly to the distinction between internalizing and externalizing behavioral problems, it is commonly accepted in empirical research that externalizing behavior problems can be subdivided in two clearly differentiated domains of behavioral problems: inattention, hyperactivity and impulsivity, on one hand, and aggressive, disruptive and antisocial behavior, on the other hand. Despite the frequent co-occurrence between these two domains of externalizing behavior problems, several studies have demonstrated its relative independence and stability throughout children's development (Hinshaw, 1992, for a review).

According to the Diagnostic and Statistic Manual of Mental Disorders (DSM-V; American Psychiatric Association [APA], 2013), externalizing behavior problems are framed within the attention-deficit and disruptive behavior disorders that usually are first diagnosed in infancy, childhood or adolescence. The attention-deficit and disruptive behavior disorders comprise three diagnostic categories: Attention-Deficit Hyperactivity Disorder (ADHD), Conduct Disorder (CD) and Oppositional Defiant Disorder (ODD). Each of these diagnostic categories is based on a set of distinct behavioral symptoms. ADHD contemplates behaviors characterized by inattention, hyperactivity and impulsivity, while CD and ODD regroup behaviors marked by aggressive, oppositional and antisocial behaviors.

Regarding the ADHD, the DSM-V (APA, 2013) defined a set of symptoms that must be observed in an individual in order to obtain a formal diagnostic of this disorder. Despite previous conceptualizations of ADHD considered that this disorder was composed of a unique factor regrouping inattention, impulsivity and hyperactivity symptoms, recent research has

supported the validity of two distinct dimensions within this disorder (Bauermeister, Canino, Polanzick & Rohde, 2010, for a meta-analytic review). This bi-dimensional conceptualization proposed in the DSM-V assumes that the behavioral symptoms are organized in two dimensions: one relative to the inattention symptoms, and the other referring to a combination of the impulsivity and hyperactivity symptoms. According with the type of symptoms observed ADHD can be categorized in three specific sub-types. The Predominantly Inattentive subtype implies the presence of at least six symptoms referring to inattention. The Predominantly Hyperactive-Impulsive presupposes the presence of at least six symptoms related with hyperactivity and impulsivity. The Combined subtype comprises the presence of at least six symptoms from each of the two ADHD dimensions, i.e., inattention and hyperactivity/impulsivity. It is important to refer that the observation of at least six symptoms is only one of the required criteria to establish a formal diagnostic of ADHD. The diagnostic criteria formulated in the DSM-V clearly explicit that the symptoms should: have been present before the child is aged 7 years, have been observed for at least 6 months to a point that is disruptive and inappropriate for the child's developmental level; have been observed in at least two or more settings (e.g., at school [or work] and at home); and there must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

In what concerns CD, this disorder is characterized by persistent and repetitive patterns of aggressive and antisocial behavior, as well as difficulties to behave according to age-appropriate norms. The ODD is typified by recurrent patterns of irritability, hostility, defiant behavior and vindictiveness. As for ADHD, the formal diagnostics of CD and ODD comprises the fulfillment of five criteria established by the DSM-V (APA, 2013), namely: 1) for CD, three symptoms must have been observed for at least 12 months and, at least one of the symptoms, has persisted over the course of the last six months; for ODD, four or more symptoms should have been observed for a period of at least six months; 2) have been present before the child is aged 7 years 3) have been observed for at least 6 months to a point that is disruptive and inappropriate for the child's developmental level; 4) have been observed in at least two or more settings; and 5) there must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

The categorical approach assumed by the DSM-V (APA, 2013) conceptualizes that a formal diagnosis is only established when a set of diagnostic criteria defined for a specific disorder is fulfilled. An individual is only considered to belong to a specific category of behavioral problems if the number of symptoms observed is equal or superior to the cut-off point previously defined as inclusion criteria of the respective behavioral category. However, the applicability of these diagnostic categories to preschool children remains debatable. First, the preschool period is characterized by successive fluctuations and changes regarding children's development and behavior. Children's behavior is relatively instable in the preschool period and, thus, a symptom characteristic of a specific disorder might represent a transient and normative behavior of the child's development, as opposed to a clinically relevant symptom. Second, children might manifest some symptoms characteristic of a specific disorder without fulfilling the totality of the diagnostic criteria established for that disorder. For these reasons, researchers usually adopt a dimensional approach of behavioral problems during the preschool period (Dellatolas, Watier, Giannopulu & Chevrie-Muller, 2007; Spira & Fischel, 2005, for a review). This approach involves summing up or creating an average of the symptoms manifested by an individual in order to obtain a measure of the intensity of a specific behavioral dimension. Although the dimensional approach is based frequently on the symptoms described in the DSM-V in order to define the distinct behavioral dimensions of externalizing problems (Willcutt et al., 2007), it allows analyzing distinct dimensions of behavioral problems without the need of establishing a formal diagnosis of a specific disorder.

The present work used a dimensional approach to behavioral problems by grouping the symptoms characteristics of a specific disorder into the same behavioral dimension. This allowed us to generate four dimensions of behavioral problems, namely *Inattention*, *Hyperactivity*, *Conduct problems* and *Unsociability*. The inattention dimension regrouped the symptoms pertaining to children's inattentive behavior, while the Hyperactive dimension comprised symptoms relative to children's hyperactivity and impulsivity. For Conduct problems we summed the symptoms referring to antisocial behavior and for Unsociability the symptoms related with children's oppositional behavior. These four dimensions of Inattention, Hyperactivity, Conduct problems and Unsociability aimed to reflect the categorical approach proposed by the DSM-V (APA, 2013), in particular the ADHD Predominantly Inattentive subtype, the ADHD Predominantly Hyperactive-Impulsive subtype, the CD and the ODD, respectively.

The conclusions presented by Hinshaw (1992) regarding the association between academic underachievement and behavior problems during early and middle childhood have been supported by numerous longitudinal studies, that have demonstrated a link between early behavior problems and academic underachievement from kindergarten to elementary school (Al Otaiba & Fuchs, 2006; Bub, McCartney & Willet, 2007; Dally, 2006; Hinshaw, 1992, for a review; Rabiner & Coie, 2000; Trzesniewski, Moffit, Caspi, Taylor, & Maughan, 2006; Vaughn, Zaragoza, Hogan & Walker, 1993).

We describe below the above-mentioned studies that focused in the association of behavior problems with reading and academic achievement during elementary school. These studies generally adopted a categorical approach to behavioral problems and have evidenced a specific pattern of relations between reading difficulties and behavioral problems. Subsequently, we present the studies performed during the preschool period that examined the association between emergent literacy skills and behavioral problems. These studies often adopted a dimensional approach to behavioral problems and extended previous research conducted into elementary school by demonstrating that the association between behavior problems and academic achievement is present during the preschool period.

During elementary school, children diagnosed with RD are at increased risk of manifesting co-morbid attention-deficit and disruptive disorders, namely ADHD, both the Predominantly Inattentive and the Predominantly Hyperactive-Impulsive subtype, CD and ODD (Hinshaw, 1992; Angold, Costello & Erkanli, 1999, for a review). However, scientific evidence sustaining that the comorbidity between RD, ADHD and CD is superior than what should be expected by chance, remains controversial. Several authors have advanced the argument that the recurrent co-occurrence of RD, ADHD and CD is largely attributable to common factors shared by these three diagnostic entities. Indeed, several studies have presented evidence that RD and CD were unrelated except by their common correlation with the attention deficits reported in ADHD (Rapport, Scanlan & Denney, 1999; Carroll, Maughan, Goodman & Meltzer, 2004; Maughan, Pickles, Hagell, Rutter & Yule, 1996; Willcutt & Pennington, 2000b). When the authors controlled for the effects of the inattentive factor of ADHD, the association between RD and CD was no longer significant. These results led the authors to conclude that the co-occurrence between RD and CD was attributed to the associations of both these disorders with ADHD.

However, more recently, the results obtained by Trzesniewski and colleagues (2006) questioned the above-mentioned results. In their study, the authors presented evidence that children classified with a research diagnosis of CD (based on maternal and teachers reports of the symptoms described in the DSM) at age 5 was negatively associated with reading underachievement at age 5, and predicted this same measure at age 7. Importantly, the results evidenced that these associations remained stable even after controlling of the effects of comorbid ADHD. These authors concluded that, although CD and ADHD were significantly correlated in preschool, they influenced independently children's later reading achievement during elementary school. These findings resemble the results obtained in several studies documenting that, although children's inattentive behavior contributes the most to later academic underachievement, disruptive and prosocial behaviors also exert a significant influence on children's subsequent educational attainment (Konold & Pianta, 2005; Pagani et al., 2008; Romano et al., 2010; Vitaro, Brendgen, Larose & Tremblay, 2005).

In the same vein, despite the well documented association between ADHD and reading problems (Merrell & Tymms, 2001; Hinshaw, 1992), a increasing body of research with school-aged children have presented evidence of the differential roles that the Inattentive subtype and the Hyperactive-impulsive subtype play on the development of reading difficulties. Despite both subtypes are concurrently associated with reading difficulties during elementary school, it is the inattentive subtype of ADHD that correlates more strongly and consistently with reading difficulties, when compared with the hyperactive-impulsive subtype (Dally, 2006; McGee, Prior, Williams, Smart & Sanson, 2002; Rabiner & Coie, 2000; Weiler, Bernstein, Bellinger & Waber, 2000; Willcutt & Pennington, 2000a). As suggested by Willcutt and Pennington (2000a), these findings advance the hypothesis that it is the inattentive behaviors of ADHD, but not the hyperactive-impulsive behaviors, that sustain the frequent comorbidity between reading difficulties and ADHD. Importantly, several longitudinal studies have presented evidence that inattentive behavior during kindergarten predicted reading achievement by the end of elementary school (Duncan et al., 2007; Rabiner & Coie, 2000), and that inattention reported at elementary school significantly predicted long-term educational attainment at age 22-23 (Pingault et al., 2011).

In France, existing literature has revealed similar patterns concerning the association between behavior problems and reading difficulties. Inattention symptoms reported by the teacher, but

not hyperactivity-impulsivity or conduct problems, were significantly related with early reading skills in preschool children (Dellatolas et al., 2007; Giannopulu, Escolano, Cusin, Citeau & Dellatolas, 2008), and predicted reading achievement on measures of word identification and reading comprehension during elementary school (Billard et al., 2010; Giannopulu et al., 2008).

Despite the extensive body of longitudinal research documenting the significant association between academic underachievement and behavior problems, longitudinal studies that examine the influence of separate dimensions of behavioral problems on children's cognitive-academic skills at kindergarten and on their subsequent academic achievement are needed. The evidence presented in several studies regarding the predictive value of distinct dimensions of behavior problems, other than inattentive behavior, on reading acquisition and academic achievement (Bracken & Fischel, 2007; Spira et al., 2005; Trzesniewski et al., 2006) underlines the importance of analyzing the influence of separate behavioral dimensions on children's academic achievement from kindergarten onwards.

Moreover, the analysis of the specific association between children's emergent literacy skills and behavioral problems during the preschool period remains an understudied field of research (Doctoroff, Greer & Arnold, 2006), when compared with the extensive body of literature that has confirmed the unequivocal relation between behavior problems and academic achievement during elementary school (Hinshaw, 1992, for a review). Nevertheless, some studies developed during kindergarten have been performed and point to the presence of the association between behavior problems and early academic achievement before school entry.

The cross-sectional study conducted by Velting and Whitehurst (1997) aimed at examining the association between emergent literacy skills and behavior problems in preschool children. The results indicated that children's emergent literacy skills were significantly correlated with the Inattentive and the Hyperactive-Impulsive dimensions of ADHD. However, none of these dimensions predicted significantly children's performances in the tasks evaluating emergent literacy skills. However, more recently, Spira and Fischel (2005), in an extensive review of the literature subordinated to the impact of preschool inattention, hyperactivity and impulsivity on children's academic development, have underlined some limitations of the



previous study. According to Spira & Fischel (2005), the assessment instrument used to evaluate the inattentive and the hyperactive-impulsive symptoms was mainly composed of items referring to hyperactivity and impulsivity symptoms. The same argument was advanced by Lonigan and colleagues (1999), who stated that an instrument assessing mainly hyperactivity and impulsivity symptoms might have compromised the emergence of significant results regarding the predictive power of the Inattention and the Hyperactive-impulsive subtypes.

In order to overcome some of the methodological limitations observed in Velting and Whitehurst's study (1997), Lonigan and colleagues (1999) conducted a study aimed at examining the concurrent associations during preschool between children's emergent literacy skills and behavior problems. The results indicated that children exhibiting higher levels of inattention, hyperactivity-impulsivity and conduct problems obtained lower performances in tasks evaluating emergent literacy skills. However, when the authors examined the power of the three behavioral dimensions to predict children's emergent literacy skills, only the Inattentive dimension contributed significantly to explain the proportion of variance of children's literacy skills. It is important to denote that these results were obtained while controlling for the simultaneous effects of the hyperactive-impulsive and the conduct problems dimensions, as well as cognitive ability (IQ). More recently, Walcott, Scheemaker and Bielski (2010) have extended these results by presenting evidence that teacher's reported inattention symptoms at age four significantly predicted children's performance in tasks evaluating emergent literacy skills (letter knowledge, phonological awareness) one year later. Importantly, these results were obtained even after controlling for the effects of oral language and the developmental levels of children's literacy skills when they were aged 4 years.

Likewise, the longitudinal study developed by Spira, Bracken and Fischel (2005) evidenced that children's emergent literacy skills and behavior (hyperactivity and classroom behavior) during preschool constituted predictive factors of their performance in measures of word decoding and reading comprehension at the end of elementary school. These results also revealed that emergent literacy and behavioral skills contributed significantly to the individual differences observed in children's reading level at the end of elementary school. The children who evidenced lower performances on the tasks assessing emergent literacy skills and behavior at the beginning of elementary school were overrepresented in the group of children

manifesting significant reading difficulties at the end of elementary school. According with the authors, the implications of these findings are noteworthy at several levels: emergent literacy and behavioral skills in preschool are robust predictors of children's reading achievement at the end of elementary school; these skills, together with children's behavior, contribute to the improvement and progress of reading ability during elementary school and constitute promotive factors of reading acquisition for children exhibiting inadequate levels of emergent literacy skills during preschool; reading acquisition is highly influenced both by emergent literacy skills and behavior during preschool and remains relatively stable from the second grade onwards (Spira et al., 2005).

The scientific evidence reporting the associations between behavior problems and emergent literacy skills during the preschool period derive mainly from international studies developed in English-speaking countries. The analyses of these associations remain relatively unexplored in France, although few studies have described a similar pattern of relations between emergent literacy skills and children's behavior. The study realized by Giannopulu and colleagues (2008) with a sample of preschoolers aimed at examining the relations between children's behavior and their performance on several tasks evaluating oral language and emergent literacy skills. In addition, these authors sought to analyze the influence of behavior problems during preschool on children's subsequent performance on measures of word-reading and text comprehension during the first year of elementary school. Behavior problems were assessed through questionnaires addressed to teachers and comprised the evaluation of several behavioral dimensions, namely hyperactivity, inattention, conduct problems and unsociability. Children's oral language and emergent literacy skills were evaluated through measures of vocabulary, phonological awareness and letter knowledge during preschool, among other cognitive tasks associated with reading development. The results indicated that, among the behavioral dimensions, children's inattentive behavior contributed robustly to predict children's emergent literacy skills in preschool. The unsociability dimension also contributed to predict children's emergent literacy skills, although the proportion of its effects was significantly lower when compared with the inattention dimension. Neither the dimensions of hyperactivity and conduct problems exhibited statistically significant predictive power of children's performances in the measures of emergent literacy skills. These results are similar to the ones obtained by Billard and colleagues (2010), who indicated that inattention symptoms reported by the teacher in

kindergarten, but not hyperactivity-impulsivity or conduct problems, predicted subsequent reading achievement measured through word identification and reading comprehension tasks during elementary school.

Taken together, a large body of scientific studies performed during preschool has documented the associations between emergent literacy skills and behavioral problems before the beginning of elementary school (Doctoroff et al., 2006; Giannopulu et al., 2008; Lonigan et al., 1999; Velting & Whitehurst, 1997). The conclusions derived from this group of works suggest that children exhibiting lower performances on measures of emergent literacy skills tend to present concurrent higher levels of symptoms referring to behavior problems. Further extending these conclusions, a large body of longitudinal research initiated during the preschool period has documented that this negative correlation tends to persist during elementary school and contributes significantly to the development of subsequent reading difficulties (Al Otaiba & Fuchs, 2006; Dally, 2006; Hinshaw, 1992, for a review; Merrel & Tymms, 2001; Rabiner & Coie, 2000; Trzesniewski et al., 2006; Vaughn et al., 1993).

However, the variety of methodological approaches and the procedures used to operationalize the constructs referring to emergent literacy skills and behavior problems have contributed to limit the clarity of the findings regarding the association between emergent literacy skills and behavior problems during the preschool period. For instance, the results regarding the association between distinct behavioral dimensions and children's emergent literacy skills remain controversial. Although it is commonly accepted in the scientific literature that the distinct dimensions of behavior problems are significantly associated with emergent literacy skills during preschool, some authors suggest that it is the inattention dimension of ADHD that is uniquely and robustly associated with children's emergent literacy skills (Spira & Fischel, 2005, for a review; Lonigan et al., 1999; Giannopulu et al., 2008; Merrel & Tymms, 2001; Rabiner & Coie, 2000). However, some researchers have underlined the significant associations between emergent literacy skills and children's behaviors characteristics of hyperactivity, conduct problems and unsociability and concluded that their impact on reading development should not be neglected with respect to the influence of children's inattentive behavior (Doctoroff et al., 2006; Spira et al., 2005; Trzesniewski et al., 2006).

Taking into account the considerable influence of emergent literacy skills and behavioral problems on children's subsequent reading achievement during elementary school, studies examining the relations between emergent literacy skills and behavior problems during the preschool period are needed. However, as noticed by La Paro and Pianta (2000), the analysis of the simultaneous effects of children's behavioral characteristics and cognitive-academic skills at school entry contribute to explain a moderate proportion of children's subsequent academic achievement. The authors concluded that the analysis of the factors influencing later academic achievement should consider the influence of children's contextual environments, such as families, schools and communities. These conclusions are in line with the broadened framework proposed by Rimm-Kaufman and Pianta (2000). Explanatory models of academic achievement based primarily on child-level factors, such as the one proposed in Duncan and colleagues work (2007), might account for only a reduced proportion of the explained variance of children's later achievement (Rimm-Kaufman & Pianta, 2000). Therefore, the study of the factors that influence children's subsequent academic achievement should take into account the impact of child-level characteristics, such as children's cognitive-academic skills and socio-emotional behavior, as well as the characteristics of the environmental contexts where these factors emerge and develop, such as family background factors.

## Family-level factors and academic achievement

In addition to the powerful influence that cognitive-academic skills and behavior problems have on children's ability to learn to read and to perform successfully in school, the scientific literature has described recurrently the considerable effects that family background factors exert on reading development and academic achievement (Boyle, Georgiades, Racine & Mustard, 2007; Bradley & Corwyn, 2002; Caille & Rosenwald, 2006; McLoyd, 1998; NICHD, 2005; Sirin, 2005). The study reported here focuses on a selected group of family-related characteristics described as robust predictors of children's later achievement. These include parental education level, family situation and size, type of early childcare, parental immigrant status, family history of reading difficulties and language-based bedtime routines.

Among the gamut of family-related factors documented in the literature as robust correlates of reading and academic achievement, *parental educational level* is consistently described as among the most important family-related predictors of reading acquisition during elementary school (Billard et al., 2008; Bowey, 1995; Burchinal et al., 2002; Myrberg & Rosén, 2009) and of subsequent educational achievement in adolescence and young adulthood (Campbell & Ramey, 1994; Entwisle et al., 2005; Magnuson, 2007; Pagani et al., 2008). Low parental educational level is frequently included as an indicator of environmental risk in studies aimed at identifying the lasting effects of early risk factors on children's later achievement (Gutman et al., 2003; Pungello et al., 2010; Sameroff, Seifer, Baldwin & Baldwin, 1993; Schoon et al., 2002). For instance, the study conducted by Hecht and colleagues (2000) revealed that parental socioeconomic status (SES), a measure pertaining to parents' income and educational level, influenced children's reading development from preschool onwards and that this influence contributed to the individual differences observed in children's emergent literacy skills at preschool. Children's whose families were characterized by a low SES and, consequently, a low level of parental education, manifested consistently lower performances on measures of emergent literacy skills, namely phonological awareness and letter knowledge. Importantly, the individual differences observed in children's emergent literacy skills at preschool, as a result of the effects of SES, were predictive of children's performances in word-reading and text comprehension tasks performed at the end of elementary school. Adding to literature describing the primordial role played by parental educational level on children's academic achievement, Magnuson (2007) presented evidence that increases in the educational level of the parents with low levels of education (i.e. mothers

completing additional schooling) contributed to predict the improvements of their children's performances on measures of academic achievement during preschool, when compared with children whose parental educational level remained unchangeable. As suggested by the authors, the effects of parental education on children's academic achievement is likely attributable to its benefits to parenting, economic status and quality of the home environment.

Other the influence of parental educational level on children's development of emergent literacy skills and early achievement at preschool, the results reported by Lonigan and colleagues (1999) indicated that parental SES, which contemplated parental educational level, influenced the relations between children's emergent literacy skills and behavioral problems during the preschool period. These authors demonstrated that the strength of the association between emergent literacy skills and behavior problems was significantly smaller in children whose families were characterized by a low SES, when compared with children from high SES. The authors advanced the hypothesis that the significant correlation between low SES and children's lower performances on measures of emergent literacy skills contributed to diminish the association between emergent literacy skills and behavior problems. Thus, the lower performances on emergent literacy tasks evidenced by children from low SES were more related with family background factors than with behavior problems. Conversely, the strength of the association between emergent literacy skills and behavioral problems was larger for children from high SES. As suggested by the authors, the lower performances on measures of emergent literacy manifested by children from high SES might be more strongly associated with the co-occurrence of behavior problems in the preschool period than with family background factors. Such findings highlight the necessity to investigate simultaneously the contributions of child-level factors and family-related characteristics to children's subsequent academic achievement. For instance, the consideration and inclusion of family-related factors, such as family SES and parent's educational level, as correlates of both emergent literacy and behavior problems allows examining the unique and independent effects of behavioral problems on children's emergent literacy skills while controlling for the effects of family-related factors.

In addition to parental educational level, a large body of literature has reported the impact of *family situation* and *family size* on children's subsequent achievement. Family status is generally conceptualized in scientific research as intact families compared with other familial

situations (e.g. single parent families, absence of a resident partner). Family size refers the number of sisters and brothers present in the household. Both these measures of family structure have been shown to be associated with children's academic achievement and, importantly, they represent often cited risk factors used in studies examining the environmental risks associated with children's academic underachievement. As an example, several longitudinal studies have presented evidence that children from non-intact families (children not living with both parents) and a larger family size act as risk factors that carry a negative impact on children's later academic achievement from kindergarten to elementary and middle school (Cadima, McWilliam & Leal, 2010; Gutman et al., 2003; Pagani et al., 2008; Pungello et al., 2010; Reynolds, Suh-Ruu & Topitzes, 2004; Vandell et al., 2010).

Another family-related characteristic described in the scientific literature as a strong predictor of children's achievement from kindergarten onwards refers to the *type of early childcare* provided to children during infancy. Type of early childcare can be categorized as informal maternal care, i.e. early child care provided exclusively by the mother, as opposed to formal non-maternal childcare (Côté, Geoffroy, Borge, Rutter & Tremblay, 2008). There is increasing evidence that children's early attendance in formal childcare settings contributes to better school readiness skills in kindergarten, compared with children that were not enrolled in formal childcare (Geoffroy et al., 2010; Côté et al., 2013). Indeed, experimental studies have evidenced that the gains of participating in early intervention programs tend to be maintained during elementary school and to translate into lasting educational and occupational benefits in young adulthood (Campbell et al., 2001; Pungello et al., 2010; Reynolds et al., 2004; Vandell et al., 2010).

Other the well-established influence of the above mentioned familial factors on children's development, an increasing body of literature has focused on understudied familial factors that have the potential to influence children's subsequent academic achievement.

The impact of *family immigrant status*, defined in contemporary research as families in which at least one of the parents' was born outside the country of residence, on children' later achievement is a topic of increasing relevance in current scientific research, as illustrated by Child Development's Special Section dedicated to children from immigrant families. In Crosnoe and Fuligni's (2012) overview of this special issue, the authors underline the

immigrant paradox instigated by competing evidence from the scientific literature, which have reported both vulnerable (Vaquera & Hao, 2012) and successful (Hao & Woo, 2012) trajectories for children from diverse immigrant backgrounds. However, as pointed by Crosnoe and Turley (2011), much of the research on the influence of immigrant families is done during adolescence, and the impact of family immigrant status on children's early school readiness and later academic achievement remains understudied.

Additionally, a recent study of Hale, Berger, Lebourgeois and Brooks-Gunn (2011) has shed some light over the impact of *language-based bedtime routines* in children's cognitive outcomes from preschool to kindergarten. Interestingly, the results indicated a positive association between the presence of language-based bedtime routines at age 3 and children's performance on cognitive subtests at kindergarten, over and above the effects of child, caregiver and household characteristics. The authors concluded that the magnitude of the effects of the language-based routines on children's cognitive development were 50% larger than the average effects of a year of Head Start for a 4-year-old. However, the findings presented by the authors were obtained with a sample of disadvantaged children and were restricted to the preschool/kindergarten period. Whether the influence of language-based bedtime routines on cognitive development is present in the general population and whether its effects are reflected in children's subsequent academic achievement represent two lines of inquiry explored in the present study.

At last, longitudinal research has highlighted the importance of considering children's *familial antecedents of reading difficulties* as a significant correlate of children's subsequent reading development and academic achievement. Two longitudinal studies initiated during the preschool period have examined the contribution of familial and reading-related factors, including measures of emergent literacy skills, to the prediction of children's reading difficulties during elementary school (Puolakanaho et al., 2007; Snowling, Gallagher & Frith, 2003). The results obtained in these studies indicated that children's difficulties in learning to read are highly familial and have put forward the notion of a familial risk of children manifesting reading difficulties later in elementary school, which is conventionally conceptualized as the presence of a history of reading difficulties in the child's family. It is important to denote that, despite the notion of familial risk commonly refers to the presence of a RD diagnostic on the child's nuclear family (as conceptualized by Snowling et al., 2003),



Puolakanaho and colleagues' (2007) operational definition of this construct implied a parental diagnosis of RD together with an history of reading difficulties in the family of the progenitor diagnosed with RD. Despite these different conceptualizations of familial antecedents of reading difficulties, the results of both studies were similar and demonstrated that the percentage of diagnosis of RD or reports of reading difficulties during elementary school was significantly higher in children manifesting familial antecedents of reading difficulties, when compared with children without this familial risk (Puolakanaho et al., 2007; Snowling et al., 2003). Importantly, the results indicated that the influence of familial antecedents of reading difficulties was exerted early in the preschool period, manifested through children's below-average performances on measures of oral language and emergent literacy skills (phonological awareness and letter knowledge), and predicted children's subsequent reading achievement during elementary school. The conclusions presented by the authors highlighted the pertinence of including information relative to children's family history of reading difficulties on screening procedures aimed to identify preschoolers that might be at risk of developing subsequent reading difficulties. The authors reinforced that the inclusion of this information, together with direct observations of children's oral language, letter knowledge and phonological awareness during preschool, increased significantly the probability of accurately detecting a children at risk of developing RD or significant reading difficulties during elementary school (Puolakanaho et al., 2007; Snowling et al., 2003). In addition, Snowling, Muter and Carrol (2007) extended these findings by demonstrating that children presenting a familial history of reading difficulties obtained poorer achievement scores at age 14 in literacy and language measures.

Of particular interest for the work here presented are the results of the study conducted by Doyen and colleagues (2004) which extend the above-mentioned findings. These authors demonstrated that a parsimonious screening procedure of familial antecedents of reading difficulties in preschool children was simultaneously associated with measures of emergent literacy skills and attention problems reported by the teachers. Despite the cross-sectional nature of this study, these results suggested that children where at least one of the elements of the nuclear family reported difficulties in learning to read during their development tended to exhibit lower performances on measures of emergent literacy skills and a higher proportion of inattention symptoms during the preschool period.

These results concur with the findings presented by Willcutt and colleagues (2007) regarding the etiology of the association between emergent literacy skills and ADHD symptoms in a sample of twins enrolled in preschool. The rationale underlying the studies performed with twin populations postulates that the comparison of pairs of monozygotic twins (who share all of their genes) and fraternal twins (who share half of their genes on average) allows to estimate the extent to which a particular trait is due to genetic or environmental influences. The results indicated that the correlation between the inattention symptoms of ADHD and emergent literacy measures, such as phonological awareness, letter knowledge and vocabulary, was significantly superior in monozygotic twins when compared with fraternal twins. Conversely, the correlations observed between the hyperactive-impulsive symptoms of ADHD and emergent literacy skills failed to reach statistical significance both in the monozygotic and fraternal twins. The authors concluded that the significant correlation between the inattention symptoms and emergent literacy skills was largely attributable to common genetic influences and, as mentioned previously, it is the inattention dimension of ADHD that relates the most with emergent literacy skills.

These findings align well with the results obtained in several studies examining the influence of familial factors in the co-occurrence between RD and ADHD (Pennington et al., 2009, for a review). Similar to the methodology employed in twin studies, family studies presuppose that if a disorder occurs more frequently within the family of an individual diagnosed with that specific disorder, when compared with families of individuals without the same disorder, then family factors play a role in the increased percentage of occurrence of the disorder. The study developed by Friedman, Chhabildas, Budhiraja, Willcutt and Pennington (2003) supported the argument regarding the familial nature of RD and ADHD by demonstrating that the co-occurrence of these disorders in elementary school is influenced by shared familial factors common to both RD and ADHD. Indeed, school children whose parents reported having been diagnosed with RD earlier in their developmental history presented a significantly higher percentage of symptoms characteristics of ADHD, when compared with children whose parents did not report a history of RD. Similarly, children whose parents indicated a diagnosis of ADHD during their developmental history tended to present a higher percentage of deficits associated with RD, when compared with children whose parents did not report a history of ADHD. The results reinforce the previous findings reporting the

familial nature of RD and ADHD and suggest that the frequent co-occurrence observed between these two disorders is attributable to shared familial factors (Friedman et al., 2003).

The results issued from genetic and familial studies document that the relation between early difficulties in learning to read, characterized by inadequate levels of emergent literacy skills and inattention symptoms typically associated with ADHD, has its onset during preschool, tends to persist into elementary school and is largely attributable to genetic and familial factors common to both reading and attention, which contribute to their frequent comorbidity. However, the findings relative to familial and genetic influences in the frequent co-occurrence observed between early emergent literacy skills and attentive behavior have been obtained in samples derived from specific populations and, thus, limit the generalizability of these results to the general population. Therefore, as suggested by Hinshaw (1992), the present study aimed at examining the role of familial antecedents of reading acquisition as a background variable implied in the co-occurrence between reading achievement and behavior problems, specifically inattentive behavior. Moreover, the impact of familial antecedents of reading difficulties on children's subsequent reading performance and academic achievement at the end of middle school remains to be explored in non-diagnosed samples of typically developing children.

In conclusion, the scientific literature reviewed for the present work emphasizes that a specific set of children's cognitive-academic and behavioral skills before school entry constitute robust predictors of children's subsequent academic trajectories in elementary and middle school. Likewise, academic achievement is strongly influenced by family-related characteristics that exert their influence early in children's educational trajectories. Notwithstanding the well-documented role that specific child- and family-level factors play on children's academic achievement, some lines of inquiry regarding the influence of cognitive-academic ability, behavior skills and family characteristics on children's later academic achievement remain open and have several implications for the work here reported.

## Concluding research questions

A first issue derived from the revision of the scientific literature is related with the scarcity of studies developed in France that examined the longitudinal contributions of child- and family-level factors to children's subsequent academic achievement at the end of elementary and middle school. Despite the comprehensive studies indicating the relevant role of children's oral language, emergent literacy skills and attentive behavior to their subsequent academic achievement, these studies have been performed mainly in English-speaking countries. Hence, the present study aims to contribute to the extant literature regarding the long-term contribution of children's cognitive-academic and behavioral skills to later academic achievement in a sample of typically developing French-speaking children.

In what concerns the child-level factors associated with later academic achievement, the extant literature has underlined that the associations between cognitive-academic skills and behavioral problems occurs early in development during the preschool period. However, some of the findings reported previously referring to the preschool period and to the predictive power of behavioral problems on later reading and academic achievement remain debatable. For instance, despite empirical evidence that it is the inattentive dimension of ADHD that relates the most robustly to children's individual differences on measures of emergent literacy skills during preschool (Velting & Whitehurst, 1997; Lonigan et al., 1999) and to later reading and academic achievement in elementary school (Duncan et al., 2007, for a review), several researchers have underlined that the impact of other behavioral dimensions, such as conduct problems and unsociability, should not be neglected (Doctoroff et al., 2006; Konold & Pianta, 2005; Pagani et al., 2008; Romano et al., 2010; Trzesniewski et al., 2006; Vitaro et al., 2005). These contradictory results incite a rigorous analysis of the pattern of associations between emergent literacy skills and distinct dimensions of behavioral problems from kindergarten to elementary school, which the present study seeks to clarify.

In what respect the effect of family background characteristics on children's subsequent academic achievement, it is widely accepted that children's academic achievement is largely influenced by family background (Bradley & Corwyn, 2002; McLoyd, 1998; Duncan & Brooks-Gunn, 2000), but it is not always clear if the effects of family background are mediated by cognitive-academic skills in kindergarten or whether they continue to have

lasting effects beyond their influence on children's cognitive-academic skills before school entry (Entwisle et al., 2005). The present study seeks to contribute to clarifying this issue.

Moreover, in the current work, a particular set of family-related characteristics with well-documented predictive power on children's later academic achievement (e.g. parental educational level, family structure) was selected together with understudied factors pertaining to family background (e.g. language-based bedtime routines, familial antecedents of reading difficulties). In the present study, we were interested in analyzing if these understudied family background measures add to the prediction of children's subsequent academic outcomes over and above the effects of well-documented predictors of later academic achievement referring to children's cognitive-academic skills and family-related characteristics.

Language-based bedtime routines in preschool have been shown to impact positively children's performances on cognitive-academic subtests later at kindergarten (Hale et al., 2011). However, its longitudinal effects on children's academic achievement beyond kindergarten remain unexplored. Hence, the present study sought to examine if the influence of language-based bedtime routines on cognitive-academic skills is present in the general population and whether its effects on children's academic achievement persist beyond kindergarten. In the present study it is hypothesized that this measure is not exclusively dependent of the families but is also subordinated to children's attributes and characteristics; children might play an active role in the establishment of these language-based bedtime routines

Another line of enquiry refers to the association of familial antecedents of reading difficulties with later academic achievement. Empirical research has highlighted that the presence of familial antecedents of reading difficulties is associated with an increased risk of children manifesting lower scores in emergent literacy skills at kindergarten and with later reading difficulties in elementary (Puolakanaho et al., 2007; Snowling et al., 2003) and middle school (age 14 years, Snowling et al., 2007). Because these findings refer to samples derived from clinically-diagnosed populations, which limit the generalizability of the results to the general population, the present study aimed to examine this pattern of relations in a sample of typically developing children derived from a non-diagnosed and to extend the previous findings to the end of middle school (age 15 years).

Furthermore, extant studies have advanced the argument pertaining to the shared familiarity of reading difficulties and inattention problems from preschool to elementary school, i.e., children whose families are characterized by familial antecedents of reading difficulties tend to present concurrent reading difficulties and inattention problems in kindergarten (Doyen et al., 2004, Willcutt et al., 2007). However, these findings refer to the preschool period and the analyses of the association among familial antecedents of reading difficulties, cognitive-academic skills and behavior problems remains understudied during elementary school. The present study aims to fill this caveat by examining the longitudinal association of familial antecedents of reading difficulties with children's reading achievement and inattention problems at the end of elementary school in a sample drawn from the general population.

Taken all together, longitudinal studies initiating before school entry have the potential of identifying the critical domains of children's early cognitive-academic competence and behavior that influence their academic trajectories during elementary and middle school. Although previous research conducted in France have shed some light over the factors implied during reading development and academic achievement, longitudinal studies aimed to analyze the developmental precursors and correlates of reading acquisition and academic achievement are still required (National Institute of Health and Medical Research ("*Institut National de la Santé et de la Recherche Médicale*", [INSERM], 2007). The work here reported aimed to add to the extant literature by examining the contributions of cognitive-academic skills, behavior problems and family-related characteristics in kindergarten to children's reading achievement at the end of elementary school and general academic achievement at the end of middle school.

With this purpose in mind, the current work was based in a prospective longitudinal study developed in France that comprised the follow-up of four community-based cohorts of typically developing children enrolled in general education classrooms from preschool through different time points of their educational careers. Because this longitudinal study was contextualized within the French educational system and for purposes of clarification of the terminology employed in the present work, the following section describes the structure and the organization of the educational system in France.

## The French educational system

The longitudinal study from which the present work was drawn comprised the follow-up of the study's participants from preschool to elementary and middle school. Thus, we present briefly in this section the structure, curricular programs and national indicators of the French educational system pertaining to the preschool, elementary and middle school periods.

As decreed in the Code of Education, ratified by the law n° 2003-339 of 14 April 2003 (*Journal Officiel de la République Française (JORF)*, 2003), the access to public education in France is free and compulsory for children aged between six and 16 years. The schooling rate of the French population within this age range is significantly high and over 94% of children were enrolled in compulsory schooling between 2000 and 2011 (*Direction de l'Évaluation, de la prospective et de la performance (DEPP)*, 2013). Even though compulsory education can be delivered by several educational settings differentiated by their type of administration, such as public and private schools or even parental tuition, approximately 80% of the children are enrolled in schools of the public educational system (DEPP, 2013).

As presented in Figure 1, compulsory education in France comprises two levels of education: primary education and secondary education. Primary education is constituted by three cycles of studies, although the first cycle and kindergarten are not part of compulsory education. The first cycle corresponds to the two years of preschool and kindergarten (ages 3-4 to 5-6 years), the second cycle comprises kindergarten and the first two years of elementary school (ages 5-6 to 7-8), and the third cycle corresponds to the last three years of elementary school (ages 7-8 to 10-11 years). Secondary education comprises two cycles of studies: the first cycle is named “*collège*” (hereafter referred to as middle school) and corresponds to the first four years of secondary education (ages 11-12 to 14-15 years), and the second cycle, which is beyond the range of compulsory education, is entitled “*lycée*” (hereafter referred to high school) and comprises the last three years of secondary education (ages 15-16 to 17-18 years). A more detailed description of the grade levels and curricular objectives that compose each cycle of studies, as well as the organizational features of the educational settings at each level of education is provided subsequently.

Figure 1. Organization of the French Educational system

		<b>École maternelle</b> (3-6 years)	<b>Preschool</b>	<b>Ages</b>	
	1 <sup>st</sup> cycle	- Petite Section - Moyenne Section - Grande Section *	- Preschool Grade 1 - Preschool Grade 2 - Kindergarten	3-4 4-5 5-6	
	“Cycle des apprentissages premiers”				
	2 <sup>nd</sup> cycle	- Cours Primaire (CP)	- 1 <sup>st</sup> Grade	6-7	
	“Cycle des apprentissages premiers”		- Cours Élémentaire 1 (CE1)	- 2 <sup>nd</sup> Grade	7-8
	3 <sup>rd</sup> cycle	- Cours Élémentaire 2 (CE2)	- 3 <sup>rd</sup> Grade	8-9	
	“Cycle des approfondissements”		- Cours Moyen 1 (CM1)	- 4 <sup>th</sup> Grade	9-10
		- Cours Moyen 2 (CM2)	- 5 <sup>th</sup> Grade	10-11	
		<b>Collège</b> (11-15 years)	<b>Middle School</b>		
Secondary education	1 <sup>st</sup> cycle	- Sixième (6 <sup>ème</sup> ) - Cinquième (5 <sup>ème</sup> ) - Quatrième (4 <sup>ème</sup> ) - Troisième (3 <sup>ème</sup> )	- 6 <sup>th</sup> Grade - 7 <sup>th</sup> Grade - 8 <sup>th</sup> Grade - 9 <sup>th</sup> Grade	11-12 12-13 13-14 14-15	
	“Cycle d’adaptation”				
	“Cycle central”				
	“Cycle d’orientation”				
	2 <sup>nd</sup> cycle	- Seconde - Première - Terminale	- 10 <sup>th</sup> Grade - 11 <sup>th</sup> Grade - 12 <sup>th</sup> Grade	15-16 16-17 17-18	
		<b>Lycée</b> (15-18 ans)	<b>High school</b>		

Notes: \* Kindergarten is considered as a grade belonging both to the 1<sup>st</sup> and 2<sup>nd</sup> cycle of primary education.

## Preschool (“École Maternelle”)

In France, the Decree-Law n° 90-788 of 6 September 1990 (JORF, 1990) ratified the structure and objectives of the preschool period into three consecutive years of formal schooling. The first year of the preschool period (“*Petite Section de Maternelle*”, hereafter referred as Preschool - Grade 1) comprises children aged 3 to 4 years; the second year of preschool (“*Moyenne Section de Maternelle*”, hereafter referred to as Preschool - Grade 2) includes children aged 4 to 5 years; and the last year of preschool (*Grande Section de Maternelle*, hereafter referred to as kindergarten) integrates children aged 5 to 6 years. The curricular reforms implemented by the Department of National Education (JORF, 2002) redefined the main objectives of the national curriculum for the preschool period. At this stage, children’s activities are essentially focused in the development of five academic domains, specifically oral language (“*le langage au cœur des apprentissages*”), social competence (“*vivre*



*ensemble*”), corporal expression (“*agir et s’exprimer avec son corps*”), comprehension of the world (“*découvrir le monde*”) and sensibility, creativity and creation (“*la sensibilité, l’imagination et la création*”).

According to the 2010 census reported by the National Institute of Statistics and Economic Studies (“*Institut National de la Statistique et des Etudes Economiques*” (INSEE), available at [www.insee.fr](http://www.insee.fr)) enrollment rates in the preschool period were of 74% for the French population aged 3 to 5 years (INSEE, 2011f). Children are enrolled in preschool activities during a 24-hour weekly period, divided into five working days, and a full-day in preschool may not exceed five and a half hours. Between 1999 and 2011, preschool classes were constituted by an average of 26 children per class (DEPP, 2013) and the teacher-child ratio was of one to 22 in 2011 (Organization for Economic Co-operation and Development, (OECD), 2013). Even though the participation of children in the preschool period is optional and voluntary in France, a large majority of French children are enrolled in this period (DEPP, 2013), since it represents the first cycle of primary education (“*cycle des apprentissages premiers*”) in the French educational system. After this first cycle of primary education, children pursue a 5-year career into elementary school, which corresponds to the second and third cycles of primary education.

### Elementary school (“*École Élémentaire*”)

Elementary school comprises five grades and is directed to children aged from 6-7 to 10-11 years (Decree-Law n° 90-788 of 6 September 1990; JORF, 1990). This period corresponds to the beginning of compulsory school and is composed by the second and third cycle of primary education. The second cycle, “*cycle des apprentissages premiers*”, is constituted by kindergarten (non-compulsory) and the two first years of elementary school, the “*Cours Préparatoire*” and the “*Cours Élémentaire 1*” (hereafter referred to as Grade 1 and Grade 2, respectively). The third cycle of primary education, “*cycle des approfondissements*” corresponds to the last three years of elementary school and is constituted by the “*Cours Élémentaire 2*”, the “*Cours Moyen 1*” and the “*Cours Moyen 2*” (hereafter referred to as Grade 3, Grade 4 and Grade 5, respectively). The national curriculum implemented by the Department of National Education (JORF, 2002) defined six main academic domains to be developed by children during elementary school: French oral and written language (“*maitrise*

*de langage et de la langue française*”), Mathematics (“*mathématiques*”), civic education (“*vivre ensemble*”), comprehension of the world (“*découvrir le monde*”), artistic education (“*éducation artistique*”) and sports and physical education (“*éducation physique et sportive*”). From the first to the second cycle of elementary school, children are progressively introduced to more complex and specific subject matters, even though the main academic domains remain the same. As an example, French subject matter in the first two years emphasizes the development of children’s vocabulary, preliteracy skills and oral language, while in the last three years there is a strong focus on literacy and written language skills. The same is observed with the domain of comprehension of the world that, in the last three years of elementary school, ramifies into history, geography and experimental and technological science. In addition to the main academic domains described previously, the national curriculum in elementary school includes an introduction to basic concepts of information technology, foreign languages and road safety.

In France, the large majority of children are enrolled in the elementary school period (enrollment rates of 98.6% for children aged 6 to 10 years according to the 2010 census; INSEE, 2011f). The duration of the weekly activities during elementary school is delimited to 24 hours distributed through the five working days and a full day of activities must not exceed six hours. In elementary school, classes are normally constituted by an average of 22 children (figures reported between 1999 and 2011; DEPP, 2013) and the teacher-child ratio is of 1 to 18 (figures relative to 2011; OECD, 2013). Children are expected to complete elementary school in five years, when they’re aged 10-11 years, but up to 14% of children repeat at least one year (“*redoublement*”) in elementary school (statistics referring to the six-year span between 2005 and 2011; DEPP, 2013).

As defined in the Law n°89-486 of the 10 July 1989 (JORF, 1989), all children enrolled in elementary school are evaluated in French and Mathematics curricular subjects at the beginning of Grade 3 and of Grade 6. These evaluations are obligatory for all children and aim to evaluate student’s academic acquisitions in the aforementioned curricular subjects at the end of the second and third cycle of primary education. Importantly, these evaluations allow the educative community to obtain an indicator of the student’s level of academic acquisitions in order to provide adequate pedagogical measures adapted to their individual needs. More recently, the National Education Department modified the timing and grade level in which these national evaluations should be performed (Bulletin Officiel, 2007). Since the

2007-2008 school year, these national evaluations are performed at the end of Grade 2 and Grade 5, i.e., the final year of the second and third cycle of primary education, respectively. Independently of the timing in which these evaluations were performed, these national assessment procedures were composed of two global scores computed for French and for Mathematics curricular subjects. In addition, each of these global scores are subdivided in several sub-scores: Reading (“*Lecture*”), Writing (“*Écriture*”), Vocabulary (“*Vocabulaire*”), Orthography (“*Orthographe*”) and Grammar (“*Grammaire*”) constitute de French global score and Number Knowledge (“*Numérotation*”), Calculus (“*Calcul*”), Geometry (“*Géométrie*”), Measures and Sizes (“*Grandeurs et mesures*”) and Organization of numeric information (“*Organisation et gestion de données*”) compose de Mathematics global score.

### Middle school (“*Collège*”)

The decree-law n° 96-465 of the 29 May 1996 (JORF, 1996) defined the organization of the middle school period into four grades: the “*Sixième*”, the “*Cinquième*”, the “*Quatrième*” and the “*Troisième*” (hereafter referred to as Grade 6, Grade 7, Grade 8 and Grade 9, respectively), addressed to children aged from 11-12 to 14-15 years. This period is divided into three pedagogic cycles aimed to consolidate children’s acquisitions developed in elementary school (Grade 6 - “*Cycle d’adaptation*”), to enlarge and improve student’s knowledge and skills (Grade 7 and Grade 8, “*Cycle central*”), and to prepare children for the transition to high school (Grade 9, “*Cycle d’orientation*”).

The national curriculum of the middle school period, revised by the Law n° 2005-380 of the 23 April 2005 (JORF, 2005), is primarily oriented towards the development of seven domains of academic competence (“*socle commun de connaissances et de compétences*”), namely: proficiency in the use of French oral and written language (“*la maîtrise de la langue française*”), practice of a foreign language (“*la pratique d’une langue vivante étrangère*”), core concepts of mathematics, science and technology (“*les principaux éléments de mathématiques et de la culture scientifique et technologique*”), information technology (“*la maîtrise des techniques usuelles de l’information et de la communication*”), citizenship (“*la culture humaniste*”), social and civic skills (“*les compétences sociales et civiques*”) and autonomy and initiative (“*l’autonomie et l’initiative*”). According with the directives of the Department of National Education (JORF, 2002, 2004), these domains of competence are

operationalized through nine subject matters, specifically: French, Mathematics, Foreign language, History/Geography/Civic education, Natural and life sciences, Technology, Plastic arts, Musical education and Sports and physical education. Moreover, from Grade 5 onwards, Physics/Chemistry curricular subject and a second language (foreign or regional) other than the foreign living language already being taught from Grade 6 are added to the curriculum.

The reported enrollment rate of French juvenile population in middle school was of 99.1%, according with the 2010 census (INSEE, 2011f). The weekly duration of the middle school curricular activities is estimated to 28 hours divided into five working days, and a full-day in middle school must not exceed five and a half hours of enrollment in school activities. At this stage, classes are composed by an average of 24 children per class (DEPP, 2013) with a teacher-child ration of 1 to 12 (OECD, 2013). The theoretical duration of middle school completion is estimated to five years, when children are aged 14-15 years. However, retainment rates during middle school were of 5.8%, 2.9%, 4.9% and 5.6% in Grade 6, 7, 8 and 9, respectively (figures referring to the period between 2005 and 2011; DEPP, 2013).

Moreover, as established in the Code of Education and revised by the Decree Law n° 2007-921 of the 15 May 2007 (JORF, 2007), children are evaluated in Grade 9 in order to obtain a national diploma of middle school completion, the "*Diplôme National du Brevet*". Even though the admission in this national diploma is not required for a student to continue into high school, it nevertheless represents the most relevant indicator of mid-school academic achievement for the French Department of National Education, since it reflects the degree of overall proficiency in academic acquisitions and skills developed during compulsory schooling. This national diploma is granted by means of the computation of a global score based on 1) student's results in three written exams performed at the end of Grade 9 (French, Mathematics and Geography/History/Civic Education curricular subjects), 2) the student's overall performance at all curricular subjects during Grade 9 and 3) teacher's evaluation of student's ability on the seven abovementioned domains of academic competence, such as proficiency in French language, information and communication technology and social and civic skills, among others. This score is then categorized in an ordinal scale comprising the following levels of increasing achievement: Failed ("*Réfusé*"), Approved ("*Admis*"), Satisfactory ("*Admis - Assez Bien*"), Good ("*Admis - Bien*") and Very Good ("*Admis - Très Bien*"). The admission rates at this diploma are significantly high with percentages of admission over 75% from 2005 to 2011 (DEPP, 2012).



## II. The Creusot study

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In this section, we focus on the description of the longitudinal Creusot Montceau-les-Mines study (hereafter referred to as Creusot study) that allowed the realization of the present work. First, we present the sociodemographic indicators of the community where the Creusot study took place and we compare it with national statistics of the general population in France. Second, we describe briefly the circumstances that motivated the development of this longitudinal investigation. We finish this section by presenting the original objectives and methodology of the Creusot study.

The work here reported draws from the population-based longitudinal study developed in the Creusot Montceau-les-Mines urban community (*Communauté Urbaine Creusot Montceau*, CUCM), an inter-communal partnership established in 1970 among the communes belonging to the Saône-et-Loire department in the region of Bourgogne in eastern France ([www.lacommunaute.fr](http://www.lacommunaute.fr)). Presently, the CUCM comprises 27 communes organized around two main urban sites, *Le Creusot* and *Montceau-les-Mines*, which alone account for over than half of the total population of the urban community.

### The Creusot Montceau-les-Mines community: Sociodemographic indicators compared with the general population in France

According to the 2010 census reported by the INSEE, the population of the CUCM was composed of 90 326 inhabitants, with 15.4% of its population being composed of children aged 0 to 14 years. Table 1 presents the gender and age group distributions of the CUCM (INSEE, 2011a) and the French population in 2010 (INSEE, 2011b). As seen, the CUCM population presents a higher percentage of individuals aged 65 years or more and a lower percentage of individuals aged from 0 to 14 and from 15 to 64 years, when compared to national figures.

Table 1. Sociodemographic characteristics of the CUCM and France population in 2010

	CUCM	France
Total	<i>N</i> = 90 326	<i>N</i> = 64 612 940
Gender (Males)	47.9%	48.4%
0 to 14 years	15.4%	18.5%
15 to 64 years	60.8%	64.7%
65 or more years	23.8%	16.8%

*INSEE*

In what regards the indicators of family structure and size presented in Table 2, the CUCM community (INSEE, 2011c), when compared with national statistics (INSEE, 2011d), presents an higher percentage of families without children and is characterized not only by a smaller percentage of children in intact and single-parent families, but also by a smaller number of children per family.

Table 2. Family structure and size of CUCM and France population in 2010

	CUCM	France
Total families with children under 25 years	<i>N</i> = 25 992	<i>N</i> = 17 789 600
<i>Family structure</i>		
Couples with children	35.9%	43.4%
Single parent families	12.7%	14.4%
Children living with father	1.9%	2.3%
Children living with mother	10.8%	12.1%
Couples without children	51.4%	42.2%
<i>Family size</i>		
Absence of children	57.1%	47.8%
1 child	19.7%	22.4%
2 children	15.5%	20.2%
3 children	5.9%	7.2%
4 or more children	1.8%	2.3%

*INSEE*

Regarding the enrollment rates of children in educational institutions from preschool to college, the CUCM (INSEE, 2011e) is comparable to the general population in France (INSEE, 2011f) in preschool, elementary school, middle school and college. As seen in Table 3, although the percentage of children enrolled in preschool was superior in the CUCM when compared with the population in France (78.5% vs. 74.4%, respectively), this tendency tends to be inverted from elementary school onwards. However, the differences in the rate of attendance between the CUCM and the French population in elementary school, middle school and college are small (0.3%, 0.5% and 2.2%, respectively).

Table 3. Enrollment rates in preschool, elementary school and middle school of the CUCM and France population in 2010

	CUCM	France
Preschool (2 to 5 years)	78.5 %	74.4 %
Elementary school (6 to 10 years)	98.3 %	98.6 %
Middle school (11 to 14 years)	98.6 %	99.1 %
College (15 to 17 years)	93.9 %	96.1 %

*INSEE*

Table 4 presents the level of academic achievement, using as indicator the highest diploma achieved, of the CUCM community (INSEE, 2011e) and the French population (INSEE, 2011f). As seen, the highest diploma achieved tends to be relatively lower in the CUCM community compared with the national figures. The CUCM population presents a higher percentage of individuals in the lower categories of academic achievement, which range from the absence of a diploma to the completion of the first two years of the second cycle of secondary school (2 years, Grade 11). After this school level, the CUCM population presents a smaller percentage of individuals having completed high school (Grade 12) or having obtained a higher education diploma when compared with the national statistics. However, these differences should be interpreted taking into account the larger percentage of individuals with 65 or more years in the CUCM (cf. Table 1).



Table 4. Highest diploma achieved by the CUCM and France population in 2010

	CUCM	France
Total (persons over 15 years old)	<i>N</i> = 70 486	<i>N</i> = 46 819 860
Absence of diploma	22.9%	18.6%
Certificate of elementary studies	14.3%	10.5%
First cycle of secondary school [Grade 9]	5.9%	6.2%
Second cycle of secondary school (2 years) [Grade 11]	30.9%	23.8%
Second cycle of secondary school (3 years) [Grade 12]	12.5%	16.1%
Higher education diploma - Short duration	8%	12%
Higher education diploma - Long duration	5.5%	13%

*INSEE*

In the same sense, the social professional categories of the active population in the CUCM community (INSEE, 2011g) are characterized by lower levels of professional qualification when compared with national figures (INSEE, 2011h). As Table 5 depicts, the percentage of the CUCM community in manager and intellectual profession is lower than national data in France.

Table 5. Socio professional category and unemployment rate of the CUCM and France population in 2010

	CUCM	France
Total (persons over 15 years old)	<i>N</i> = 76 427	<i>N</i> = 52 650 120
Farmer	0.4%	0.9%
Craftsman, trades people, entrepreneurs	2.4%	3.3%
Manager and higher intellectual professions	3.6%	8.7%
Intermediate professions	11%	13.9%
Employees	15.1%	16.6%
Labor workers	15.5%	13.4%
Retired workers	34.4%	26.2%
Persons without professional activity	17.6%	16.9%
Unemployment rate (ages 15 to 64 years)	13.7%	12.1%

*INSEE*

The percentage of less qualified professions (labor workers, intermediate professions, craftsman, trades people, entrepreneurs and farmer) is comparable between the CUCM community and the national statistics, with the exception of a higher percentage of labor workers in the CUCM. In addition, the unemployment rate is slightly superior in the CUCM community compared with national figures, which aligns with the statistics reported by the INSEE (2008) regarding the important proportion of the population living in vulnerable conditions in the CUCM.

Overall, when compared with national figures, the CUCM community is characterized by a population with a higher percentage of elder individuals (65 years or more), lower levels of academic achievement and enrolled in socio-professional activities requiring fewer professional qualification. Overall, the CUCM community is constituted by a population from diverse socio-cultural and professional backgrounds and is representative of the general population typically found in suburban and rural regions in France.

### Initial objectives and methodology of the Creusot study

The Creusot Montceau-les-Mines study (Creusot study) is a longitudinal investigation initiated in 2001 as a result of the endeavors of the CUCM, the *Fédération des Œuvres Laïques* and the *Inspection Académique de Saône-et-Loire: Académie de Dijon*, i.e., the Saône-et-Loire division of the French Department of National Education (*Ministère de l'Education Nationale*). The Creusot study has benefited from the support of several institutions such as the *Mutuelle Générale de l'Education Nationale* (MGEN), the INSERM and the CUCM. In addition, this study took part in a report developed by the inter-ministry commission under the supervision of the *Direction Générale de la Santé* of the *Ministère des Affaires Sociales et de la Santé*, which aimed at evaluating the pertinence of several assessment instruments of language and reading development for screening and diagnosis purposes in the French population (Vallée & Dellatolas, 2005).

Throughout its duration, the Creusot study was made possible due to the synergetic partnership established among the CUCM (school administrators, teachers, parents and children), the *Inspection Académique de Saône-et-Loire* (Françoise Cusin, MD - study

coordinator, school doctors, nurses and administration staff) and the INSERM (researchers and psychologists), in which the latter ensured the scientific coordination and data analysis of the research project (Georges Dellatolas, MD, PhD - study coordinator). As required by ethical requirements, parents, teachers and school administrators provided informed consent in order to conduct the research, and confidentiality of collected data was assured by the study coordinators (Françoise Cusin, MD and Georges Dellatolas, MD, PhD).

The objectives of the Creusot study originated from the initiatives of Dr. Françoise Cusin, Dr. Monique Jacquier-Roux and Dr. Michel Zorman, counseling doctors of the *Inspection Académique de Saône-et-Loire*, who intended to extend previous research regarding the validation of screening instruments aimed to identify child- and environmental-level factors at preschool that could place children at risk of subsequent learning difficulties. This general objective was in line with the governmental plan implemented by the Ministry of Health and the Ministry of National Education regarding the screening and diagnosis of children with specific language and reading disorders (Rapport Ringard, 2000; Bulletin Officiel, 2002). The directives of this governmental plan emphasized the importance of an early identification of children with oral and reading difficulties during preschool through standardized assessment instruments, which could promote the prevention of specific language, reading and learning disabilities later in elementary school.

## Initial objectives

In accordance with the recommendations of the Ministry of Health and the Ministry of National Education, the Creusot study was aimed primarily at a) examining child- and environment-related factors in preschool associated with reading acquisition and academic achievement in later stages of schooling and b) providing added-value information that could complement screening and assessment instruments used in early childhood education. These objectives aimed to contribute to the anticipation and prevention of later reading difficulties and academic underachievement and the triggering of adequate educational interventions. More specifically, these general aims intended to scrutinize specific objectives, such as:

- Investigate the respective roles and the relations of child- and environmental-level factors with children's oral language, reading acquisition and academic achievement;
- Explore the association of behavioral problems reported by the teachers and parents (hyperactivity, inattention, conduct problems and unsociability) with learning difficulties, namely in what respects oral language and reading and writing acquisition;
- Assess the predictive value of preschool observations, such as oral language and behavioral difficulties, on children's later academic achievement, specifically reading difficulties, during the beginning of elementary school.

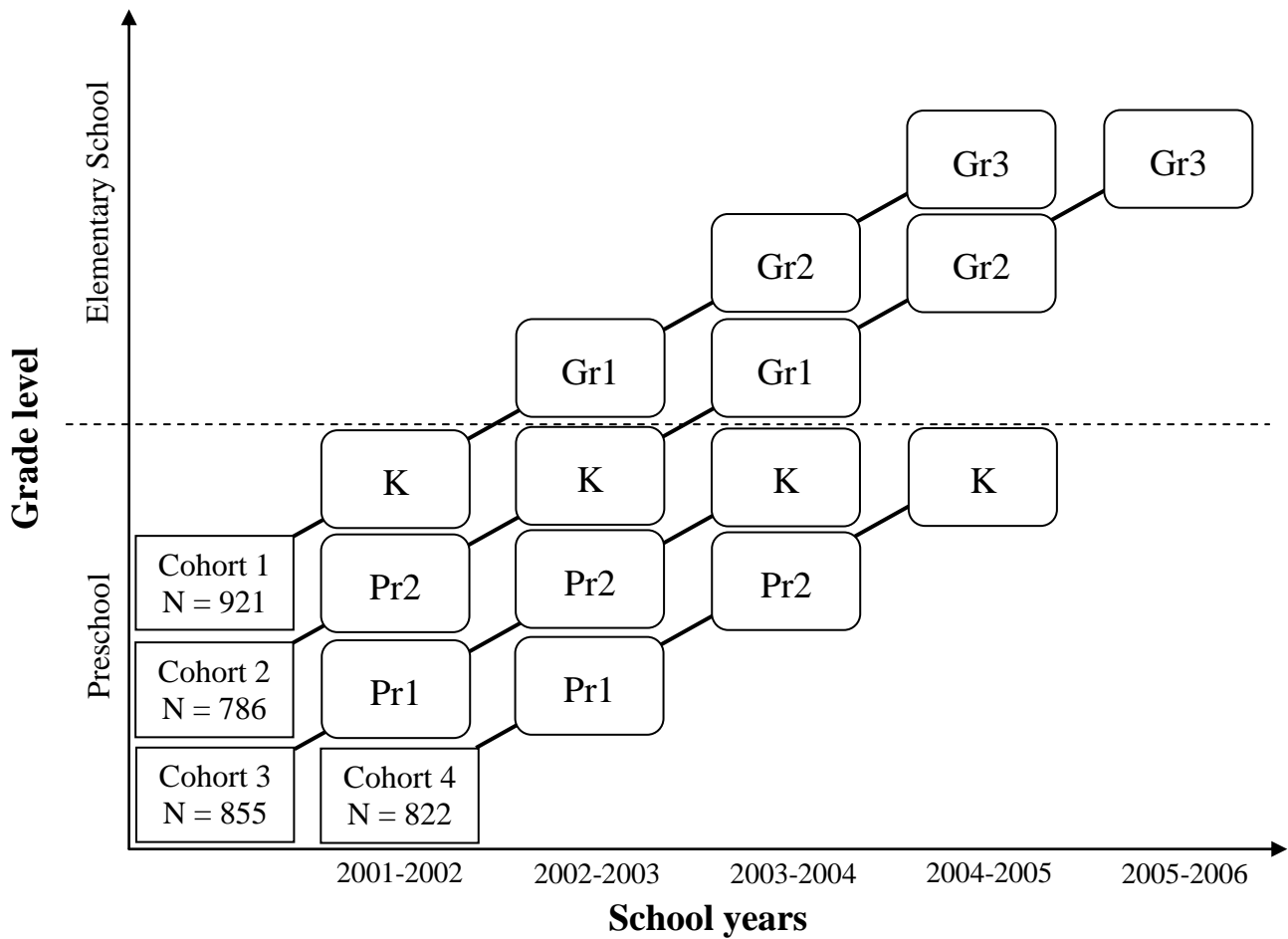
## Method (from 2001-2002 to 2005-2006)

### Participants

In order to achieve the abovementioned goals, the Creusot study adopted a prospective longitudinal methodology that comprised the screening of 90% of the children who attended the 48 preschools of the CUCM community (N=3300, approximately). Figure 2 displays the follow-up methodology and the number of participants enrolled in the study at preschool. As seen, four parallel cohorts of children were followed from preschool onwards. The cohorts 1, 2 and 3 were composed of children that were enrolled in Kindergarten (K), Preschool Grade 2 (Pr2) and Preschool Grade 1 (Pr1) in the 2001-2002 school year, respectively, and cohort 4 comprised children who attended Preschool Grade 1 in the 2002-2003 school year.

The methodological design of the Creusot study contemplated the follow up of Cohort 1 and 2 to the middle of elementary school (Grade 3, Gr3) and of Cohort 3 and 4 through kindergarten. Thus, Cohort 1 and cohort 2 were followed from kindergarten and Preschool Grade 2 (2001-2002 school year) through Grade 3 of elementary school (2004-2005 and 2005-2006 school years, respectively). The third and the fourth cohorts were followed from Preschool Grade 1 (2001-2002 school year) through kindergarten (2003-2004 and 2004-2005 school years, respectively). During the follow-up period estimated for each cohort in the study's initial methodology, data was collected at each school year from preschool to elementary school. Informed consent was obtained from parents and school administrators in order to proceed to data collection.

Figure 2. Follow-up methodology of the Creusot study from 2001-2002 to 2005-2006



Notes:

Preschool (*Maternelle*)

Pr1. Preschool Grade 1 (*Petite Section*)

Pr2. Preschool Grade 2 (*Moyenne Section*)

K. Kindergarten (*Grande Section*);

Elementary School (*Ecole Élémentaire*)

Gr1. Grade 1 (*Cours Primaire*)

Gr2. Grade 2 (*Cours Élémentaire 1*)

Gr3. Grade 3 (*Cours Élémentaire 2*)

## Measures

### Preschool

Table 6 presents the informants and the instruments used at each school year to assess the participants' cognitive-academic skills, oral language, behavioral attributes, as well sociodemographic and familial characteristics. The data pertaining to children's cognitive-academic skills, behavior and socio-familial characteristics was collected by means of standardized assessment instruments administered to children and questionnaires addressed to parents and teachers. All the data referring to the participant's academic achievement was collected retrospectively through consultation of each participant's school records.

In preschool, the assessment performed in the first year included questionnaires directed to parents and teachers aimed to assess children's oral language and behavior, specifically the Language and Behavior Questionnaire (Questionnaire Langage et Comportement 3,5 ans (QLC), Chevrie-Muller, Goujard, Plaza, Simon & Dufouil, 1994) and the Language Screening and Prevention Questionnaire (Dépistage et Prévention du Langage à 3 ans (DPL 3); Coquet & Maetz, 1996).

During the second year of preschool, children were evaluated directly by means of the Evaluative Battery of Cognitive Functions (Batterie Rapide d'Évaluation des Fonctions Cognitives (BREV); Billard, Gillet, Livet, Motte & Vallée, 2001), a standardized battery aimed to assess different dimensions of cognitive development, such as oral language, perceptual reasoning, working memory, attentive behavior and early reading and arithmetic skills. In addition, children were assessed with the Screening battery for language difficulties (Epreuves de Répérage des Troubles du Langage 4 ans (ERTL4); Roy & Maeder, 1992), which comprises several tasks aimed to evaluate children's difficulties in oral language and speech production. Moreover, parents and teachers were asked to provide information regarding children's behavior at home and at school by means of questionnaires (Giannopulu et al., 2008).

The kindergarten period corresponded to the school year where information regarding sociodemographic and familial characteristics was collected, in addition to the assessment of the participant's cognitive-academic skills and behavior. Parents were asked to complete

questionnaires regarding their educational level, the child's family (e.g. the type and size of family, the type of early childcare provided to the child), as well as a questionnaire aimed to assess the presence of familial antecedents of reading difficulties. Moreover, both parents and teachers filled questionnaires evaluating children's behavior (Giannopulu et al., 2008). The participant's were assessed through direct observation by means of the Health Examination: School Developmental Assessment for children aged 5-6 years (Bilan de Santé Evaluation pour le Développement pour la Scolarité à 5/6 ans (*BSEDS 5-6*); Zorman & Jacquier-Roux, 2001). This battery corresponds to a standardized instrument widely used in France as part of a screening protocol performed by the Department of National Education to all children aged 5 to 6 years before school entry. This instrument is aimed to assess children's motor and cognitive development and includes a series of tasks that comprise exams of vision and audition, as well as the assessment of oral language, early-reading skills, perceptual reasoning, short-term verbal memory and fine and gross motor skills.

#### Elementary school

According with the study's initial follow-up methodology, data collection during elementary school was performed exclusively for Cohort 1 and Cohort 2. For these two cohorts, data was collected during Grade 1, Grade 2 and Grade 3 of elementary school.

In the first grade of elementary school, children were evaluated by means of reading-related tasks aimed to assess children's skills regarding text comprehension and word and non-word reading (Sprenger-Charolles, Siegel, Béchenec, & Serniclaes, 2003). Moreover, teachers were asked to complete a questionnaire assessing children's behavior at school (Giannopulu et al., 2008).

For the second grade of elementary school, age appropriated reading-related tasks were used to assess children's text comprehension and word and non-word reading (Sprenger-Charolles, Siegel, Béchenec, & Serniclaes, 2003), as done in the first year of elementary school.

Table 6. Measures and informants of the Creusot study original follow-up design at each time point of assessment

<i>Preschool</i>	<i>Measures and informants</i>
Grade 1	<p>Parents questionnaires:</p> <ul style="list-style-type: none"> <li>. <b>Language and Behavior</b> (in French QLC3,5; Chevrie-Muller et al., 1994) – This questionnaire is a standardized measure of language development and behavior for children aged 3 - 4 years. This 29-item questionnaire evaluates preschoolers’ oral comprehension and production and quality of speech, as well as playful behavior (individually or in group).</li> <li>. <b>Language Screening and Prevention</b> (in French, DPL3; Coquet &amp; Maetz, 1996) – This instrument is a standardized measure of language development for children aged 3-4 years. This 10-item questionnaire is aimed to assess four competency domains: socialization and communication, expression and comprehension, vocabulary and drawing.</li> </ul> <p>Teachers Questionnaires:</p> <ul style="list-style-type: none"> <li>. <b>Language and Behavior</b> (in French QLC3,5; Chevrie-Muller et al., 1994)</li> <li>. <b>Language Screening and Prevention</b> (in French, DPL3; Coquet &amp; Maetz, 1996)</li> </ul>
	Grade 2



Table 6 (cont.) Measures and informants of the Creusot study original follow-up design at each time point of assessment

<i>Preschool</i>	<i>Measures and informants</i>
Kindergarten	Child assessment: <ul style="list-style-type: none"> <li>. <b>Health Examination: School Developmental Assessment for children aged 5-6 years</b> (in French <i>BSEDS</i>, Zorman &amp; Jacquier-Roux, 2001) – This screening instrument is used as a standard medical evaluation performed by the Department of National Education to all preschool children aged 5-6 years. It evaluates children’s motor, social and cognitive development, as well as a large set of early-reading skills, such as: letter knowledge, phonological awareness, oral comprehension and production, vocabulary, memory and rapid naming)</li> </ul>
	Parents questionnaires: <ul style="list-style-type: none"> <li>. <b>Familial background and sociodemographic</b> characteristics – This questionnaire includes information concerning the child’s family, namely: nationality, type and size of family, parents educational level, familial antecedents of reading difficulties, children’s behavior and oral expression development).</li> <li>. <b>Parental antecedents of reading acquisition problems</b> (Doyen et al., 2004) – This 4 item questionnaire assesses if parents of the study’s participants have evidenced difficulties in learning to read during their development. Results obtained with this measure have provided interesting findings and allowed the preparation of two manuscripts (one published, Doyen et al., 2004, and one recent re-submission).</li> <li>. <b>Child Behavior Problems</b> (Giannopulu et al., 2008)</li> </ul>
	Teachers questionnaire: <ul style="list-style-type: none"> <li>. <b>Child Behavior Problems</b> (Giannopulu et al., 2008)</li> </ul>
<i>Elementary school</i>	<i>Measures and informants</i>
Grade 1 <sup>a)</sup>	Child assessment: <ul style="list-style-type: none"> <li>. <b>Reading and written language tests</b> – These tests are aimed to evaluate children’s expressive and receptive language by means of two tasks, namely: word reading (regular, irregular and pseudo word) and passage comprehension.</li> </ul>
	Teachers questionnaire: <ul style="list-style-type: none"> <li>. <b>Child Behavior Problems</b> (Giannopulu et al., 2008)</li> </ul>
Grade 2 <sup>a)</sup>	Child assessment: <ul style="list-style-type: none"> <li>. <b>Reading and written language tests</b> – These tests are aimed to evaluate children’s expressive and receptive language by means of two tasks, namely: word reading (regular, irregular and pseudo word) and passage comprehension.</li> </ul>
Grade 3 <sup>a)</sup>	Child assessment <ul style="list-style-type: none"> <li>. <b>National Evaluation of French and Mathematics curricular subject matter</b> (Department of National Education) – It is a standard procedure of the National Department of Education to evaluate all children’s achievement in French and Mathematics. These evaluations allow comparing children’s academic progress nationally by means of 2 global scores computed for French and for Mathematics. In addition, each of these scores are subdivided in several sub-scores, namely: Reading, Writing, Vocabulary, Grammar and Orthography constitute de French general score and Numbers Knowledge, Calculation, Geometry, Measures and Sizes and Organization of numeric information compose de Mathematics global score.</li> </ul>

Notes: <sup>a)</sup> Evaluations available for Cohorts 1 and 2 exclusively.

In Grade 3, data regarding the results obtained by the participants of the first and second cohorts in the national evaluations of French and Mathematics curricular subjects were collected as a measure of children's academic achievement (cf. section French educational system for a detailed description of these evaluations).

As mentioned previously, the initial methodological design of the Creusot study contemplated a follow-up period from preschool (Preschool Grade 1, 2 or Kindergarten) to the middle of elementary school (Grade 3). The data collected in these grade levels allowed the investigation of the associations between child- (cognitive-academic skills and behavioral attributes) and environmental-level factors (family contextual characteristics) both concurrently in the preschool period and longitudinally from preschool to the beginning of elementary school. The results of these analyses have been exposed in several published articles and a brief summary of the main results is presented in Appendix 1.

The Creusot study has yielded unique and original insights regarding the cross sectional associations among children's cognitive-academic skills, behavioral attributes and family contextual factors in a general population of preschoolers aged 4 to 6 years. In addition, the analyses allowed uncovering the short-term relations and predictive power of the study's measures at preschool in explaining children's subsequent cognitive-academic outcomes at the beginning of elementary school (Grade 3) when children were aged 6 to 7 years. These results have considerable educational implications with respect to the early screening and identification of children who might be at risk for reading difficulties and academic underachievement later in their educational careers.

Notwithstanding the significant results of the Creusot study, the extent to which these relations persist longitudinally from kindergarten to subsequent stages of children's educational careers beyond the middle of elementary school, as well as their influence on children's academic achievement at the end of elementary and middle school, remains to be explored. The work presented subsequently sought to provide a longitudinal extension of the results obtained in the Creusot study to the end of elementary and middle school.



### III. The present work

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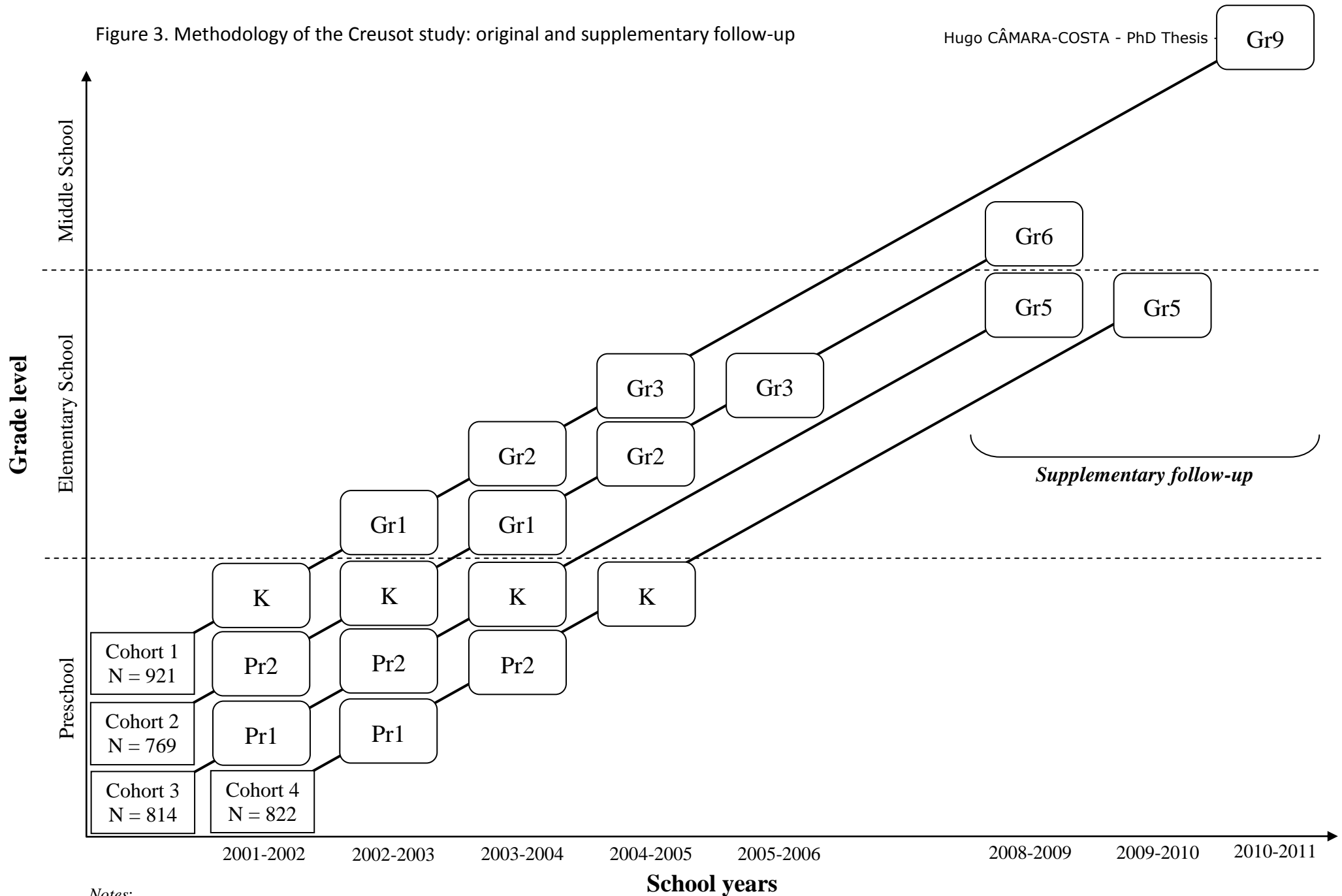
#### Overview of the objectives and methodology

The current section introduces the personal work developed from the 2010-2011 to the 2013-2014 school years as part of the PhD program of the University Paris Descartes. We began this section by presenting a brief historical of the development and the activities accomplished during the PhD project presented in this report. Subsequently, we outline its objectives and methodology, in particular the participants that took part in the present work, the measures collected and the procedures implemented for collecting these measures. Finally, we detail the plan of the analyses performed with the data collected during the PhD project in order to present the results of these analyses in the following section.

As stated earlier, the initial methodology of the Creusot study estimated the participant's follow-up from preschool to mid-elementary school (Grade 3). The extension of the follow-up period to the end of elementary and middle school was decided by the coordinating partners of the Creusot study (CUCM, *Inspection Académique de Saône-et-Loire* and INSERM). This coordinating group considered that the continuity of the follow-up period provided a valuable and unique opportunity to synthesize longitudinal data in a general population of French students followed from preschool to the end of elementary and middle school.

Hence, the PhD project methodological design derived primarily from the opportunity of extending the initial follow-up period of the Creusot study from the middle of elementary school (Grade 3) to the end of elementary school (Grade 5, for Cohorts 3 and 4) and middle school (Grade 6, for Cohort 2; Grade 9, for Cohort 1). Figure 3 illustrates the original and the supplementary follow-up design of the study, as well as the number of participants in each of the cohorts. As seen, Cohort 1, for which data had been collected between kindergarten and Grade 3 in the original methodology of the Creusot study, was estimated to be followed through the last year of middle school, i.e. Grade 9 (Gr9, 2010-2011 school year). For Cohort 2, for which data had been collected from Preschool Grade 2 to Grade 3 of elementary school, the follow-up period was extended to Grade 6 (Gr6, 2008-2009 school year).

Figure 3. Methodology of the Creusot study: original and supplementary follow-up



Notes:

Preschool (*Maternelle*): Pr1. Preschool Grade 1 (*Petite Section*); Pr2. Preschool Grade 2 (*Moyenne Section*); K. Kindergarten (*Grande Section*);  
 Elementary School (*Ecole Elémentaire*): Gr1. Grade 1 (*Cours Primaire*); Gr2. Grade 2 (*Cours Elémentaire 1*); Gr3. Grade 3 (*Cours Elémentaire 2*); Gr5. Grade 5 (*Cours Moyen 2*)  
 Middle School (*Collège*): Gr6. Grade 6 (*Sixième*); Gr9. Grade 9 (*Troisième*)

In what respects Cohorts 3 and 4, which had both been followed from Preschool Grade 1 to Kindergarten, the supplementary follow-up period estimated to accompany the participants through Grade 5 (Gr5, 2008-2009 and 2009-2010 school years, respectively).

With the extension of the follow-up period of the original Creusot study, the current work aimed to 1) collect information regarding the results obtained in the national evaluations by the study's participants at the end of elementary and middle school and 2) to incorporate this information with existing data available for each cohort collected previously from preschool to the middle of elementary school (Grade 3). For this purpose, data regarding the results in the national evaluations performed at the end of elementary school (Grade 5, Cohorts 3 and 4), at the beginning (Grade 6, Cohort 2) and at the end of middle school (Grade 9, Cohort 1) was collected for all the participants that composed the four cohorts of the Creusot study in kindergarten. Table 7 present the assessment measures used at Grade 5 (Cohorts 3 and 4), Grade 6 (Cohort 2) and Grade 9 (Cohort 1). These measures represented the main outcomes of the supplementary follow-up and were selected because they represent national indicators of general academic achievement at the end of elementary (Grade 5 and 6) and middle school (Grade 9) for the French Department of National Education.

In addition, at Grade 5, a subset of the participants of Cohort 3 had been evaluated with a standardized battery assessing reading acquisition (*ODEDYS*, Jacquier-Roux, Valdois, Zorman, 2002) and teachers evaluated children's behavior through questionnaires (Giannopulu et al., 2008). This data was available only for a representative subset of 150 participants enrolled at Grade 5 in the 2008-2009 school year. It should be noticed that this data had been previously collected as part of the initial methodology of the Creusot study. However, because the management and analysis of this data was performed in the context of the present study, these measures were considered for the analyses of the work here reported.

With the exception of the data collected for Cohort 3 by means of the *ODEDYS* battery and the teacher's questionnaire at Grade 5, all data regarding the supplementary follow-up was collected by the PhD student and a member of the Research and Development Unit on Language ("*Pôle Recherche et Développement sur les Langages*"), a division of the CUCM whose mission consisted in the coordination and communication with the local partners of the Creusot study.

Table 7. Measures and informants of the supplementary follow-up of the Creusot study at each time point of assessment

<i>Elementary school</i>	<i>Measures and informants</i>
Grade 5	<p>Child assessment</p> <p><sup>a)</sup> <b>Dyslexia Screening Battery</b> (in French ODEDYS, Jacquier-Roux, Valdois &amp; Zorman, 2002) – This standardized screening instrument allows to identify children who manifest reading difficulties, as well as the exam of children’s reading level. This measure comprises 9 subtests that evaluate children’s reading skills, such as: word reading (regular, irregular and pseudo-word), word and sentence repetition, vocabulary, phonological awareness, comprehension, rapid naming, memory and reading fluency.</p> <p><sup>b)</sup> <b>National Evaluation of French and Mathematics curricular subject matter</b> (Department of National Education)</p> <p>Teachers</p> <p><sup>a)</sup> <b>Child Behavior Problems</b> (Giannopulu et al., 2008)</p>
<i>Middle school</i>	<i>Measures and informants</i>
Grade 6 <sup>c)</sup>	<p>Child assessment</p> <p><b>National Evaluation of French and Mathematics curricular subject matter</b> - (Department of National Education) - These evaluations allow to compare children’s academic progress nationally by means of 2 global scores computed for French and for Mathematics. In addition, each of these scores are subdivided in several sub-scores, namely: Comprehension (Interpretation and Analysis), Writing, Vocabulary and Grammar constitute de French general score and Numbers Knowledge, Calculation, Space and Geometry, Measures and Sizes and Organization of numeric information compose de Mathematics global score.</p>
Grade 9 <sup>d)</sup>	<p>Child assessment</p> <p><b>Diplôme National du Brevet</b> - National Evaluation of French and Mathematics curricular subject matter (Department of National Education) – This evaluation is a standard procedure of the Department of National of Education in order to assess the student’s overall achievement in French and Mathematics at the end of college. Results vary from 0 (minimum) to 20 (maximum).</p>

Notes: <sup>a)</sup> Assessments available for a subset ( $n=150$ ) of the participants of Cohort 3 exclusively; <sup>b)</sup> Evaluations available for Cohorts 3 and 4 exclusively; <sup>c)</sup> Evaluations available for Cohort 2 exclusively; <sup>d)</sup> Evaluations available for Cohort 1 exclusively.

The differences in the grade levels at which the national evaluations of French and Mathematics curricular subjects were performed are due to the directives of the National Department of Education introduced in 2007. These directives proposed that the national evaluations, administered till 2007 in Grade 6, should be performed in Grade 5 from the 2007/08 school year onwards.

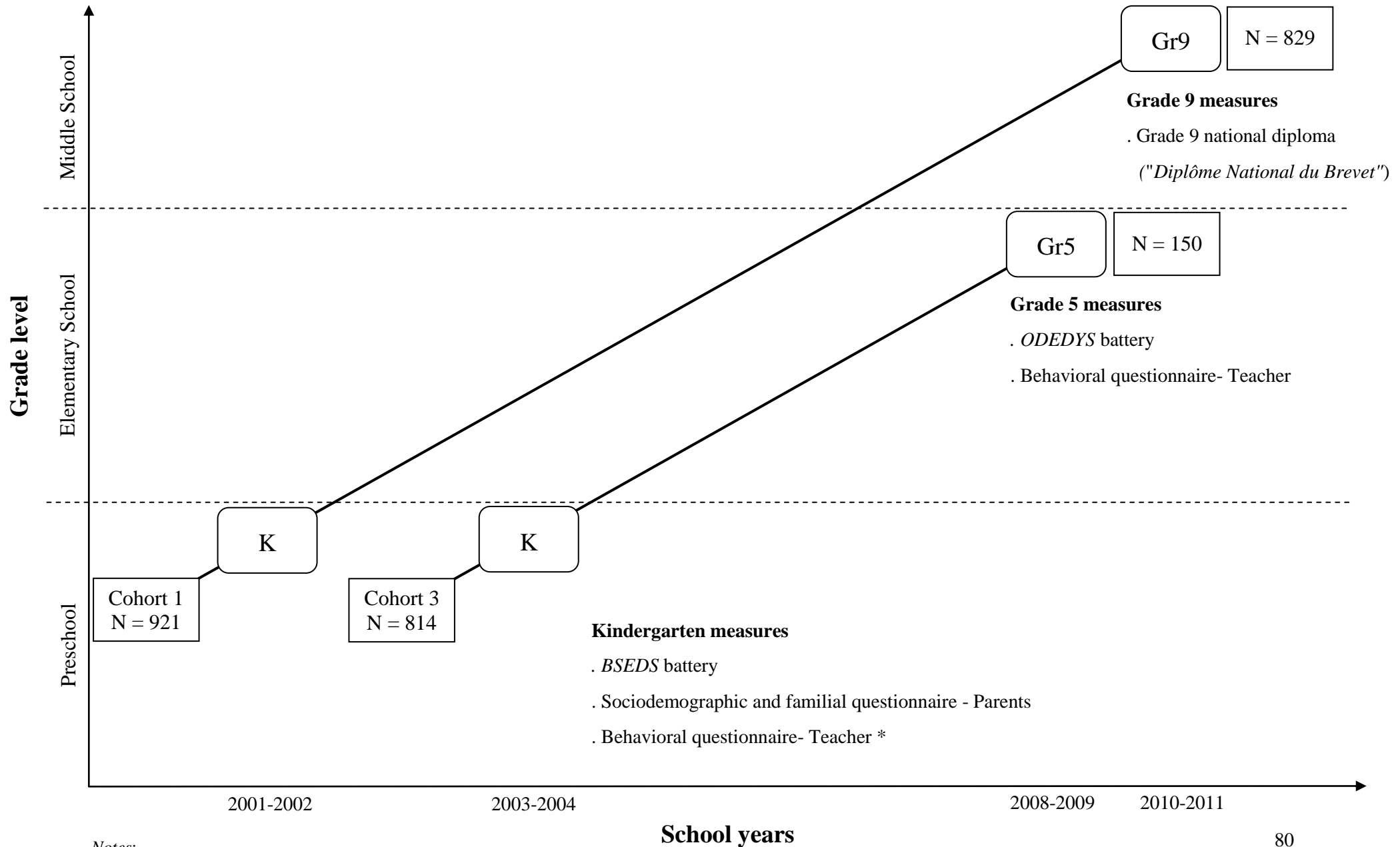
The supplementary follow-up allowed the collection of the results in the national evaluations of 82% ( $n=2706$ ) of the participants from the four original cohorts of the Creusot study in kindergarten: 703 (87% of the kindergarten cohort) participants of Cohort 3 and 773 (94%) participants of Cohort 4 had data regarding the national evaluations at Grade 5; for Cohort 2, the data on the participant's national evaluations was available for 411 (54% of the kindergarten cohort) participants; and the results in the Grade 9 national evaluations were retrieved for 829 (90% of the kindergarten cohort) of the participants in Cohort 1. Sample attrition represented 10%, 46%, 6% and 13% from the initial kindergarten samples of Cohorts 1, 2, 3 and 4, respectively. The loss of participants was mainly related with geographical relocation of the participants between kindergarten and elementary or middle school. For Cohort 2, the reduced number of evaluations available in Grade 6 was explained by the amendments introduced by the French Department of National Education recommending the realization of these evaluations at Grade 5 instead of Grade 6 (cf. Table 7).

Data collection for all cohorts was performed between January 2011 and May 2013. These activities were executed in 54 days distributed over 26 work travels to the CUCM. In addition to data collection, the main activities performed during the time period of the PhD comprised the management and analysis of the collected data, as well as literature reviews regarding the state of the art of extant research. Moreover, these activities comprised scientific meetings each semester between the coordinating partners of the Creusot study and the research staff for logistics and planning purposes and a seminar aimed to communicate the main results of the supplementary follow-up to the local community (June 2013). Finally, an article issued from the analyses referring to Cohort 3 was accepted for publication in the *Journal Research in Developmental Disabilities* (Costa et al., 2013; cf. Appendix 2).

Despite the large amount of data collected for the study's participants at the end of elementary and middle school, only the data collected for Cohort 1 and 3 was considered in the analyses reported here. As seen in Figure 4, Cohort 1 was followed from kindergarten (2001-2002 school year) to the end of middle school (Grade 9, 2010-2011 school year) and Cohort 3 was followed from kindergarten (2003-2004 school year) to the end of elementary school (Grade 5, 2008-2009 school year). This option was driven by conceptual and pragmatic considerations. On one hand, the compilation and organization of all the data collected between 2011 and 2013 rendered insurmountable the task of synthesizing and analyzing all the data collected.



Figure 4. Cohorts and measures considered for the plan of analyses



Notes:

Preschool (*Maternelle*): K. Kindergarten (*Grande Section*); Elementary School (*École Élémentaire*); Gr5. Grade 5 (*Cours Moyen 2*) ; Middle School: Gr9. Grade 9 (*Troisième*);

\* Data available for Cohort 3 exclusively.

On the other hand, the objectives defined for the current work aimed primarily at examining the longitudinal associations between the study's measures from kindergarten to the end of middle school. In this sense, only Cohort 1 had longitudinal data that allowed investigating the associations between the kindergarten measures and the school outcomes from kindergarten to middle school. Moreover, we were interested in examining the effects of behavior problems and children's cognitive-academic skills in kindergarten as explicative measures of children's reading outcomes at the end of elementary school. In this respect, only Cohort 3 had data referring to children's reading acquisition and behavior problems at the end of elementary school. Therefore, for Cohort 3, only the data collected for a representative subset of 150 participants (90% of the initial kindergarten sample) enrolled in Grade 5 and referring to children's reading achievement assessed through a standardized assessment battery (*ODEDYS*, Jacquier-Roux, Valdois & Zorman, 2002) and teacher's questionnaire of behavioral problems (Giannopulu et al., 2008), were considered for the analyses. As mentioned previously, although this data had been collected previously as part of the initial methodology of the Creusot study, its organization and analysis was performed in the context of the present research and, thus, were used in the statistical analyses of the work described here.

## Objectives

The extension of the follow-up period of the Creusot study represented a compelling opportunity to test longitudinally the associations of children's cognitive-academic skills, behavioral attributes and familial characteristics with subsequent reading and academic achievement from kindergarten to the end of elementary and middle school. Accordingly, the main goal of the present work was to investigate the contribution of child- and family-level variables assessed in kindergarten in the prediction of children's reading acquisition in Grade 5 and general academic achievement in Grade 9. More specifically, we sought to:

- Investigate cross-sectional relations between children's cognitive-academic skills, behavioral problems (hyperactivity, inattention, conduct problems and unsociability) and family characteristics at kindergarten and at Grade 5;

- Investigate the effects of children's cognitive-academic skills, behavioral problems and family-level factors in kindergarten on children's reading acquisition at the end of elementary school and academic achievement at the end of middle school;
- Assess the specific predictive value of kindergarten observations, such as oral language, behavioral difficulties, cognitive-academic skills and family contextual factors, on children's subsequent reading and academic achievement;
- Examine the factors that might place a child at risk for reading difficulties and academic underachievement and explore the deleterious effects related with the accumulation of risk factors.

The objectives defined for the present work aimed to extend the goals established previously in the initial methodology of the Creusot study to the end of elementary and middle school and to provide additional understanding of the risk factors associated with children's academic underachievement. In this sense, the present work represents a supplementary phase of the original study aimed to examine the contribution of child- and family-level factors to academic achievement from kindergarten to the end of elementary and middle school.

## Method

### Participants

The selection of the participants that would be included in the new phase of the follow-up period, i.e., through the end of elementary and middle school, was based on children's enrollment in kindergarten during the original Creusot study. To be included in the supplementary follow-up period children were required to have participated in the Creusot study in kindergarten during the 2001-2002 (Cohort 1) and the 2003-2004 (Cohort 3) school year. This inclusion criterion was based on data-driven and theoretical considerations. The kindergarten period represented the grade level where the large majority of the assessments were performed during preschool, namely in what concerns the collection of sociodemographic and familial measures. In addition, the literature reviewed for the present work (see Chapter I) has highlighted that the skills and competences children manifest before

school entry (i.e. kindergarten) are robust correlates and powerful predictors of their subsequent academic achievement in elementary school and beyond. Thus, all children of Cohort 1 and Cohort 3 enrolled at kindergarten in the 2001-2002 and 2003-2004 school years were considered for the supplementary follow-up phase of the Creusot.

After defining the participants from each cohort that would be included in the supplementary follow-up, we began collecting the outcome data. For Cohort 1, the results obtained in the national evaluations performed in Grade 9 (2010-2011 school year) for all the children that composed Cohort 1 in kindergarten (2001-2002 school year) were collected retrospectively. For Cohort 3, we synthesized and analyzed the data available for a representative set of participants from Cohort 3 in kindergarten (2003-2004 school year), for whom we had available data regarding reading achievement and teacher's reports of behavioral problems at Grade 5 (2008-2009 school year).

To be included in the final analysis samples, participants were required to have available data on the outcome measures defined for each cohort. For Cohort 1, these inclusion criteria resulted in a final sample of 829 participants (90% of the initial kindergarten sample in the 2001-2002 school year) that had data regarding the national evaluations performed in Grade 9 (2010-2011 school year). For Cohort 3, the sample for analysis was composed of 812 kindergarteners (2003-2004 school year), from which a subset of 150 participants (19% of the initial kindergarten sample) was followed through Grade 5 (2008-2009 school year). As mentioned earlier, attrition rate for Cohort 1 represented 10% of the initial kindergarten sample of the Creusot study and was mainly attributable to students' relocation between kindergarten and middle school during the 10-year follow-up span. For Cohort 3, the reduced number of participants followed from kindergarten through Grade 5 was due to limitations in the research resources required to perform direct assessment to the participants that composed the initial kindergarten sample.

## Measures

The measures selected for the present work differed according with the data available for each cohort. Thus, for Cohort 3, the data considered for analysis comprised the participant's performances in an assessment battery evaluating reading achievement at the end of

elementary school (Grade 5), as well as teacher's reports of behavioral problems in the same grade level. For Cohort 1, the selected outcome measure referred to children's scores in the national evaluations performed at the end of middle school (Grade 9) by the French Department of National Education.

### Elementary school

In the final year of elementary school (Grade 5), a representative subset of the participants of Cohort 3 was evaluated with the Dyslexia Screening Battery ("*Outil de Dépistage des Dyslexies*" (*ODEDYS*); Jacquier-Roux, Valdois & Zorman, 2002). This battery is an age-appropriate standardized instrument that assesses reading and orthographic skills through a large span of reading-related subtests, such as sentence dictation, rapid naming, word reading and phonological awareness, among others. Simultaneously, the teachers and the parents of this subset of participants of Cohort 3 filled out questionnaires aimed to assess children's behavior (Giannopulu et al., 2008). This instrument corresponded to the same questionnaire administered to this cohort in kindergarten during the 2003-2004 school year (cf. table 6 Measures and informants of the original follow-up design of the Creusot study). Due to the limited resources regarding research staff to collect data in Grade 5, only a reduced number of participants were evaluated with the *ODEDYS* battery and with the teacher's behavioral questionnaire at this grade level. From the initial sample of 812 participants of Cohort 3 in kindergarten, data regarding the *ODEDYS* battery and the teachers' questionnaires was retrieved for 150 (19%) and 114 (14%) of the participants, respectively.

It is informative to assert that the data pertaining to the *ODEDYS* battery and to the teachers' behavioral questionnaire was collected during the original follow-up of the Creusot study. For reasons related with the organization of the present work, they are mentioned in this section because they correspond to measures referring to Grade 5. However, since these measures were not collected during the supplementary follow-up of the Creusot study, the procedures of data collection pertaining to these measures are presented later in the section dedicated to the analyses performed with the data collected at Grade 5 rather than in the following section.

## Middle school

The results of the “*Diplôme National du Brevet*” accomplished at the end of Grade 9 (2010-2011 school year) were collected for the participants of Cohort 1. These national evaluations aim to reflect the degree of overall academic achievement at the end of middle school and are generally used by the French Department of National education as a national indicator of general achievement at Grade 9. (Grade 9; cf. section “French educational system” for a detailed description of these evaluations).

## Procedure

Data collection began during the 2011-2012 school year. With the exception of cases related with grade retention, geographical relocation or school dropout, the participants of Cohort 1 were expected to be enrolled in Grade 10 of high school (“*Lycée*”). Thus, we aimed at collecting retrospectively the results of the national evaluations obtained previously by these participants when they were enrolled in Grade 9 during the 2010-2011 school year.

For the participants of Cohort 1, the results regarding the national evaluations performed in Grade 9 (“*Diplôme National du Brevet*”) during the 2010-2011 school year were available in the departmental data base of the the Saône-et-Loire division of the French Department of National Education. As required by ethical procedures, school administrators and the Saône-et-Loire division were contacted and informed consent was obtained in order to conduct the supplementary phase of the follow-up. This data base compiled the results of the national evaluations performed in Grade 9 during the 2010-2011 school year of all the students enrolled in the middle schools of the Saône-et-Loire department, which included the schools that served the CUCM. After familiarization with the data base software, the research staff collected the results of the national evaluations by cross-checking the name, surname and date of birth of all participants of Cohort 1 with the data base. In order to guarantee the participants anonymity, only the research staff had access to this information and data was collected independently from the personnel of the French Department of National Education.

Whenever a participant’s result in the national evaluations was not found in the data base, a thorough examination of the student’s school record was performed in order to detect the reason related with the absence of the national evaluation. The data base of the Saône-et-Loire

division comprised school records of all the students enrolled in the middle schools that served the CUCM. These records provided comprehensive information regarding grade retention and school dropout, among others. If the absence of results in the Grade 9 national evaluations was related with grade retention or school dropout, the data base allowed to uncover if the absence of results was related with these specific motifs. Thus, the absence of results in Grade 9 was associated with students' that had either repeated one or more grades or that had left school because aged more than 16 years (the maximum age of compulsory education). Therefore, these participants did not sit the national evaluations in Grade 9 in the 2010-2011 school year. For the purposes of the analyses performed in the present work, these participants were considered in the analysis sample as student's that did not obtained the national diploma at Grade 9 during the 2010-2011 school year.

Another reason for the absence of the results in the national evaluations at Grade 9 refers to geographical relocation between kindergarten and middle school. The information that constituted a student's school record comprised no indication regarding geographical relocation. If a student had moved out of the Saône-et-Loire department during middle school, his school records referred to the last grade level in which he was enrolled in middle school. In addition, if a student had relocated before middle school, there would be no school record because the data base referred only to the middle school period. For this specific reason, the participants for whom there were no school records in Grade 9 were interpreted as missing data due to geographical relocation outside the Saône-et-Loire department.

All the data regarding the national evaluations conducted in Grade 9 during the 2010-2011 school period was collected in two phases. In the first phase, the results of all the participants who attended the national evaluations during the 2010-2011 school year was collected from September 2011 to July 2012. In the second phase, we conducted a comprehensive examination of all the study's participants that did not present results in the Grade 9 national evaluations. This phase occurred between September 2012 and July 2013.

### Plan of analysis

The selection of the data available for Cohort 3 and Cohort 1 oriented the analytic plan of the present work in three sets of analyses: two sets of analyses developed with the available data of Cohort 3 and one set of analyses conducted with the data collected for Cohort 1.

The first set of analyses (1) was performed with the data available from Cohort 3 in kindergarten. This data consisted of children's performances in the *BSEDS* battery (cognitive-academic skills), teacher's reports of children's behavior (behavioral problems) and parental questionnaires assessing familial characteristics (parental level of education and familial antecedents of reading difficulties). In these analyses, we aimed at examining the cross-sectional associations in kindergarten among children's cognitive-academic skills, behavioral problems and familial characteristics.

The second set of analyses (2) focused on the data available for Cohort 3 at kindergarten together with the data collected from a representative subset of 150 participants followed from kindergarten to the end of elementary school (Grade 5). At Grade 5, the outcome measures corresponded to children's performances in the *ODEDYS* battery (word-reading achievement) and teachers' behavioral questionnaire (behavior problems). This set of analyses sought to investigate the longitudinal interrelations of children's cognitive-academic skills, behavioral problems and familial characteristics at kindergarten with word reading achievement at Grade 5.

The third set of analyses (3) investigated the longitudinal associations in Cohort 1 of child- and family-related factors assessed at kindergarten with the participant's results in the Grade 9 national diploma. For these analyses, we synthesized the data available in kindergarten with the data collected at Grade 9. In kindergarten, the study measures comprised the *BSEDS* subtests (cognitive-academic skills) and sociodemographic and familial characteristics assessed through parental questionnaires (family size, parental educational level, familial antecedents of reading difficulties, among others). In Grade 9, the data analyzed corresponded to the participants' results in the national evaluations performed at Grade 9.

The results of the statistical analyses performed in the present work are presented in the following section. For each set of analyses, we recapitulate the theoretical framework that motivated the analyses and we provide detailed information regarding participants, measures and the statistical procedures conducted. Finally, we present the main results obtained at each set of three sets of analyses.





1. Associations among emergent literacy skills, behavior problems and family characteristics in kindergarten

(Cohort 3)

Cross sectional analyses - Kindergarten (2003 - 2004)

(*n* = 812)

## Introduction

The scientific literature reviewed in the first chapter of the present work has highlighted that children's oral language and emergent literacy skills during kindergarten represent developmental precursors of conventional forms of reading and writing acquisition later in elementary school. (Dickinson et al., 2003; Hecht et al., 2000; Muter et al., 2004; Storch & Whitehurst, 2002; Torgesen et al., 1997; Wagner et al., 1997; Watier et al., 2006; Whitehurst & Lonigan, 1998). These skills refer specifically to children's oral language skills, such as vocabulary and oral comprehension, and emergent literacy skills, such as phonological awareness and letter knowledge.

In addition, researchers have underlined the negative impact of behavior problems in the development of early reading-related and preliteracy skills at kindergarten. As an example, several studies have demonstrated the deleterious association between inattentive behavior and emergent literacy skills during kindergarten, over and above the negative effects of other dimensions of behavior, such as hyperactivity/impulsivity, disruptive behavior and socialization difficulties (Lonigan et al., 1999; Spira & Fischel, 2005, for a review). However, several authors have pointed out that the effects of other behavioral dimensions other than inattentive behavior should not be neglected. In this line, a considerable number of studies have presented evidence that children's social behavior is positively associated with enhanced performances on measures evaluating emergent literacy skills in kindergarten (Doctoroff et al., 2006; Giannopulu et al., 2008; Trzesniewski et al., 2006). Hence, the results advanced by scientific studies examining the associations between distinct dimensions of children's behavior, early-reading and emergent literacy skills before school entry are not conclusive. As suggested by Doctoroff and colleagues (2006), the relation between behavior problems and emergent literacy remains understudied during the preschool period. The present analyses seek to contribute to clarify the role that distinct dimensions of children's behavior play in the development of emergent literacy skills before school entry.

Moreover, the analysis of the relations between children's pre-reading skills and behavior problems during kindergarten should consider a broader perspective that recognizes the role of family contextual factors, in addition to children's prior skills and behavior. Among the large set of family factors described in the scientific literature as having an effect on

children's early development, a specific indicator describing the presence of a familial history of difficulties in learning to read in at least one of the child's relatives has been demonstrated to be associated with children's lower performances on tasks evaluating emergent literacy skills in kindergarten (Puolakanaho et al., 2007; Snowling et al., 2003). Furthermore, a previous study conducted in the same school period has extended the scope of abovementioned results by presenting evidence that the presence of parental antecedents of reading difficulties was not only negatively associated with children's emergent literacy skills, but also positively correlated with teachers' reports of inattentive behavior (Doyen et al., 2004). These results are in accordance with findings obtained in familial and twin studies which have demonstrated that children's emergent literacy skills were associated specifically with inattentive behavior during kindergarten and that this relation is largely influenced by genetic and familial factors common to both domains of cognitive-academic and behavioral development (Friedman et al., 2003; Willcutt et al., 2007). However, these findings were derived from studies conducted with specific targeted samples which limit their generalization to the general population. Additionally, the association between familial antecedents of reading difficulties and a more diversified array of emergent literacy skills, other than phonological awareness and letter knowledge, remains to be explored. The analyses here reported aim to contribute in the clarification of these issues.

## Objectives

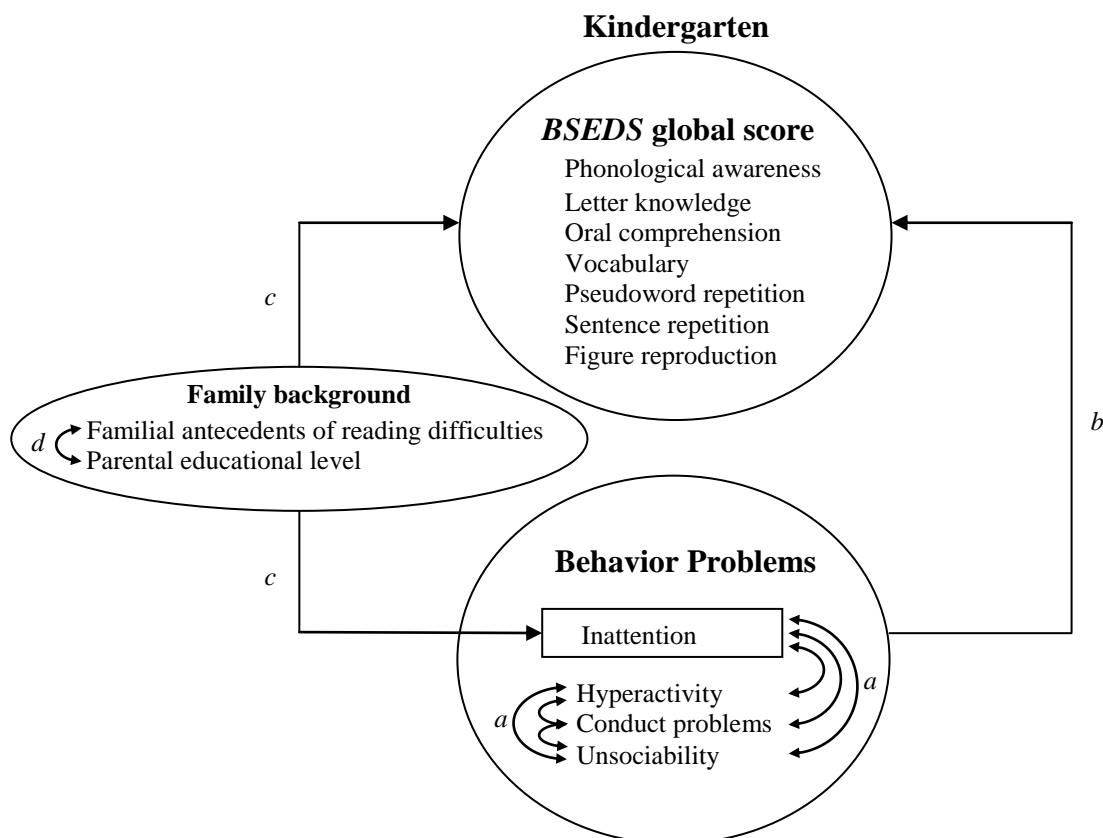
The main goal of present work is to examine the pattern of concurrent associations among children's emergent literacy skills, oral language, behavior problems and family contextual factors in a sample of kindergarteners before school entry. More specifically, the present work aims to:

- Examine the concurrent associations among children's emergent literacy skills, distinctive dimensions of behavioral problems and familial contextual factors, namely familial antecedents of reading difficulties and parental educational level, in kindergarten;
- Investigate the contribution of distinctive behavioral dimensions in the prediction of kindergartener's emergent literacy skills;

- Analyze the specific contribution of inattentive behavior and familial antecedents of reading difficulties in the prediction of children’s emergent literacy skills and describe the pattern of associations of a diversified set of children’s emergent literacy skills with inattentive behavior and familial antecedents of reading difficulties in kindergarten.

The general conceptual model presented in Figure 5 resumes the analytic plan of interrelations in kindergarten among the composite measure of cognitive-academic skills (emergent literacy skills and non-verbal cognitive ability), teachers’ reports of behavior problems and family characteristics (familial antecedents of reading difficulties in kindergarten and parental educational level).

Figure 5. General model for analysis in kindergarten: Relations among emergent literacy skills, familial antecedents of reading difficulties and behavioral problems in kindergarten



**Plan of analysis of the interrelations among the study’s variables in kindergarten**

- Correlations among teacher’s behavioral factors
- Correlations between *BSEDS* global composite score and teacher’s behavioral factors
- Association of family background (familial antecedents of reading difficulties and parents’ educational level with *BSEDS* composite score and behavior problems
- Associations between familial antecedents of reading difficulties and parents’ educational level

## Method

### Participants

The participants were selected from the Cohort 3 of the Creusot study, a larger prospective longitudinal study in the general population. This sample was composed of all children attending the 48 preschools of the Creusot Montceau-les-Mines community during the 2003-2004 school year, when children were in the final year of the preschool period (i.e. kindergarten), and for whom we had outcome data in at least one of the study's measures at kindergarten (parents' sociodemographic background and familial antecedents of reading difficulties questionnaire, cognitive-academic skills and teachers' behavioral questionnaire). As required by ethical imperatives, parents and school administrators were contacted and invited to participate in the study and informed consent was obtained in order to conduct this research.

A total of 812 children, 422 boys and 390 girls, aged five to six years (mean 5.8 years, SD 3 months) constituted the kindergarten sample used in the analyses described subsequently. From this sample, 745 (91.7%) participants had available data concerning sociodemographic indicators and family contextual characteristics, such as familial antecedents of reading difficulties, 590 (72.5%) presented information regarding the behavior questionnaires addressed to teachers and 677 (83.5%) had data referring to assessment of cognitive and emergent literacy skills.

The participants composing this sample were representative of children from diverse socio-cultural backgrounds of a general population of suburban and rural communities in France. Note however that the participants of this community-based sample do not constitute a nationally representative sample since children from large urban areas were absent.

All participants attended general education classrooms and there were no gender differences in the group composition of this kindergarten sample. Only 5% of the parents reported being of a different nationality other than French, and no significant differences between and within samples were found when parents' nationality was taken into account.

## Measures

Kindergarten assessment (2003-2004 school year)

### *Sociodemographic questionnaire*

Parents were asked to provide background information relative to their families by means of questionnaires. These included questions concerning parents' level of education (final school grade completed by each parent) and information regarding familial reading acquisition background, namely the presence of difficulties in learning to read in any of the child's siblings. For parents' educational level, we generated a binary variable defining whether none or at least one of the parents had obtained a high school diploma ("*Baccalauréat*"), according with the methodology employed in previous studies (Billard et al., 2008, 2009; Giannopulu et al., 2008; Dellatolas et al., 2007). The computation of this binary measure allowed the composition of two homogeneous subgroups according to parental level of education: a low educational level subgroup defined as families where none of the parents had completed high school and a median-high educational level subgroup characterized by families where at least one of the parents presented a high school diploma. In what concerns the reports of difficulties in learning to read in any of the child's siblings, a dichotomized score was computed specifying whether parents indicated if at least one of the siblings manifested difficulties in learning to read during their childhood.

### *Familial antecedents of reading difficulties questionnaire*

Parents completed a questionnaire aimed at examining the presence of reading-related difficulties during their own childhood. Each parent was asked to respond separately to the following question: "During your childhood did you manifest one or several of the following problems that frequently worried your parents or teachers: (1) "a delay in oral language"; (2) "difficulties in expressing yourself orally or making yourself understand"; (3) "difficulties in learning to read"; and (4) "difficulties in learning to write"<sup>1</sup>. Each of these items was scored zero (no) or one (yes). Due to the extremely low frequency of positive responses to questions (1) and (4), only questions (2) and (3) were considered in the computation of a composite

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<sup>1</sup> From the original: « Pendant votre enfance avez-vous eu un ou plusieurs des problèmes suivants qui inquiètent souvent les parents ou les enseignants (parfois à tort): 1. Un retard de langage ?; 2. Des difficultés pour vous exprimer oralement ou pour vous faire comprendre?; 3. Des difficultés pour apprendre à lire?; 4. Des difficultés pour apprendre à écrire correctement (orthographe)? »

measure of parental antecedent of reading difficulties. Note that the generic term “reading difficulties” includes parental reports of oral language difficulties.

In addition, since the purpose of the present study was to identify the presence or absence of a history of reading difficulties in children’s family, we considered simultaneously parents’ responses to this questionnaire, as well as their responses to the abovementioned familial background questionnaire regarding the presence of reading difficulties in at least one of the child’s siblings. In this way, familial antecedents of reading difficulties were defined as a binary variable in which at least one of the parents reported the presence of oral or written language difficulties in one of the members of the family (i.e., the parents and/or the siblings) or not.

*Bilan de Santé: Évaluation du Développement pour la Scolarité de 5 à 6 ans (BSEDS)*

The *BSEDS* battery ([Health Examination: School Developmental Assessment for Children aged 5–6 years], Zorman & Jacquier-Roux, 2001) is a standardized screening instrument widely used with the French preschool population and it is constituted by an array of subtests evaluating children’s oral language, emergent literacy, perceptual reasoning, working memory and fine and gross motor skills in kindergarten (available at [www.cognisciences.com](http://www.cognisciences.com), for further details). In France, the administration of this battery is a systematic assessment procedure performed nationally by school doctors to all children aged five to six years enrolled in kindergarten, in accordance with the directives of the French Department of National Education (2002). The objective of this systematized evaluation consists in the screening and early identification of the developmental factors that might place a child at risk of presenting later learning difficulties during their academic trajectory, specifically in what concerns the development of subsequent delays in reading and writing skills.

For the purposes of the analyses described in this section, nine subtests were selected from the large collection of tasks that compose this battery, namely: Rhyme identification, Syllabic counting, Syllabic deletion, Vocabulary, Pseudoword repetition, Oral comprehension, Letter reading, Sentence repetition and Figure reproduction. These subtests were chosen based on their psychometric soundness and evidence that these measures of oral language and emergent literacy skills predict later reading acquisition and allow for the early identification of children at risk of developing later reading difficulties (Zorman & Jacquier-Roux, 2001).



(1) *Phonological awareness* was evaluated through three subtests: Rhyme identification, Syllabic counting and Syllabic deletion. In the Rhyme identification subtest, the child is asked to identify the word that shares the final syllable with a word presented orally by the examiner. The examiner pronounces a word and child has to identify the one (from a group of three words) that ends with the same sound of the word previously enunciated by the examiner. This subtest is composed of eight target words and one point is awarded for each rhyme identified correctly. The total score corresponds to the number of correct answers (maximum = 8). Regarding the Syllabic counting subtest, the child is requested to enunciate the syllables that compose a word orally presented by the examiner. This subtest is composed of five target words (three disyllabic words and two trisyllabic words). One point is attributed to each word correctly divided into its component syllables and the total score equals the sum of all the correct answers (maximum = 5). The Syllabic deletion subtest consists of asking the child to repeat a word presented orally by the examiner without its final syllable. It is explained to the child that the examiner will present a word and that she has to pronounce the same word after suppressing its final syllable (e.g. repeat the word “radio” without pronouncing the syllable “dio”, expected response “ra”). This subtest comprises 10 target words and the total score corresponds to the number of correct answers (maximum = 10). Finally, a global composite score of phonological awareness is computed by adding the total of correct answers in each of the subtests (maximum = 23).

(2) *Vocabulary*: The child was asked to identify the picture (from a group of six) that better corresponded to the word previously presented orally by the examiner. Two points were attributed whenever the child identified the correct picture and one point when an acceptable, although incorrect, picture was designated by the child. This subtest is composed of 15 items and the total score represents the sum of the scores obtained at each item (maximum = 30).

(3) *Oral comprehension*: Children’s semantic and syntactic comprehension was assessed by means of a subtest in which the child was required to identify the picture that corresponds to the sentence previously presented orally by the examiner (e.g. “Le crayon est derrière la boîte” [The pencil is behind the box]). The examiner pronounces the target sentence to the child, who is then asked to select from a frame containing four pictures which is the one that corresponds to the sentence. This subtest is constituted by 10 sentences and the total score is the number of pictures correctly identified by the child (maximum = 10).

- (4) *Letter reading*: In this subtest the child is requested to identify the name or sound of 12 letters presented in a frame by the examiner. The total score corresponds to the total number of letters correctly pronounced and identified in the frame (maximum = 12).
- (5) *Pseudoword repetition*: This subtest assesses children's short-term verbal memory by means of a task in which the child is asked to repeat 16 non-words (eight disyllabic and eight trisyllabic) orally presented by the examiner one at a time. One point is attributed to each non-word correctly repeated and the total score is the number of correct repetitions (maximum = 16).
- (6) *Sentence repetition*: In this task evaluating short-term verbal working memory the child is requested to repeat two sentences presented orally by the examiner. ("Il y a un garçon dont la casquette est verte" [There is a boy whose hat is green] and "La fille a été interrogé par le robot" [The girl was interrogated by the robot]). The score attributed to each sentence ranges from zero to eight according to the number of words correctly repeated in each sentence (maximum = 16 points).
- (7) *Figure reproduction*: This subtest evaluates children's perceptual reasoning and visual-spatial ability. The child is asked to copy six patterns of increasing complexity in a dotted sheet. One point is coded for each pattern successfully copied (maximum=6 points).

Due to the objectives defined for the current analyses and to the large set of subtests that compose the *BSEDS* battery, we generated a global score aimed to reflect children's overall performance in this assessment instrument. For this purpose, the sum of the standard scores obtained in all the nine subtests administered from the *BSEDS* battery was divided by the total number of items that composed each of the nine subtests. This *BSEDS* global composite score aimed to represent the percentage of items successfully performed by children from the totality of items that composed the subtests of this battery. The reliability for the *BSEDS* global composite score was good (Cronbach's *alpha* reliability = .78), which is within the acceptable limits regarding the parameters of internal consistency. Note that, although this composite measure represents children's overall performance on cognitive-academic tasks (since visual and perceptive ability were included in this global measure), this composite score was essentially constituted by measures evaluating children's emergent literacy skills.

*Teachers' behavioral questionnaire*

Teachers completed a 21-item questionnaire (Giannopulu et al., 2008) used to assess children's classroom behaviors during kindergarten. Table 8 presents the items composing this assessment measure. Each item stated a particular behavior (e.g. "the child can't concentrate") and was rated on a three-point scale to denote whether the child displayed the particular behavior (i.e., 0 = no, 1 = sometimes, 2 = yes).

Table 8. Items of the teacher's behavioral questionnaire

Order	Questions <sup>2</sup>	Factors
1	The child does not stop moving	F1 Hyperactivity
2	The child is fidgety	
3	The child is noisy	
6	The child disturbs others	
17	The child has difficulties in concentrating	F2 Inattention
18	The child is easily distracted	
20	The child has difficulty in to finish what she started	
21	The child gets discouraged easily	
4	The child gets upset easily	F3 Conduct problems
5	The child gets angry easily	
9	The child is touchy/susceptible	
13	The child does not accept criticism	
12	The child does not respect rules during leisure games	F4 Unsociability
14	The child is not always accepted by the others	
15	The child does not collaborate with his colleagues	
16	The child does not collaborate with the teacher colleagues	
7	The child breaks his personal objects	Not selected
8	The child is insolent	
10	The child is influenceable	
11	The child opposes to authority figures	
19	The mood of the child often changes	

<sup>2</sup> From the original : (1) **F1 Hyperactivité** : L'enfant n'arrête pas de se déplacer ; (2) L'enfant est remuant ; (3) L'enfant fait beaucoup de bruit ; (6) L'enfant dérange les autres enfants ; **F2 Inattention** : (17) L'enfant a du mal à se concentrer ; (18) L'enfant est souvent distrait ; (20) L'enfant ne finit jamais ce qu'il entreprend ; (21) L'enfant se décourage facilement ; **F3 Troubles de conduite** : (4) L'enfant s'énerve facilement ; (5) L'enfant pique des crises de colère ; (9) L'enfant est susceptible ; (13) L'enfant n'accepte pas la critique ; **F4 Insociabilité** : (12) L'enfant ne respecte pas les règles des jeux ; (14) L'enfant n'est pas toujours accepté par les autres ; (15) L'enfant ne collabore pas avec ses camarades ; (16) L'enfant ne collabore pas avec l'enseignant(e) ; **Non sélectionnées** : (7) L'enfant casse ses affaires ; (8) L'enfant est insolent ; (10) L'enfant est influenceable ; (11) L'enfant s'oppose à l'autorité ; (19) L'humeur de l'enfant change souvent.

A previous study conducted by Giannopulu and colleagues (2008) has reported the usefulness of this questionnaire as a screening instrument for the identification of behavioral problems by the classroom teachers. These authors mentioned that the development and items selection of this questionnaire was based in previous empirical research regarding the Conners Teacher and Parent Rating Scales (Conners, 1969, 1973, 1997; Fantuzzo et al., 2001; Gianarris et al., 2001; Miller, Koplewicz, & Klein, 1997; *cit in* Giannopulu et al., 2008). Hence, according with the methodology employed in the abovementioned study, we performed a principal component analysis of the 21 questions of the questionnaire at kindergarten. Four factors were defined and each factor was composed of four questions (cf. Table 8). These factors were named according to the specificity of the questions they were based on, namely: F1, “hyperactivity”; F2, “inattention”; F3, “conduct problems” and F4, “unsociability”. We generated new variables, one for each factor, by summing up the teachers’ answers to the questions that composed each specific factor. These four factors accounted for 61% of the variance in the teachers’ behavioral reports at kindergarten and the internal consistency of each factor was good with Cronbach’s *alpha* values of .87, .82, .78, and .74 for “hyperactivity”, “inattention”, “conduct problems” and “unsociability”, respectively. It is informative to denote that these factors represent a measure of intensity reflecting both the number of classroom behaviors reported by the teacher and the frequency in which they occur in the classroom setting.

## Procedure

Data collection began during the first semester of kindergarten in the 2003-2004 school year. Behavioral and cognitive assessment was conducted with all children enrolled in the preschools of the Creusot Montceau-les-Mines community. Through collaboration with school medical staff, frequently composed of a doctor and a nurse, parents were assigned questionnaires concerning sociodemographic and familial characteristics, and teachers completed questionnaires regarding children’s classroom behavior at kindergarten. Concomitantly, school doctors administered the *BSEDS* health examination battery, which includes vision and audition exams, as well as the assessment of oral language and cognitive-academic skills. This assessment was performed in the school’s medical cabinets to each participant individually in one session with a maximum duration of 50 minutes. In this session, the assessment was initiated with the vision and audition exams, which usually has a duration of 10 minutes, followed by the subtests that compose the *BSEDS* battery, which

requires 30 to 40 minutes of application time. This systematic assessment began in October 2003 and all data was collected in January 2004. The sociodemographic and behavioral questionnaires were delivered to parents and teachers between November and December 2003 and their retrieval was concluded in April 2004.

#### Preliminary analysis and analytic plan

The statistical analyses were performed with the SAS 9 ® software (SAS, Institute Inc. Cary, NC, USA). Firstly, the internal consistency indicators of each of the study's instruments were evaluated (cf. Measures section), and descriptive analysis of the data were performed for each of the measures at kindergarten. Secondly, in accordance with the objectives defined for the current analyses, we examined the pattern of associations in kindergarten among family characteristics, teacher's reports of behavioral problems and children's overall performance in the *BSEDS* battery (global composite score) by means of student's *t*-test, chi-square tests and Pearson's correlations (CORR procedure in SAS). Finally, we used linear regressions (REG procedure in SAS) in order to investigate the contributions of the familial and behavioral measures as explicative variables (predictors) of children's overall performance in the *BSEDS* battery.

In order to examine the concurrent relations among the kindergarten measures, the Pearson correlation procedure was used to assess the associations among the four teachers' factors derived from the behavioral questionnaire, as well as the associations between these factors and children's global scores in the *BSEDS* battery. The interpretation of this correlation coefficient was based not only on the *p*-value referring to the statistical significance of this procedure, which indicates the probability that is attributable to chance when there is an significant association between variables, but also on the magnitude of the effect sizes, which refers to the strength of the association between variables. In what respects the statistical significance *p*-value, we opted in all the analyses reported hereafter for a  $p < .05$  level in order for a variable to be considered statistically significant. This value indicates that only 5% of the results are attributed to chance. Regarding the magnitude of the effect sizes, we followed the guidelines presented by Cohen (1992), who underlined that the Pearson correlation coefficient (*r*) represents an index of the strength of the effect sizes, in which effects sizes between variables are considered small if  $r = .10$ , medium if  $r = .30$  and large if  $r = .50$ .

Moreover, student's *t*-tests were performed in order to conduct mean comparisons of teacher's behavioral factors and children's overall performance in the *BSEDS* battery according to familial antecedents of reading difficulties (absence vs. presence) and parents' educational level (low vs. median-high). As for the Pearson correlation coefficient, the interpretation of this procedure relied both on the indexes of statistical significance and effect sizes. In what regards the latter, Cohen's *d* was calculated in order to evaluate the magnitude of the effect sizes. As suggested by the Cohen (1992), small effect sizes are considered if  $d = .20$ , medium effect sizes if  $d = .50$  and large effect sizes if  $d = .80$ .

In addition, chi-square tests were performed to investigate the association between parents' educational level and familial antecedents of reading difficulties. This statistical procedure allows for the analysis of the relation between dichotomized measures. The results of this procedure were interpreted according to the statistical significance and effect sizes indexes. For the latter, Cohen's *w* was computed and used as the index of the magnitude of the effect sizes. The strength of the associations between measures is considered small if  $w = .10$ , medium if  $w = .30$  and large if  $w = .50$ .

The results obtained in the analysis of the concurrent associations among the variables in kindergarten oriented the linear regression procedures performed subsequently. These procedures aimed to investigate the unique contribution of teacher's behavioral problems and familial antecedents of reading difficulties in the proportion of variance explained in children's overall performance in the *BSEDS* battery. The selection of the variables to be included in the regression analyses was based on theoretical considerations, in accordance with the objectives delineated for the current analyses, and driven by the results of the previous analyses examining the concurrent relations among variables in kindergarten. Thus, we conducted these regression analyses in several steps. On one hand, we were interested in examining the contribution of teachers' behavioral factors in the prediction of children's overall performance in the *BSEDS* battery. On the other hand, we aimed to scrutinize specifically the role of the measure of familial antecedents of reading difficulties as a predictive variable of children's performances in the *BSEDS* battery, while controlling for the effects of the remaining variables referring to teachers' behavioral factors and family contextual characteristics.

For the purposes of the present analyses, the regression procedures allowed to estimate the proportion of variance in children's overall performance in the *BSEDS* battery (dependent variable) accounted by each of the behavioral and familial measures (independent variables) introduced in the regression model. The results of the regression procedures were interpreted on the basis of the statistical significance obtained for the parameter estimates ( $\beta$ ) of each variable and the overall effect sizes of all the variables introduced in the model ( $r^2$ ). The statistical significance of the parameter estimate ( $\beta$ ) attributed to each variable introduced in the model allows to determine if a particular variable is contributing independently to the proportion of variance explained in the dependent variable, while controlling for the effects of the remaining variables included simultaneously in the regression model. Importantly, these parameter estimates were considered independently of the hierarchical order of introduction of the variables in the regression model (type III sum of squares). In addition, the r-square coefficient ( $r^2$ ) represents an estimate index defining the total variance attributable to all the variables introduced concomitantly in the regression model.

Lastly, student's *t*-tests and Pearson correlation procedures were performed between the kindergarten measures that significantly predicted children's overall performance in the *BSEDS* battery and each of the subtests that composed this assessment battery. We were interested in examining the patterns of associations between each of the subtests composing the *BSEDS* battery and each of the predictor variables that were statistically significant in the regression procedures. The interpretation of the results obtained in these analyses was based on the statistical significance and effect sizes of these statistical procedures, as described previously for the student's *t*-test and Pearson correlation procedures.

## Results

The results presented subsequently are organized in accordance with the analytic plan of interrelations among the study variables described in the general conceptual model (cf. Figure 5). We begin by presenting the descriptive statistics of the study's variables in kindergarten (Table 9). Subsequently, we describe the results of the correlations among teacher's behavioral factors in kindergarten (Pathway *a*, Table 10) and between these behavioral factors and children's overall performance in the *BSEDS* battery (Pathway *b*, Table 11). Afterwards, we indicate the associations of children's overall performance in the *BSEDS* battery and

teachers behavioral factors with family background (Pathway *c*), namely familial antecedents of reading difficulties (Table 12) and parental educational level (Table 13), and we describe the results of the associations between the latter family background characteristics (Pathway *d*, Table 14). Moreover, we present the results of the regression analysis using the teacher's behavioral factors and the family background characteristics as predictors of the *BSEDS* global composite score (Table 15). Lastly, we describe the results concerning the specific associations of each subtest of the *BSEDS* battery with the teacher's Inattention factor (Table 16), familial antecedents of reading difficulties (Table 17) and parents' educational level (Table 18).

### 1. Descriptive and demographic statistics

The descriptive statistics and sociodemographic characteristics of the kindergarten measures used in the present analyses are presented in Table 9. As previously mentioned, reliabilities (Cronbach's *alpha*) for the teachers' questionnaire and the *BSEDS* battery were in the acceptable range. Moreover, there was an adequate variability in the *BSEDS* measures and children's performances in this battery were free from floor and ceiling effects, which allowed us to examine their association with teachers' behavioral factors and familial variables. However, it is informative to denote that the number of observations (*N*) available for some of the variables differed according to the assessment measures used to collect data at kindergarten. Therefore, due to the presence of missing data for some of the participants, the data analysis was based on the total of participants that presented complete data in each of the measures included in the analyses described subsequently.

Table 9. Descriptive statistics of the study variables in kindergarten

<i>Kindergarten variables</i>	N	%	M	SD	Min	Max
<i>Sociodemographic background</i>	812					
Sex (boys)		52				
Age (years)			5.84	.34	5.07	7.19

% (Percentage); Mean (M); Standard Deviation (SD); Minimum (Min); Maximum (Max)



Table 9 (continued). Descriptive statistics of the study variables in kindergarten

<i>Kindergarten variables</i>	N	%	M	SD	Min	Max
<i>Sociodemographic background</i>	812					
Parents educational level						
At least one parent has high school diploma	395	53				
<i>Familial antecedents of reading difficulties</i>						
Cases reported	167	21				
<i>BSEDS</i>						
Global composite score	677		.71	.14	.24	.99
Phonological awareness composite score	789		15.70	5.85	0	23
Rhymes	796		5.37	2.41	0	8
Syllabic counting	794		4.38	1.17	0	5
Syllabic deletion	789		5.89	3.63	0	10
Vocabulary	753		20.18	4.29	1	30
Oral Comprehension	798		7.53	1.74	1	10
Letter reading	786		5.82	3.38	0	12
Pseudoword Repetition	796		12.55	3.13	1	16
Sentence repetition	766		13.78	2.89	0	16
Figure reproduction	781		4.24	1.88	0	6
<i>Teachers' Questionnaire</i>	590					
Hyperactivity			1.05	1.99	0	8
Inattention			1.22	1.98	0	8
Conduct Problems			.64	1.49	0	8
Unsociability			.31	.95	0	7

% (Percentage); Mean (M); Standard Deviation (SD); Minimum (Min); Maximum (Max)

## 2. Association and correlation analyses

### 2.1. Cross sectional associations of teachers' behavioral factors in kindergarten

The analyses of the associations of the behavioral factors derived from the teachers' questionnaires were performed through Pearson correlation procedures ( $r$ ). The results of these analyses are presented in Table 10.

As seen, the associations among the four behavioral factors were positive and statistically significant ( $p < .05$ , in all cases). The results evidenced medium effect sizes between the Hyperactivity factor and the Inattention, Conduct problems and Unsociability factors. Likewise, the strength of the association between the Conduct problems factor and

Unsociability was large. Moreover, the results revealed associations of medium magnitude of the Inattention factor with the Conduct problems and Unsociability factors.

Table 10. Correlations among teacher's behavioral factors in kindergarten

	Inattention	Conduct Problems	Unsociability
<i>Teachers' Questionnaire</i>			
Hyperactivity	.51***	.55***	.52***
Inattention		.39***	.41***
Conduct Problems			.52***

\*\*\*  $p < .001$

## 2.2. Cross-sectional associations between *BSEDS* battery and teacher's behavioral factors in kindergarten

The Pearson correlation procedure was used to investigate the associations between children's overall performance in the *BSEDS* battery and the four behavioral factors. Table 11 depicts the results of these analyses. The totality of teachers' behavioral factors was negatively correlated with children's overall performance in the *BSEDS* battery ( $p < .05$ , in all cases). However, the magnitude of the effect sizes varied according to the behavioral factor being analyzed. The results indicated an association of medium magnitude between the Inattention factor and children's overall performance in the *BSEDS* battery. For the associations of the Hyperactivity, Conduct problems and Unsociability factors with the overall *BSEDS* composite score, the strength of the effect sizes was small.

Table 11. Correlations between *BSEDS* global composite score and teachers' behavioral factors in kindergarten

	<i>BSEDS composite score</i>
	<i>r</i>
<i>Teachers' Questionnaire</i>	
Hyperactivity	-.24 ***
Inattention	-.43 ***
Conduct Problems	-.10 *
Unsociability	-.23 ***

\*  $p < .05$ , \*\*\*  $p < .001$

### 2.3. Cross-sectional associations between familial characteristics with *BSEDS* battery and teacher's behavioral factors in kindergarten

To evaluate the mean differences in children's overall performance in the *BSEDS* battery and teachers' behavioral factors according to familial antecedents of reading difficulties and parents' educational level, we performed student's *t*-tests. The results of these analyses are presented in Table 12 and 13, respectively.

In what regards children's overall performance in the *BSEDS* battery according to the presence or absence of antecedents of reading difficulties in the child's family, the results revealed statistically significant differences in the *BSEDS* composite score according to parents' reports of familial antecedents of reading difficulties ( $p < .05$ ). As seen in Table 12, children's whose parents indicated the presence of familial antecedents of reading difficulties presented lower overall performances in the *BSEDS* battery, when compared to children whose parents' did not report a familial history of reading difficulties. Despite the statistical significance of the mean differences observed in the *BSEDS* global score according to the presence or absence of familial antecedents of reading difficulties, it is elucidative to signalize that the magnitude of the effect sizes were small ( $d = .36$ ).

Table 12. Mean comparisons of *BSEDS* global composite score and teachers' behavioral factors according to familial antecedents of reading difficulties in kindergarten

	<i>Familial antecedents of reading difficulties</i>						<i>df</i>	<i>t</i>	<i>d</i>
	Absence			Presence					
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>			
<i>BSEDS</i>									
Global composite score	.72	.14	545	.67	.14	132	675	3.16 **	.36
<i>Teachers' Questionnaire</i>									
Hyperactivity	.98	1.94	459	1.29	2.17	128	585	-1.56 <i>ns.</i>	.16
Inattention	1.08	1.86	451	1.69	2.31	128	577	-3.07 **	.31
Conduct Problems	.60	1.47	460	.76	1.58	130	588	-1.09 <i>ns.</i>	.11
Unsociability	.27	.88	458	.41	1.19	129	585	-1.38 <i>ns.</i>	.15

*ns.* non significant, \*\*  $p < .01$

With respect to the mean differences in teacher's behavioral factors according to the presence or absence of familial antecedent of reading difficulties, the results indicated that only the mean differences in the Inattention factor were statistically significant according to family history of reading difficulties ( $p < .05$ ). Children whose parents had reported the presence of familial antecedents of reading difficulties presented a higher frequency of inattentive behaviors reported by the teacher. The effect sizes relative to the magnitude of the association between the Inattentive factor and familial antecedents of reading difficulties were small ( $d = .31$ ). There were no significant mean differences in the Hyperactivity, Conduct problems and Unsociability factors according to the presence or absence of a familial history of reading difficulties.

The same statistical procedure was used in order to examine mean differences in *BSEDS* overall performance and teachers' behavioral factors according to parents' educational level (Table 13).

The results revealed that children's overall performance in the *BSEDS* battery was significantly different according to a low or median-high educational level of the parents ( $p < .05$ ). Children from families where parental educational levels were median high presented higher overall performances in the *BSEDS* battery, when compared to children characterized by lower educational levels of the parents. The analysis of the effect sizes indicated a medium magnitude of the association between parental educational level and children's *BSEDS* global scores ( $d = .50$ ).

Regarding the mean differences of teachers' behavioral factors according to parents' educational level, the results revealed statistically significant differences in the Inattention factor as a function of the educational levels of the parents. Children whose parents' educational level was median-high obtained in average less reports of inattentive behaviors by the teacher ( $p < .05$ ). Moreover, the coefficient relative to the magnitude of the association between teachers' Inattention factor and parental educational level revealed small effect sizes between these two measures ( $d = .21$ ).

Table 13. Mean comparisons of *BSEDS* global composite score and teachers' behavioral factors according to parents' educational level in kindergarten

	<i>Parents educational level</i>						<i>df</i>	<i>t</i>	<i>d</i>
	High school diploma								
	None of the parents			At least one					
	M	SD	N	M	SD	N			
<i>BSEDS</i>									
Global composite score	.68	.14	287	.75	.12	339	624	-7.11***	.50
<i>Teachers' Questionnaire</i>									
Hyperactivity	1.09	2.06	261	.93	1.87	284	543	.94 <i>ns.</i>	.08
Inattention	1.47	2.06	258	.97	1.89	284	540	2.96**	.21
Conduct Problems	.64	1.44	264	.61	1.51	283	545	.29 <i>ns.</i>	.02
Unsociability	.26	.93	265	.31	.96	281	544	-.65 <i>ns.</i>	.05

*ns.* non significant, \*\*  $p < .01$ , \*\*\*  $p < .001$

#### 2.4. Cross-sectional associations of familial antecedents of reading difficulties and parents educational level in kindergarten

Lastly, chi-square tests were used to examine the associations between familial antecedents of reading difficulties and parents' educational level, as presented in Table 14.

Table 14. Chi-square test between familial antecedents of reading difficulties and parents educational level in kindergarten

	<i>Parents educational level</i>		<i>df</i>	<i>chi-square</i>	<i>w</i>
	High school diploma				
	None of the parents	At least one			
	N (%)	N (%)			
<i>Familial antecedents of reading difficulties</i>					
Absence	242 (69.14)	337 (85.32)	1	28.03 ***	.19
Presence	108 (30.86)	58 (14.68)			

\*\*\* $p < .001$

The results indicated a statistically significant association between these measures (chi-square<sup>2</sup> (1) = 28.03,  $p < .05$ ). The presence of familial antecedents of reading difficulties tended to be reported by parents characterized by lower educational levels, when compared with families that did not reported a family history of reading difficulties. The analysis of the magnitude of the effect sizes between familial antecedents of reading difficulties and parents' educational level indicated small effect sizes between these two measures ( $w = .19$ ).

### 3. Regression analyses

#### 3.1. Predicting *BSEDS* global score from teacher's behavioral factors and familial characteristics in kindergarten

In order to examine the proportion of variance of children's overall performance in the *BSEDS* battery accounted for by teachers' behavioral factors and familial characteristics, we performed linear regression analyses. The selection of the variables included in this linear regression was based on the statistical significance of the associations ( $p < .05$ ) obtained in the analyses described previously. We performed these linear regressions in three steps and the results of these analyses are exposed in Table 15.

In the first step (Step 1), we aimed at investigating the contribution of the behavioral factors as predictive variables of the *BSEDS* global score and, thus, only the behavior factors derived from the teachers' questionnaire were introduced in the regression model. In the second step (Step 2), we introduced the variable referring to familial antecedents of reading difficulties together with the behavioral factors and, subsequently, in a third step (Step 3), the variable pertaining to parents' educational level was included in the regression model. In these steps of analyses, we were interested at examining the unique contribution of the familial antecedents of reading difficulties in the proportion of variance explained of the *BSEDS* global score, while controlling for the effects of teachers' behavioral factors and parents' educational level.

The results of the first step of analyses (Step 1) revealed that the four behavioral factors derived from the teachers' questionnaire contributed to explain 20% ( $r^2 = .20$ ) of the total variance of the *BSEDS* global score [ $F(4,450) = 27.36$ ,  $p < .0001$ ]. However, only the contribution of the Inattention, Conduct Problems and Unsociability factors was statistically significant ( $p < .05$ ). The Hyperactivity factor failed to reach statistical significance ( $p = .54$ ).

Table 15. Regression analysis of the *BSEDS* composite score in kindergarten

	<i>BSEDS composite score</i>				
	$r^2$	$\beta$	$S(\beta)$	$t$	$p$
<b>Step 1</b>	.20				
<i>Teachers' Questionnaire</i>					
Hyperactivity	.	-.003	.004	-.61	.54
Inattention		-.03	.004	-8.07	<.0001
Conduct Problems		.01	.005	2.07	.04
Unsociability		-.02	.008	-2.24	.03
<b>Step 2</b>	.20				
<i>Teachers' Questionnaire</i>					
Inattention		-.03	.003	-10.10	<.0001
<i>Familial antecedents of reading difficulties</i>					
		-.04	.02	-2.46	.014
<b>Step 3</b>	.25				
<i>Teachers' Questionnaire</i>					
Inattention		-.03	.003	-9.41	<.0001
<i>Familial antecedents of reading difficulties</i>					
		-.03	.01	-2.05	.04
<i>Parents educational level</i>					
		.06	.01	5.14	<.0001

$r^2$ . R-square;  $\beta$ . Parameter Estimate;  $S(\beta)$ . Parameter Estimate /Standard Error

It is interesting to denote in this analyses the positive sign evidenced by the regression coefficient ( $\beta$ ) of the Conduct problems factor, while controlling for the simultaneous effects of the remaining behavioral factors. This particular result, together with the previous results relative to the strong correlations observed among the teachers' behavioral factors, indicates that children whose teachers reported Conduct problems concomitantly with another behavioral dimension tended to present higher results in the *BSEDS* global score.

The first step of the regression analyses revealed that teachers' reported Inattention, Conduct problems and Unsociability contributed independently for the proportion of variance explained in children's overall performance in the *BSEDS* battery. However, taking into account the objectives delineated for the present analyses and the evidence that only the teachers' Inattention factor was associated with the measure of familial antecedents of reading difficulties, only the Inattention factor derived from the teachers questionnaires was considered in the analyses described subsequently.

Hence, in the second step (Step 2) of the regression analyses we introduced the teachers' Inattention factor together with the measure of familial antecedents of reading difficulties. The results indicated that the measure of familial antecedents of reading difficulties contributed significantly to the proportion of variance explained in children's overall performance in the *BSEDS* battery, and independently of the effects of the Inattention factor reported by the teachers ( $p < .05$ , for both measures). Taken together, both the measure of familial antecedents of reading difficulties and teachers' Inattention factor accounted for 20% of the variance in the *BSEDS* global score [ $F(2,473) = 58.38, p < .0001$ ].

The final step of the regression analyses (Step 3) comprised the inclusion of parent's educational level together with the measure of familial antecedents of reading difficulties and teachers' Inattention factor. The results of this regression model indicated that the inclusion of parents' educational level contributed to increase the proportion of variance explained of the *BSEDS* global score ( $r^2 = .25$ ). Despite the introduction of parents' educational level in the regression model, both the measure of familial antecedents of reading difficulties and teachers' Inattention factor continued to contribute independently to the proportion of variance explained of the *BSEDS* global score ( $p < .05$ ). These three measures accounted for 25% of the proportion of variance explained in children's overall performance in the *BSEDS* battery [ $F(3,444) = 50.48, p < .0001$ ].

#### 4. Association and correlation analyses

##### 4.1. Associations of *BSEDS* subtests with teachers' Inattention factor and familial characteristics in kindergarten

The results obtained in the regression analyses motivated the realization of supplementary analyses aimed to scrutinize the specific associations between the predictive variables derived from the regression models and the set of subtests that composed the *BSEDS* battery. The Pearson correlation procedure was used to examine the associations with the teachers' behavioral factors, and student's *t*-tests were performed in order to uncover mean differences in the *BSEDS* subtests according to the measures of familial antecedents of reading difficulties and parents' educational level.



Table 16 presents the results of the associations between teachers' behavioral factors and the *BSEDS* subtests. The totality of the subtests correlated negatively with the teacher's Inattention factor. This result indicates that a larger number of inattentive behaviors reported by the teacher were associated with children's lower performances in the subtests of the *BSEDS* battery. The associations between the large majority of the subsets and the teachers' Inattention factor were characterized by medium effect sizes (Pearson's  $r$  ranging from .26 to .34), excluding the association of the Pseudoword repetition subtest with the Inattention factor, which indicated small effect sizes ( $r = -.18$ ).

Table 16. Correlations between *BSEDS* subtests and the teachers' Inattention factor in kindergarten

	Inattention
	$r$
<i>BSEDS Subtests</i>	
Phonological awareness	-.34 ***
Vocabulary	-.26 ***
Oral comprehension	-.27 ***
Letter reading	-.28 ***
Pseudoword repetition	-.18 ***
Sentence repetition	-.26 ***
Figure reproduction	-.30 ***

\*\*\*  $p < .001$

Furthermore, as shown in Table 17, the results of the mean comparisons of the *BSEDS* subtests according to familial antecedents of reading difficulties revealed statistically significant differences in the majority of the subtests ( $p < .05$ , in five out of seven cases).

Children whose parents reported a history of reading difficulties in the family tended to obtain lower performances in the *BSEDS* subtests, when compared with children whose parents did not report a family history of reading difficulties. The magnitude of the associations (Cohen's  $d$  coefficient) oscillated between .10 and .37 indicating small effects sizes between familial antecedents of reading difficulties and the *BSEDS* subtests. The exception to this pattern was observed for the means of the Letter reading and Figure reproduction subtests, which were not significantly different in the absence or presence of a family history of reading difficulties.

Table 17. Mean differences of *BSEDS* subtests according to familial antecedents of reading difficulties in kindergarten

	<i>Familial antecedents of reading difficulties</i>						<i>df</i>	<i>t</i>	<i>d</i>
	Absence			Presence					
	M	SD	N	M	SD	N			
<i>BSEDS subtests</i>									
Phonological awareness	15.99	5.73	611	14.45	6.08	178	787	3.12 **	.26
Vocabulary	20.54	4.17	583	18.95	4.46	170	751	4.30 ***	.37
Oral comprehension	7.63	1.72	615	7.20	1.79	183	796	2.90 **	.25
Letter reading	5.90	3.38	608	5.56	3.38	178	784	1.20 <i>ns.</i>	.10
Pseudoword repetition	12.69	3.06	614	12.06	3.31	182	794	2.39 **	.20
Sentence repetition	13.92	2.71	597	13.27	3.41	169	764	2.60 **	.23
Figure reproduction	4.31	2.85	600	4.03	1.95	181	779	1.71 <i>ns.</i>	.15

*ns.* non significant, \*\*  $p < .01$ , \*\*\*  $p < .001$

Regarding the means comparisons of the *BSEDS* subtests according to parental educational level, the results presented in Table 18 revealed statistically significant differences in all the mean values of the subtests according to the low or median-high educational level of the parents ( $p < .05$ , in all cases).

Table 18. Mean differences of *BSEDS* subtests according to parents' educational level in kindergarten

	<i>Parents educational level</i>						<i>df</i>	<i>t</i>	<i>d</i>
	High school diploma								
	None of the parents			At least one					
	M	SD	N	M	SD	N			
<i>BSEDS subtests</i>									
Phonological awareness	14.69	5.99	343	16.99	5.28	382	723	-5.49 ***	.39
Vocabulary	19.38	3.97	323	21.26	4.16	370	691	-6.04 ***	.44
Oral comprehension	7.22	1.78	349	7.92	1.61	383	730	-5.58 ***	.40
Letter reading	5.56	3.49	343	6.33	3.23	379	720	-3.05 **	.23
Pseudoword repetition	12.18	3.28	345	13.04	2.93	386	729	-3.73 ***	.28
Sentence repetition	13.37	3.07	327	14.36	2.42	374	699	-4.77 ***	.34
Figure reproduction	4.04	1.91	341	4.54	1.74	379	718	-3.70 ***	.27

\*\*  $p < .01$ , \*\*\*  $p < .001$

Children whose parents presented a median-high educational level evidenced higher performances in the *BSEDS* subtests, when compared to children from families characterized by lower parental educational levels. Moreover, the magnitude of the associations between parental educational level and children's performances in the *BSEDS* subtests ranged from .23 to .44 suggesting small to medium effect sizes between these measures.

Altogether, these results point out to statistically significant associations and moderate effect sizes between children's performances in the subtests that composed the *BSEDS* battery and the teachers' Inattention factor, while the effects of familial antecedents of reading difficulties and parents educational level tended to be smaller, albeit statistically significant. Moreover, these results indicate that the effects of familial antecedents of reading difficulties were specific to particular subtests, as opposed to the widespread effects of Inattention and parental educational level on the totality of the *BSEDS* subtests.

In conclusion, the first set of analysis aimed to examine the cross-sectional relations between emergent literacy and oral language skills, behavior and familial characteristics during kindergarten. The sample was constituted of 812 children ( $M=5,8$  years,  $SD=3$  months) enrolled in the final year of kindergarten, representative of a suburban and rural community of France. Data were collected along the school year and included the administration of the *BSEDS 5-6 years* battery (Zorman & Jacquier-Roux, 2001) aimed to evaluate children's oral language and emergent literacy skills. Behavioral assessment was performed by means of questionnaires directed to the teachers, and allowed the composition of four indexes of behavioral problems, namely hyperactivity, attention difficulties, conduct problems and unsociability (Giannopulu et al., 2008). Family background was investigated and included familial antecedents of reading difficulties and parents' educational level, obtained through questionnaires assigned to the parents.

The results indicated that the measures of emergent literacy skills were significantly associated with teachers' reports of behavioral problems, parents' educational level and familial antecedents or reading difficulties. Amid the diverse behavioral problems reported by the teachers, hyperactivity, attention difficulties, conduct problems and unsociability were associated with emergent literacy skills. In addition, results revealed that children whose

parents indicated the presence of difficulties in learning to read in their family exhibited lower scores on measures of emergent literacy skills and, simultaneously, a higher frequency of teacher's reports of attention difficulties. Overall, our analyses confirmed the influence of behavioral problems, namely inattention, conduct problems and unsociability, as well as a family history of reading difficulties, in the development of emergent literacy skills, in a non-diagnosed community sample of preschool children. The findings of the present work suggest that children with a family history of reading difficulties are at increased risk for the co-occurrence of reading difficulties and attention problems from kindergarten onwards.



2. Associations of emergent literacy skills, behavior problems and family characteristics at kindergarten with word reading achievement at Grade 5

(Cohort 3)

Cross sectional analyses - Grade 5 (2008 - 2009)

Longitudinal analyses - Kindergarten (2003-2004) to Grade 5 (2008-009)

( $n = 150$ )

## Introduction

Longitudinal studies aimed at examining the development of reading ability from kindergarten through elementary school have consistently presented evidenced that preschoolers' oral language and emergent literacy skills, such as phonological awareness and letter knowledge, may each facilitate the ability to read words during elementary school (Hecht et al., 2000; Lonigan et al., 2000; Storch & Whitehurst, 2002).

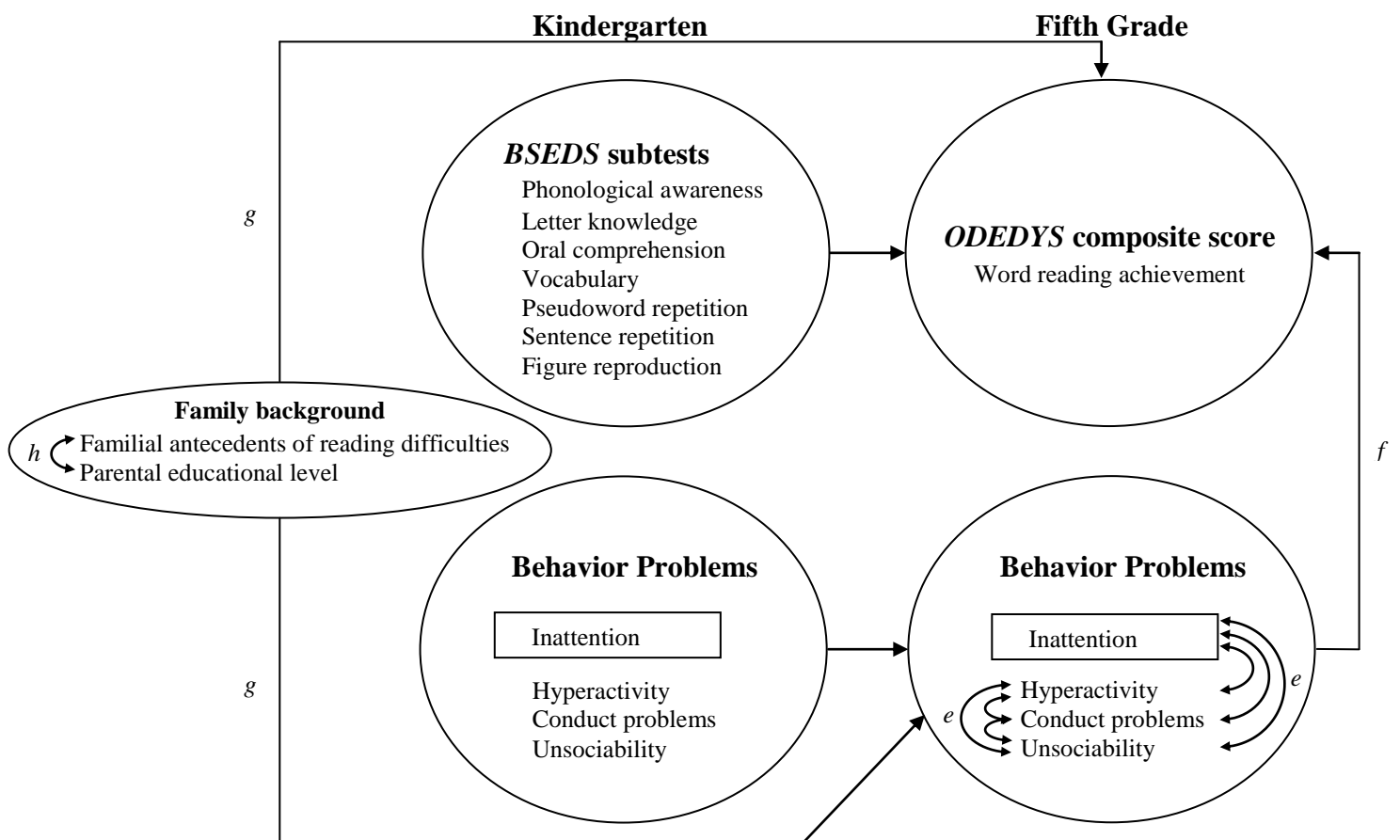
In addition, inattentive behavior, when compared with other externalizing problems, has an adverse influence on the development of emergent literacy skills and contributes to the prediction of reading acquisition during elementary school (Bub et al., 2007; Dally, 2006; Rabiner & Coie, 2000). Likewise, the presence of familial antecedents of reading difficulties is associated with measures of emergent literacy skills at kindergarten and with later word reading achievement at elementary school (Puolakanaho et al., 2007; Snowling et al., 2003).

Based on the literature review, the second set of analyses was oriented by the general conceptual model synthesized in Figure 6. This conceptual framework includes the cross-sectional analyses described formerly in the first set of analyses and introduces the longitudinal pathways of interrelations between the kindergarten measures (cognitive-academic skills, behavioral problems and family characteristics) and word reading at the end of elementary school (Grade 5).

A new component of Figure 6 that has been added in this model is the association of familial antecedents of reading difficulties with teachers' behavioral reports of inattention symptoms at the end of elementary school. This assumption is based on a previous study regarding the concurrent association found during kindergarten among parental antecedents of reading difficulties, early literacy skills and teachers' reports of inattention symptoms (Doyen et al., 2004). In addition, evidence suggests that school-aged children exhibiting a family history of reading difficulties were more likely to manifest Attention-Deficit Disorder Without Hyperactivity (ADD/WO; Hynd, Lorys, Semrud-Clikeman & Nieves, 1991). More recently, twin studies have advanced the argument of the shared familiarity between RD and ADHD (Friedman et al., 2003) and underscored that the association between inattention and reading is in place from kindergarten onwards and is partially attributable to common genetic and

environmental influences, such as the familial context (Ebejer et al., 2010; Paloyelis, Rijdsdijk, Wood, Asherson & Kuntsi, 2010; Willcutt et al., 2007). Therefore, it is proposed that the presence of familial antecedents of reading difficulties will be associated with cognitive-academic abilities, specifically emergent literacy skills, teachers' reports of inattention symptoms, and word reading from kindergarten to fifth grade.

Figure 6. General model for analysis in Grade 5: Relations among emergent literacy skills, familial antecedents of reading difficulties behavioral problems, and word reading from kindergarten to Grade 5.



**Plan of analysis of the interrelations among the study's variables from kindergarten to Grade 5**

- e. Correlations among teacher's behavioral factors at Grade 5
- f. Correlations between *ODEDYS* composite score and teacher's behavioral factors
- g. Associations of family background (familial antecedents of reading difficulties and parents' educational level with *ODEDYS* composite score and behavior problems at Grade 5
- h. Associations between familial antecedents of reading difficulties and parents' educational level at Grade 5



## Objectives

The main goal of the present analyses was to examine the extent to which emergent literacy skills, behavioral problems and familial antecedents of reading difficulties in kindergarten contributed to the prediction of a measure of word reading achievement at the end of elementary school. More specifically, we sought to:

- Examine if teachers' reports of attention problems would be substantially and consistently associated with word reading at Grade 5, when compared with teachers' reports of Hyperactivity, Conduct problems and Unsociability;
- Investigate if children whose parents reported antecedents of reading difficulties in the family tended to obtain a higher frequency of teachers' reports of attention problems and lower performances on measures of word-reading ability in Grade 5, when compared with children without a family history of difficulties in learning to read;
- Analyze if word reading at Grade 5 would be best predicted by kindergarten measures of emergent literacy skills. In addition, scrutinize if a family history of reading difficulties and teachers' reports of attention problems in kindergarten would contribute independently to the prediction of the word reading outcome, while controlling for the effects of emergent literacy skills in kindergarten.

## Method

### Participants

The data used in the present analyses was drawn from the third cohort of the Creusot study. This data spanned a six-year period and refers to a sample of children who were enrolled in kindergarten during the 2003-2004 school year and were followed to the last year of elementary school (Grade 5) during the 2008-2009 school year. The sample used in the analyses reported in this section (hereafter referred to as Grade 5 sample) was a subset of the kindergarten sample described in the cross-sectional analyses presented in the earlier section of the present work.

Due to limited resources regarding research staff to collect data at fifth grade, a representative set of 10 elementary schools was selected across a total of 34 schools from the Creusot Montceau-les-Mines community. This selection procedure aimed to ensure the representativeness of the community's population according with the geographic area of implementation of each elementary school and its suburban or rural condition. For each of the selected elementary schools, data on reading performance and teachers' behavioral reports was collected for all children enrolled in Grade 5 classrooms during the 2008-2009 school year. To be included in the Grade 5 sample, children were required to a) be part of the kindergarten sample during the 2003-2004 school year, and b) to have outcome data in at least one of the study measures at fifth grade (reading performance or teachers' behavioral reports). From the initial kindergarten sample of 812 children, 19% had outcome data on reading performance and 14% had data on teachers' behavioral reports at fifth grade.

This resulted in a fifth grade sample composed of 150 students, 77 boys and 73 girls, with ages ranging from 10 to 11 years (mean 10.7 years, SD 3 months). Although the data collection design at Grade 5 aimed to ensure representativeness of the kindergarten sample, the reduced percentage of participants followed from kindergarten through fifth grade resulted in significant differences between children who were followed from kindergarten to Grade 5 and children who were only assessed at kindergarten. The differences between participants and non-participants in the fifth grade sample are presented below (see Results). All children in the Grade 5 sample attended general education classroom and there were no significant differences in gender and parental nationality within this sample.

## Measures

### Kindergarten assessment (2003-2004 school year)

The instruments used to assess children's emergent literacy skills, behavioral problems, sociodemographic and familial characteristics in kindergarten have been described earlier in the antecedent section of the current work. In kindergarten, the assessment included:

- Sociodemographic questionnaire addressed to parents;
- Familial antecedents of reading difficulties questionnaire addressed to parents;
- *BSEDS* battery administered to kindergarteners;
- Behavioral questionnaire addressed to teachers.

As mentioned earlier, the reliability of the *BSEDS* battery (Cronbach's  $\alpha = .78$ ) and of the teacher's behavioral factors at kindergarten was good (Cronbach's  $\alpha = .87, .82, .78$ , and  $.74$  for Hyperactivity, Inattention, Conduct problems and Unsociability, respectively), and, thus, justified the appropriateness of these instruments for the Grade 5 analyses.

#### Grade 5 assessment (2008-2009 school year)

The assessment performed in fifth grade included two standardized instruments aimed at assessing children's reading and orthographic skills. Moreover, teachers were asked to complete a 21-items questionnaire regarding children's behavior in the classroom. This questionnaire was an identical version of the one administered in kindergarten (a detailed description of this instrument has been provided earlier, cf. Table 8). Thus, data collection at fifth grade comprised:

- *L'Alouette* reading test (Lefavrais, 1967, 2006);
- *ODEDYS* battery (Jacquier-Roux, Valdois & Zorman, 2002);
- Teachers' behavioral questionnaire (Giannopulu et al., 2008).

#### *L'Alouette*

The *l'Alouette* (Lefavrais, 1967, 2006) is a standardized reading test commonly used by clinicians and researchers in France to identify school-aged children that exhibit reading difficulties. This instrument was chosen because it assesses children's reading fluency and accuracy and provides a standardized reading age according with the child's chronological age or school level.

In this test, the child has to read a 265-word text as quickly and as accurately as possible. The text is composed of rare words, as well as some spelling and semantic traps, and reading comprehension is not taken into account. The child has three minutes to complete the task. The total score corresponds either to the number of correct words read in three minutes or to the reading time (if fewer than three minutes), once the number of errors is computed. This score is then converted into a standardized reading age that spans from six to 16 years.

*Outil de Dépistage des Dyslexies (ODEDYS) - Version 2*

The *ODEDYS battery* (Dyslexia Screening Instrument – 2<sup>nd</sup> Version; Jacquier-Roux, Valdois & Zorman, 2002; available at [www.cognisciences.com](http://www.cognisciences.com), for further details) allowed us to assess the word reading outcome at fifth grade by means of a large span of reading and writing tasks. For the purpose of the present study, eight subtests from the *ODEDYS* battery were considered in addition to the *l'Alouette*: Word Reading (Irregular, Regular and Pseudoword Reading), Word Dictation (Irregular, Regular and Pseudoword Dictation) and Sentence Dictation (Accordance and Use Sentences). The selection of these subtests was based on their reported reliability and sensitivity to identify children with reading difficulties during elementary school (Jacquier-Roux, Valdois & Zorman, 2002). Moreover, these selected subtests represent the components of the *ODEDYS* battery aimed to assess the ability to read words at the end of elementary school.

## Word reading (irregular, regular and pseudoword reading)

In this task, the child was provided a list of 20 irregular, 20 regular and 20 pseudowords and was asked to read each list of words as quickly as possible. A score of one was attributed for each word correctly read and three scores were generated, one for words, one for irregular words and another for pseudowords (max = 20 for each set of words). In addition, children's reading speed was recorded as the number of seconds required to read each of the lists of regular, irregular and pseudowords. This scoring system yielded a minimum and maximum score of 37 and 188 seconds, respectively.

## Word dictation (irregular, regular and pseudoword dictation)

This task evaluates children's phonological and orthographic ability. Three sets of 10 irregular, 10 regular and 10 pseudowords each were presented orally to the child. The child was required to write each of the presented words. The total score was the number of words correctly written and three scores were generated for each set of 10 words (max = 10 for each category of words). For pseudowords, a correct answer was also attributed if a child presented an orthographic form that was phonologically correct (e.g. « nagul », « nagule », « nagulle » = one point).

Sentence dictation (use and accordance sentences)

The child was required to write a text composed of five sentences. The main aim of this task was to measure the phonological and orthographic processing of two sets of 10 words each, according to their spelling accuracy (use sentences) and grammatical accordance (accordance sentences). The total score was the sum of the correct answers for each set of 10 words (max = 10 for use sentences and max = 10 for accordance sentences).

Given the multiple measures derived from the *ODEDYS* battery at Grade 5, we aimed to combine them into a composite score of word reading in order to increase reliability and reduce the number of comparisons. For this purpose, we began by combining the standard scores of the three word reading subtests, the reading speed scores for each of the word reading subtests, and the five dictation subtests of words and sentences, into three aggregated measures, respectively. Correlation analysis procedures were then performed to examine the pattern of concurrent relations between these three aggregated measures together with the remaining subtests of the *ODEDYS* battery. The three aggregated scores were substantially correlated among each other ( $r > .50$ ,  $p < .001$ , in all cases), but were only weakly correlated with the remaining subtests of the *ODEDYS* battery.

Subsequently, we conducted a principal component analysis of these aggregated measures and all the subtests from the *ODEDYS* battery. The first factor was composed of these three aggregated measures and accounted for 70% of the variance in the *ODEDYS* overall performances at fifth grade (the factor loadings of these aggregated measures were .86, .82 and .83 for the word reading score, the word reading speed and the dictation score, respectively). Therefore, we considered it appropriate to combine them into a composite score. Raw scores of the tasks that composed each of the three aggregated measures were transformed into  $z$  scores and we generated a normally distributed composite score by summing the  $z$  scores across these three measures. Hence, the word reading composite score represents the combination of eight subtests from the *ODEDYS* battery, as well as children's reading speed in the word reading subtests. Note that this "word reading" composite includes the scores of spelling tasks. Reliability of this composite was good (Cronbach's alpha reliability = .78) and its correlation with *l'Alouette*, a standardized measure of reading fluency and accuracy, was high ( $r = .77$ ,  $p < .001$ ). Consequently, only this composite score was taken into account in the present study as the word reading outcome at fifth grade.

In addition, we used this composite score to discriminate children experiencing reading difficulties and normal readers at Grade 5. Children who evidenced significantly lower performances on the word reading outcome at Grade 5 (defined by a cut off score of one standard deviation below the sample mean) were defined as a reading difficulties group, while children whose performances were above this cut off score composed the normal readers group. This cut off point selected approximately 11 % of the participants in the Grade 5 sample, a prevalence that is congruent with estimates from epidemiological studies (Shaywitz et al., 1990; Fluss et al., 2008 and Watier et al., 2006, for studies developed in France).

#### *Teachers' behavioral questionnaire*

In accordance with the methodology employed by authors of this questionnaire (Giannopulu et al., 2008), we performed a principal component analysis of the 21 questions of the teachers' questionnaire in Grade 5. The results replicated the same four factors derived from the teachers' questionnaire in kindergarten and the same terminology was used for teachers' behavioral factors at Grade 5, namely "hyperactivity", "inattention", "conduct problems" and "unsociability" (cf. table 8). Each factor was composed of teacher's responses to four questions and, as done previously for the kindergarten analyses, we generated new variables by summing up the teachers' responses that composed each specific factor. Hence, these factors represent not only the number of behaviors that teachers reported but also the frequency in which they occurred in the classroom. These four factors accounted for 64% of the variance in the teachers' behavioral reports at fifth grade. The internal consistency of each factor was good with Cronbach's *alpha* values of .87, .81, .80 and .63 at fifth grade for "hyperactivity", "inattention", "conduct problems" and "unsociability", respectively.

#### Procedure

At fifth grade, the *ODEDYS* battery was individually administered in one session per child by trained staff of the research team during the spring semester of the 2008-2009 school year. Concomitantly, teachers were asked to complete a questionnaire concerning children's classroom behavior and reports were collected during the same period of the assessment of reading and writing skills. Fifth grade teachers were unaware both of the results of the cognitive and behavioral testing performed at kindergarten and of the results of the reading and writing assessment performed at Grade 5.

## Plan of analysis

The statistical analyses were conducted with the SAS 9 ® software (SAS, Institute Inc. Cary, NC, USA). We began our analyses by examining the internal consistency of the study measures at fifth grade and by performing descriptive analysis of the variables of interest at this grade level. Subsequently, we used chi-square tests and independent samples *t*-tests to perform group comparisons between the participants followed from kindergarten to Grade 5 and those who were not followed.

The cross sectional analyses of the fifth grade sample included chi-square tests and independent samples *t*-tests used to uncover any differences in the participants' word reading global scores and teachers' behavioral factors at Grade 5 according to parents' educational level and familial antecedents of reading difficulties. In addition, the Pearson correlation procedure was used to examine the associations of teachers' behavioral factors and the word reading global scores at Grade 5.

For the longitudinal analyses of the fifth grade sample, we used the Pearson correlation procedure to analyze the association of teachers' factors at kindergarten with word reading at Grade 5, and the correlation among teachers' factors from kindergarten to fifth grade. Moreover, linear regressions (REG and GLM procedures of SAS) were used to examine the longitudinal effects of familial antecedents of reading difficulties and teachers' behavioral factors in the word reading outcome at Grade 5, while controlling for the effects of children's emergent literacy skills. These regression analyses allow to estimate the degree to which the aforementioned variables (predictors) explained independent variance (type III sum of squares) in children's outcomes at fifth grade (word reading global score). Only the kindergarten and fifth grade measures that were significantly related with children's word reading outcomes at Grade 5 were considered for inclusion in these regression analyses. It should be mentioned that, in these regression analyses, we adjusted for the potential effects of background demographic confounds, namely gender and parents' level of education. In addition, we controlled for the effects of the months of testing of the emergent literacy skills at kindergarten (from January to June). Lastly, chi-square and student's *t*-tests were used to perform group comparisons between children with lower word reading performances at Grade, defined as a reading difficulties group, and normal readers at the same school period.

## Results

The results of the second set of analyses are presented in accordance with the plan of analyses defined to examine the interrelations among the study variables in Grade 5 (cf. general conceptual model presented in Figure 6). First, the descriptive statistics of the study's measure at Grade 5 are presented (Table 19), as well as the results of the group comparisons performed in order to analyse the differences between the participants followed and non-followed from kindergarten through Grade 5 (Tables 20 and 21). Secondly, we present the concurrent associations among teacher's behavioral factors in Grade 5 (pathway *e*, Table 22) and between these behavioral factors and the *ODEDYS* composite score referring to word reading achievement at Grade 5 (pathway *f*, Table 23). We then describe the associations of the *ODEDYS* word reading composite score and teacher's behavioral factors at Grade 5 with family background (pathway *g*), specifically familial antecedents of reading difficulties (Table 24) and parental educational level (Table 25), as well as the associations between these two family background variables (pathway *h*, Table 26). Moreover, we present the results of the regression analysis indicating the relative contribution of children's cognitive-academic skills, teacher's behavioral factors and family background characteristics in kindergarten to the prediction of the *ODEDYS* word reading composite score at Grade 5 (Table 27). Finally, we describe the results of the group comparisons performed between the group of children defined as experiencing reading difficulties and normal readers according to the familial characteristics (Table 28), the subtests of the *BSEDS* battery measured at kindergarten and teacher's reports of inattention problems at Grade 5 (Table 29).

### 1. Descriptive statistics and preliminary analyses

Demographic and descriptive statistics for all the measures at Grade 5 are presented in Table 19. As seen, the number of observations (N) available for some of the study's variables differed according with the assessment measures used to collect data. Thus, due to the presence of missing data, the analyses described subsequently were based on the total of participants that presented complete data for each of the measures at Grade 5. The performances in the *ODEDYS* subtests were free from floor and ceiling effects on almost all tasks, with the exception of modest ceiling effects on two of the dictation tasks. However, there was sufficient variability on these measures to allow us to examine their association with the remaining variables.



Table 19. Descriptive statistics of the study variables in Grade 5

<i>Fifth grade variables</i>	N	%	M	SD	Min	Max
<i>Sociodemographic background</i>						
	150					
Sex (boys)		51				
Age			10.77	.33	10.08	11.42
<i>Parents educational level</i>						
At least one parent has high school diploma	59	39				
<i>Familial antecedents of reading difficulties</i> (cases reported)						
	21	14				
<i>ODEDYS</i>						
Word Reading composite score	150		-.0006	.84	-2.56	1.41
<i>Teachers' Questionnaire</i>						
	114					
Kindergarten Hyperactivity			.85	1.60	0	7
Fifth grade Hyperactivity			.95	1.82	0	8
Kindergarten Inattention			1	1.71	0	8
Fifth grade Inattention			.97	1.65	0	7
Kindergarten Conduct Problems			.71	1.37	0	8
Fifth grade Conduct Problems			.66	1.32	0	7
Kindergarten Unsociability			.14	.46	0	2
Fifth grade Unsociability			.40	.91	0	4

In order to examine group differences between the participants followed and non-followed from kindergarten through fifth grade, chi-square and *t*-test comparisons were conducted for all the study's variables. Results of these analyses are summarized in Table 20 and 21.

As seen in Table 20, the group followed through fifth grade contained a significantly higher proportion of students whose at least one parent had a high school diploma, when compared with the kindergarten group. Students in the non-followed group came from families with a significantly higher proportion of parents that reported reading difficulties in the family, as compared to students in the fifth grade sample.

Table 20. Group differences between the children non-followed and followed from kindergarten through Grade 5 according to sociodemographic and familial variables

	Non-followed		Followed		<i>chi-square</i>	<i>df</i>	<i>p</i>
	N	(%)	N	(%)			
<i>Sociodemographic background</i>							
<i>Sex</i>							
Boys	343	(52.13)	79	(51.30)	.03	1	.85
Girls	315	(47.87)	75	(48.70)			
<i>Parents educational level</i>							
None of the parents has high school diploma	293	(49.16)	57	(38.26)	5.69	1	.01
At least one parent has high school diploma	303	(50.84)	92	(61.74)			
<i>Familial antecedents of reading difficulties</i>							
Absent	514	(77.88)	133	(86.36)	5.51	1	.02
Present	146	(22.12)	21	(13.64)			

Table 21. Group differences between the children non-followed and followed from kindergarten through Grade 5 according to the *BSEDS* composite score and teachers' ratings of behavioral problems

	Non-followed			Followed			<i>t</i>	<i>p</i>
	M	SD	N	M	SD	N		
<i>BSEDS</i>								
Global composite score	.69	.14	536	.73	.11	141	-3.45	.0006
<i>Teachers' Questionnaire</i>								
Kindergarten Hyperactivity	1.08	2.06	498	.83	1.58	89	1.32	.18
Kindergarten Inattention	1.25	2.02	491	1.01	1.71	88	1.20	.23
Kindergarten Conduct Problems	.61	1.52	501	.73	1.36	89	-.70	.48
Kindergarten Unsociability	.33	1.01	499	.13	.45	88	3.03	.003

Moreover, as presented in Table 21, *t* test comparisons revealed that children followed from kindergarten through Grade 5 obtained significantly higher global scores in the *BSEDS* battery and a lower proportion of unsociability symptoms reported by the teacher, than the non-followed group.

However, both groups were equivalent concerning gender and teachers' reports of Hyperactivity, Inattention and Conduct problems.

The significant differences found between the groups of participants followed and non-followed through fifth grade may be partially explained by grade retention (i.e. two subsequent years at the same grade) of some students with academic difficulties from kindergarten onwards. In the French educational system, children showing low educational achievement can be retained throughout the course of elementary school. Therefore, students retained during elementary school were not in fifth grade during the school year where data collection took place. Preschoolers with lower performances on the measures of early reading skills and whose parents had lower educational levels presented a significantly higher probability of being retained during elementary school, due to the often cited influence of these variables on children's school achievement (for a review, see Duncan et al., 2007). Hence, grade level retention of participants from kindergarten to fifth grade contributed to the sample attrition observed between the two grade levels and provides a plausible justification for the over-representation of children in the fifth grade sample with better cognitive resources and a family background characterized by higher educational levels of the parents.

## 2. Cross-sectional analyses in Grade 5

### 2.1. Cross-sectional associations of teacher's behavioral factors in Grade 5

To assess the concurrent association among the four factors derived from the teachers' behavioral questionnaire, correlation analyses were conducted within the fifth grade sample.

As seen in Table 22, teachers' behavioral reports were all significantly associated with each other at the .001 level. Teachers' reports of Hyperactivity were significantly correlated with Inattention ( $r = .49$ ), Conduct problems ( $r = .45$ ) and Unsociability ( $r = .53$ ). Furthermore, teachers' reports of Conduct problems correlated significantly with Unsociability ( $r = .45$ ), and Inattention was correlated both with Conduct problems ( $r = .26$ ) and Unsociability ( $r = .33$ ). The magnitude of the effect sizes was large for the majority of teachers' behavioral factors, with the exception of the association of Inattention with Conduct problems that indicated medium effect sizes between these two factors.

Table 22. Correlations among teacher's behavioral factors in Grade 5

	Inattention	Conduct Problems	Unsociability
<i>Teachers' Questionnaire</i>			
Hyperactivity	.49***	.45***	.53***
Inattention		.26***	.33***
Conduct Problems			.45***

\*\*\*  $p < .001$ 

## 2.2. Cross-sectional associations between *ODEDYS* word reading score and teachers' behavioral factors in Grade 5

To assess the concurrent associations between children's overall performance in the *ODEDYS* battery and teachers' behavioral reports at fifth grade, we conducted Pearson correlation analyses. The results of these analyses are presented in Table 23. As shown, the results revealed that only Inattention reported by the teacher was concurrently related with word reading at fifth grade ( $r = -.34, p < .001$ ) and that the magnitude of the association indicated medium effect sizes between these measures. Conversely, the correlations of teachers' reported Hyperactivity, Conduct problems and Unsociability with the word reading composite score in Grade 5 failed to reach statistical significance ( $p > .05$  in all cases).

Table 23. Correlations between the *ODEDYS* word reading score and teachers' behavioral factors in Grade 5

	<i>Grade 5 ODEDYS word reading score</i>
	<i>r</i>
<i>Teachers' Questionnaire</i>	
Hyperactivity	.002 <i>ns.</i>
Inattention	-.34 ***
Conduct Problems	.09 <i>ns.</i>
Unsociability	.05 <i>ns.</i>

*ns.* non significant, \*\*\*  $p < .001$

### 2.3. Cross-sectional associations of familial characteristics with the *ODEDYS* word reading score and teacher's behavioral factors in Grade 5

In order to examine group differences in the word reading score and teachers' reports of behavioral problems at fifth grade according to familial antecedents of reading difficulties and parents' educational level, *t*-test comparisons were performed. The results of the analyses pertaining to familial antecedents of reading difficulties are displayed in Table 24 and the results referring to parents' educational level are presented in Table 25.

Regarding the measure of familial antecedents of reading difficulties, the results presented in Table 24 revealed that parental reports of familial antecedents of reading difficulties were related with lower word reading scores ( $t = 3.33, p = .001$ ) and with a higher frequency of teachers' reports of Inattention ( $t = -2.75, p = .007$ ).

Table 24. Mean comparisons of the *ODEDYS* word reading score and teachers' behavioral factors according to familial antecedents of reading difficulties in Grade 5

	<i>Familial antecedents of reading difficulties</i>						<i>df</i>	<i>t</i>
	Absence			Presence				
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>		
<i>ODEDYS</i>								
Word reading score	.09	.77	131	-.54	1.02	21	23.8	3.33 ***
<i>Teachers' Questionnaire</i>								
Hyperactivity	.91	1.74	101	1.05	2.06	20		-.32 <i>ns.</i>
Inattention	.78	1.40	101	1.85	2.32	20		-2.75**
Conduct Problems	.70	1.38	100	.40	.88	20		.93 <i>ns.</i>
Unsociability	.41	.83		.30	.92	20		.49 <i>ns.</i>

*ns.* non significant; \*\*  $p < .01$ ; \*\*\*  $p < .001$

Moreover, as presented in Table 25, the results of the mean comparisons regarding the *ODEDYS* word reading score and teachers' reports of behavioral problems at Grade 5 according to parents' educational level indicated that parental education was related neither with the word reading outcome nor with teachers' reports of behavioral problems at fifth grade ( $p > .05$ , in all cases).

Table 25. Mean comparisons of the *ODEDYS* word reading score and teachers' behavioral factors according to parents' educational level in Grade 5

	<i>Parents educational level</i>						<i>df</i>	<i>t</i>
	<i>High school diploma</i>							
	<i>None of the parents</i>			<i>At least one</i>				
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>		
<i>ODEDYS</i>								
Word reading score	-.06	.80	56	.04	.87	91	145	.70 <i>ns.</i>
<i>Teachers' Questionnaire</i>								
Hyperactivity	1.18	1.99	46	.82	1.68	71	115	1.11 <i>ns.</i>
Inattention	1.28	1.81	46	.79	1.52	71	115	1.59 <i>ns.</i>
Conduct Problems	.72	1.34	46	.63	1.33	70	114	.35 <i>ns.</i>
Unsociability	.59	1.13	46	.28	.70	71	115	1.81 <i>ns.</i>

*ns.* non significant

Finally, the associations between parental educational level and familial antecedents of reading difficulties were examined through chi-square tests. The results presented in Table 26 indicate that parents' educational level was not significantly associated with the measure of familial antecedents of reading difficulties in the participants composing the fifth grade sample ( $p > .05$ ).

Table 26. Chi-square test between familial antecedents of reading difficulties and parents educational level in Grade 5

	<i>Parents educational level</i>		<i>df</i>	<i>chi-square</i>
	<i>High school diploma</i>			
	<i>None of the parents</i>	<i>At least one</i>		
	<i>N (%)</i>	<i>N (%)</i>		
<i>Familial antecedents of reading difficulties</i>				
Absence	48 (38.71)	79 (61.29)	1	.96 <i>ns.</i>
Presence	8 (38.10)	13 (61.90)		

*ns.* non significant

### 3. Longitudinal analyses

#### 3.1. Predicting word reading at fifth grade from cognitive-academic skills, familial antecedents of reading difficulties at kindergarten and teachers' behavioral questionnaire (kindergarten and Grade 5)

The longitudinal contribution to the prediction of the *ODEDYS* word reading outcome at Grade 5 of the variables included in the analyses reported in the present section was assessed by means of univariate regression procedures. The results of these analyses are presented in Table 27 and depict the parameter estimate coefficient attributed to each study variable in the prediction of word reading at fifth grade, as well as the proportion of variance uniquely accounted by each variable included in the statistical model. These results were obtained from different sets of regression analysis and only the variables significantly correlated with word reading at Grade 5 were included in these analyses. This eliminated all variables except teachers' reports of Inattention at Grade 5 ( $r = -.34, p = .0002$ ), parental reports of familial antecedents of reading difficulties ( $r = -.26, p = .001$ ), and three emergent literacy measures from the *BSEDS* battery at kindergarten, namely syllabic deletion ( $r = .30, p = .0002$ ), oral comprehension ( $r = .24, p = .003$ ) and letter reading ( $r = .31, p = .0001$ )

The first set of regression analyses (Step1) examined the unique influence of familial antecedents of reading difficulties and teachers' reports of Inattention at Grade 5 on the word reading outcome, without controlling for the effects of the literacy-related variables measured at kindergarten. The results indicated that these two variables uniquely accounted for 15% of the proportion of variance of the word reading outcome at fifth grade. In a second stage (Step 2), we entered the abovementioned *BSEDS* subtests into our analysis as possible predictors of word reading at fifth grade. The results indicated that the subtests of syllabic deletion, oral comprehension and letter reading made significant independent contributions to the prediction of word reading at Grade 5 ( $r^2 = .18$ ).

Subsequently, familial antecedents of reading difficulties (Step 3) and teachers' reports of Inattention at grade 5 (Step 4) were progressively added to the model one at a time, while controlling for the effects of the three *BSEDS* subtests on word reading at fifth grade. This allowed us to assess the unique contribution of familial antecedents of reading difficulties and teachers' reports of Inattention at Grade 5 in the proportion of variance of the word reading

outcome. The inclusion of familial antecedents of reading acquisition in the statistical model contributed to increase the proportion of total variance explained by these four variables ( $r^2 = .20$ ). Despite the reasonably low, although statistically significant, proportion of variance explained by familial antecedents of reading acquisition, the results of this model demonstrate the unique contribution of familial antecedents of reading difficulties in the word reading outcome at Grade 5, even after the emergent literacy variables were entered into the model.

Table 27. Regression analysis of the ODEDYS word reading composite score at fifth grade

	<i>Grade 5 ODEDYS word reading score</i>				
	$r^2$	$\beta$	$S(\beta)$	$t$	$p$
<b>(Step 1)</b>	.15				
<i>Teachers' Questionnaire</i>					
Fifth grade Inattention		-.15	.05	-3.24	.002
<i>Familial antecedents of reading difficulties</i>		-.43	.20	-2.10	.04
<b>(Step 2)</b>	.18				
<i>BSEDS subtests</i>					
Syllabic deletion		.06	.02	2.56	.012
Oral Comprehension		.09	.05	1.99	.048
Letter reading		.07	.03	2.67	.008
<b>(Step 3)</b>	.20				
<i>BSEDS subtests</i>					
Syllabic deletion		.05	.02	2.29	.02
Oral Comprehension		.08	.05	1.69	.09
Letter reading		.06	.02	2.62	.009
<i>Familial antecedents of reading difficulties</i>		-.42	.20	-2.13	.04
<b>(Step 4)</b>	.25				
<i>BSEDS subtests</i>					
Syllabic deletion		.05	.03	2.18	.03
Oral Comprehension		.05	.05	1.05	.30
Letter reading		.08	.03	2.65	.009
<i>Teachers' Questionnaire</i>					
Fifth grade Inattention		-.09	.05	-1.75	.08
<b>(Step 5)</b>	.26				
<i>BSEDS subtests</i>					
Syllabic deletion		.05	.03	2.11	.04
Letter reading		.08	.03	2.77	.006
<i>Familial antecedents of reading difficulties</i>		-.37	.21	-1.76	.08
<i>Teachers' Questionnaire</i>					
Fifth grade Inattention		-.08	.05	-1.66	.10

$r^2$ . R-square;  $\beta$ . Parameter Estimate;  $S(\beta)$ . Parameter Estimate /Standard Error



In contrast (Step 4), despite the unique contribution of fifth grade teachers' reports of Inattention in the proportion of variance explained in the word reading outcome ( $r^2 = .25$ ), its value failed to reach significance once the emergent literacy skills measured at kindergarten were taken into account. This result suggests that the emergent literacy skills measured at kindergarten accounted for the association between teachers' reports of Inattention and word reading at Grade 5. Therefore, we conducted a correlation analysis to examine the association between teachers' reports of Inattention at fifth grade and the *BSEDS* subtests administered during kindergarten that significantly predicted the word reading outcome at grade 5. Results evidenced that only the subtest of letter reading was significantly correlated with teachers' report of Inattention at Grade 5 ( $r = -.30, p = .001$ ). This result suggests that the association between teachers' reported Inattention and word reading at Grade 5 was mediated by the study's measure of letter reading skills.

The final set of regression analyses (Step 5) included the simultaneous entry of all the above mentioned variables as explanatory variables of the Grade 5 word reading outcome. In these analyses, the measure of oral comprehension failed to reach statistical significance and was not included in the final model ( $p = .30$ ). Results revealed that the variables of syllabic deletion, letter reading, familial antecedents of reading difficulties and teachers' reports of Inattention at Grade 5 accounted for 26% of the proportion of variance of the word reading outcome. However, both familial antecedents of reading difficulties and teachers' reports of Inattention only marginally contributed to the prediction of the word reading outcome in fifth grade ( $p = .08$  and  $p = .10$ , respectively). In addition, these results suggest that emergent literacy skills at kindergarten mediated to some extent the effect of familial antecedents of reading difficulties and teachers' reports of Inattention on the reading outcome at Grade 5.

### 3.2. Comparisons between the reading difficulties group and normal readers in Grade 5

Lastly, chi-square and student's *t*-tests were used to compare children with reading difficulties and normal readers according with sociodemographic background and the variables significantly correlated with word reading at Grade 5. As seen in Tables 28 and 29, the results of these analyses corroborated the findings from the regression analysis, with the exception of teachers' reports of Inattention at Grade 5. The reading difficulties group presented lower performances on the subtests of syllabic deletion, oral comprehension and letter reading and

there were medium and large effects of these variables in the differences observed between groups (effect sizes (Cohen's  $d$ ) > .68). In addition, this group also presented a higher frequency of parental reports of familial antecedents of reading difficulties when compared with the normal readers group. However, there were no significant differences between these two groups concerning teachers' reports of Inattention ( $p = .09$ ).

Table 28. Group differences between children with reading difficulties and normal readers at Grade 5 according to the family background variables

	Reading difficulties	Normal readers	<i>chi-square</i>	<i>df</i>	<i>p</i>
	N (%)	N (%)			
<i>Sociodemographic background</i>					
<i>Sex</i>					
Boys	6 (37.5)	72 (52.94)	1.4	1	.24
Girls	10 (62.5)	64 (47.06)			
<i>Parents educational level</i>					
None of the parents has high school diploma	6 (37.5)	50 (38.17)	.002	1	.95
At least one parent has high school diploma	10 (62.5)	81 (61.83)			
<i>Familial antecedents of reading difficulties</i>					
Absence	10 (62.5)	121 (88.97)	8.42	1	.004
Presence	6 (37.5)	15 (11.03)			

*df.* degrees of freedom

Table 29. Group differences between children with reading difficulties and normal readers at Grade 5 according to the *BSEDS* subtests and teacher's ratings of inattention problems

	Reading difficulties			Normal readers			<i>t</i>	<i>p</i>	<i>es</i>
	M	SD	N	M	SD	N			
<i>ODEDYS subtests</i>									
Syllabic deletion	4.19	3.15	16	6.71	3.19	134	-3.03	.007	.77
Oral Comprehension	6.56	1.63	16	7.79	1.45	135	-2.87	.01	.81
Letter reading	4.31	2.27	16	6.19	2.79	131	-3.04	.006	.68
<i>Teachers' Questionnaire</i>									
Fifth grade Inattention	1.87	2.26	15	.80	1.48	102	1.76	.09	.65

*es.* effect sizes

In conclusion, the second set of analyses allowed investigating the relations between cognitive-academic skills, teachers' reports of behavioral problems, and word reading achievement in a community sample of French students followed from kindergarten to the end of elementary school (Grade 5). Family background was investigated and included familial antecedents of reading difficulties and parents' educational level. The analyses explored the pattern of concurrent relations between behavioral, familial and cognitive-academic measures in a sample of 812 preschoolers, and their predictive power in explaining word reading achievement in a sub-sample of 150 children followed from kindergarten to fifth grade.

The results indicated that word reading at Grade 5 was predicted by kindergarten measures of emergent literacy skills, specifically phonological awareness and letter knowledge. Teachers' reports of inattention symptoms and family antecedents of reading difficulties were associated with word reading at Grade 5, but their effects were no longer significant once the effects of emergent literacy skills were controlled. The study's measure of familial antecedents of reading difficulties was longitudinally associated with teachers' reported Inattention and word reading at Grade 5. These results indicate that children with a family history of reading difficulties are at increased risk for the co-occurrence of reading difficulties and attention problems at the end of elementary school, extending previous results indicating the presence of this association during kindergarten. These findings confirm the shared influence of familial antecedents of reading difficulties on the comorbidity between inattention symptoms and reading difficulties in a non-diagnosed community sample of kindergartener's followed through late elementary school.

3. Associations of cognitive-academic skills and family characteristics at kindergarten with academic achievement at Grade 9

(Cohort 1)

Longitudinal analyses - Kindergarten (2001-2002) to Grade 9 (2010-2011)

(*n* = 829)

## Introduction

The extant literature has recurrently emphasized that children's academic competence from kindergarten onwards is largely influenced by family background characteristics (Bradley & Corwyn, 2002; McLoyd, 1998; Duncan & Brooks-Gunn, 2000). However, most of these studies have investigated short-term links between familial characteristics and academic outcomes in English-speaking countries. In addition, it is not always clear if the effects of family background are mediated by cognitive-academic skills in kindergarten or whether they continue to have lasting effects beyond their influence on children's skills before school entry (Entwisle et al., 2005).

The present analyses examined the longitudinal contribution of a unique set of family characteristics at kindergarten (age 5) in predicting academic achievement at the end of middle school (age 15), while controlling for the effects of children's cognitive-academic skills in kindergarten. A singular aspect of this work refers to the analysis of the effects of familial antecedents of reading difficulties and language-based bedtime routines as additional factors in predicting mid-term academic outcomes.

## Objectives

- Examine the longitudinal contribution of a unique set of family characteristics at kindergarten (age 5) in predicting later academic achievement at the end of middle school (age 15);
- Analyze specifically mid-term effects of familial antecedents of reading difficulties and language-based bedtime routines, as additional risk factors in predicting children's academic outcomes at the end of middle school;
- Investigate whether the influence of these family factors on later academic achievement at the end of middle school persists once the effects of children's cognitive-academic skills in kindergarten are controlled;

## Method

### Participants

The work reported here used data from a longitudinal investigation conducted in the general population of the Creusot Montceau-les-Mines community (Saône-et-Loire) in the central-eastern region of France (Callu et al., 2003, 2005; Costa et al., 2013; Doyen et al., 2004; Giannopulu et al., 2007, 2008). The participants attended kindergarten (last year of the preschool period) during the 2001-02 school year ( $n = 921$ , ages 5-6 years). To be included in the present analyses, participants were required to present at least one of the assessment measures performed in kindergarten and to have available data at Grade 9.

This resulted in a final sample of 829 participants aged 14.5-15.5 years ( $M = 15.01$ ,  $SD = .32$ ) composed of 448 boys and 381 girls, for whom we had outcome data at Grade 9 for the 2010-2011 school year. Sample attrition represented 9.9% of the initial kindergarten sample and plausible reasons for this attrition mainly included geographical relocation between kindergarten and middle school. Group comparisons between the participants followed and non-followed from kindergarten to Grade 9 indicated no significant differences in the main variables of interest. Table 30 summarizes the gender and age characteristics of the follow-up sample. This sample was composed of adolescents from diverse socio-cultural backgrounds representative of a general population of suburban and rural communities in France. All participants attended French-speaking general education classes.

### Measures

#### Kindergarten assessment (2001-2002 school year)

##### *Family characteristics questionnaire*

Parents' responses to the items in this questionnaire were re-coded into nine variables (cf. Table 34). Eight variables were dichotomous and one ordered (*family size*). *Parents nationality* (two variables): French or foreign. *Familial history of reading difficulties*: Presence or absence of history of reading difficulties in at least one first-degree relative. *Medical history*: Presence or absence of significant health problems in infancy. *Family situation*: The child is living with both parents vs. other situations (child living with only one

parent, living with one of the parents and his/her partner or with other relatives or persons). *Bedtime routines*: Presence or absence of any kind of language-based bedtime routines, such as storytelling, looking at children's books, reading a story, listening to music or singing nursery rhymes. *Early childcare*: The questionnaire provided four alternatives: informal childcare provided exclusively by the mother, by a relative, by a non-relative, or formal childcare setting. Early childcare was dichotomized into maternal childcare (all children cared for exclusively by their mothers) vs. all other forms of early childcare. *Parental educational level* was based on the final school grade completed by each parent. We generated a binary variable defining whether the parental level of education was low (i.e. neither of the parents had a secondary school diploma) or moderately-high (i.e. at least one of the parents obtained a secondary school diploma). *Family size*: The number of siblings in the household was treated as a continuous variable and ranged from 0 to 13.

#### *Oral language skills - Parent questionnaire*

Parents completed a 10-item questionnaire used to assess the children's oral language skills and each question was coded as "no" (0) or "yes" (1). Table 31 shows the items in this questionnaire. Previous research has indicated the usefulness of this questionnaire for screening preschoolers with developmental delays in oral language skills (Callu et al., 2003).

#### *Classroom behavior and cognitive-academic skills - Teacher questionnaire*

This questionnaire is part of the *BSEDS* battery (Zorman & Jacquier-Roux, 2001) and aims to obtain teachers reports on children's overall development in language, cognitive, social and motor (fine and gross) skills. Table 32 presents the 17 items that constitute this questionnaire. Teachers are provided with validated guidelines for rating items. Each item was rated in a binary (yes or no) scoring system.

#### *Bilan de Santé: Evaluation du Développement pour la Scolarité de 5 à 6 ans (BSEDS)*

The *BSEDS* battery ([Health Examination: School Developmental Assessment for Children aged 5–6 years], Zorman & Jacquier-Roux, 2001) is a standardized assessment instrument that evaluates children's cognitive, motor and social development in kindergarten. For the purposes of these analyses, 12 subtests of the *BSEDS* battery were chosen together with four supplementary measures assessed during kindergarten. Table 33 presents the 16 subtests administered at kindergarten. Regarding the *BSEDS* battery, nine subtests corresponded to the

ones used in the kindergarten analyses, namely Rhyme identification, Syllabic counting, Syllabic Deletion, Receptive Vocabulary, Oral comprehension, Letter Reading, Pseudoword repetition, Sentence repetition and Figure Reproduction (cf. *BSEDS* description presented earlier in kindergarten), and three additional subtests were included, specifically Digit span, Cancellation task and Rhombus reproduction. Moreover, four supplementary measures that do not belong to the *BSEDS* assessment protocol were administered at kindergarten and considered in the present analyses, namely Expressive vocabulary, Word repetition, Rapid naming and Verbal Fluency. A brief description of these subtests is presented subsequently.

- (1) *Expressive vocabulary*: The child was asked to give a definition of a word presented orally by the examiner. One point is attributed for each acceptable definition provided by the child and the subtest is stopped after five consecutive failures. This subtest is composed of 30 items and the total score represents the sum of correct answers provided at each item (maximum = 30).
- (2) *Word repetition*: In this subtest assessing short-term verbal memory the child is requested to repeat 10 word presented orally by the examiner (“crocodile”, “peuple”, “pauvreté”, “brioche”, “goéland”, “géographie”, “fleur”, “dromadaire”, “sachet” and “tortue”). One point is attributed to each word correctly repeated and the total score corresponds to the total number of correct answers (maximum = 10).
- (3) *Rapid Naming*: This task is aimed to evaluate processing speed ability by asking the child to name as quickly as possible 16 images of 5 different drawings. The score of this subtest consisted in the time the child took to name the 16 images (recorded in seconds).
- (4) *Verbal fluency*: In this subtest evaluating processing speed the child is asked to name as many animals as possible within 20 seconds. The score in this subtest corresponds to the number of different animals indicated by the child.
- (5) *Digit span*: The purpose of this subtest is to assess children’s short-term working memory skills. The child is asked to repeat five series of digits (from two to five digits) of increasing length in the same order presented orally by the examiner. The total score corresponds to the number of digits from the longest series correctly repeated (maximum = 5).



- (6) *Cancellation task*: This subtest aims to assess perceptual reasoning and visual ability. The child is presented a sheet with several drawings and is required to cross out with a pencil the drawings referring to the bells randomly distributed in the sheet. The total score consists of the number of bells correctly crossed-out in one minute (maximum = 35, the total amount of bells)
- (7) *Rhombus reproduction*: The objective of this subtest is to evaluate children's perceptual reasoning and visual ability. The child is asked to reproduce a rhombus with a pencil in the vertical plane. One point is awarded for a correct reproduction.

As mentioned previously, the subtests of the *BSEDS* battery have good psychometric validity based on the reported reliability and sensitivity to identify children at risk for developing learning difficulties, specifically in the prediction of later reading acquisition (Giannopulu et al., 2008; Zorman & Jacquier-Roux, 2001). We opted to include the additional *BSEDS* subtests in the present analyses because they represent specific domains of children's general cognitive ability described as strong correlates of later academic achievement (Bosse & Valdois, 2009; Campbell et al., 2001; Gathercole, Pickering, Knight & Stegmann, 2004). These domains refer specifically to short-term working memory (Digit Span), visual ability and perceptual reasoning (Cancellation task and Rhombus reproduction). Moreover, the four supplementary measures considered in the present analyses allowed complementing the *BSEDS* evaluation, since they tap specific skills described in the scientific literature as additional factors to consider in the analysis of reading achievement, namely oral language (Expressive vocabulary), short-term verbal memory (Word repetition) and processing speed of verbally coded information (Rapid naming and Verbal Fluency) (Whitehurst & Lonigan, 1998).

Grade 9 assessment (2010-2011 school year)

*National diploma ("Diplôme National du Brevet")*

The Grade 9 diploma is a national indicator of academic achievement at the end of middle school. This diploma is awarded on the basis of the computation of a global score based on 1) the student's results in three written exams taken at Grade 9 (French, Mathematics and Geography/History), 2) average marks in all curricular subjects at Grade 9 through the school year, and 3) teacher evaluation of the student's proficiency in seven academic domains (e.g.

information technology, social and civic skills, among others). This indicator is ordered in five levels of increasing achievement: “Failure”, “Pass”, “Satisfactory”, “Good” and “Very good”. For the purpose of our analyses, the mention “Failure” comprised students that did not pass in the Grade 9 diploma, and also students that did not sit the diploma in the same year as a result of repeats of at least one grade between kindergarten and middle school. In addition, we grouped the “Good” and “Very good” levels into the same category (hereafter referred to as “Good/Very good”). This allowed us to generate four homogeneous and comparable groups of middle school outcomes at Grade 9.

### Procedure

Informed consent was obtained from parents, school administrators and teachers in order to conduct this research, in accordance with ethical requirements. In kindergarten, all measures were obtained between January and June in the 2001-2002 school year. Parents completed two questionnaires: one on sociodemographic and familial characteristics and another aimed to evaluate the children’s oral language skills. Teachers completed a questionnaire assessing children’s cognitive development in kindergarten and school doctors performed a standardized health check examination for each participant individually (*BSEDS*, described below). This examination is part of a standard protocol recommended by the French National Education Department. The systematic application of this instrument involves a short version (screening form), but, for the purpose of the present study, the complete version was administered.

For the follow-up outcomes at Grade 9, academic achievement classifications were attributed to all the study participants in July 2011. The regional services of the National Education Department were acquainted with the purposes of the study and informed approval was obtained in order to have access to the school records for each of the study participants.

### Statistical analysis and analytic plan

Data analyses were conducted using the SAS 9<sup>®</sup> software (SAS, Institute Inc. Cary, NC, USA) and cross-checked using the *R* statistical package (2013). In a first set of analyses, we examined the associations between the four levels of the Grade 9 outcomes and each of the assessment instruments used in kindergarten: (1) parent 10-item questionnaire, (2) teacher 17-

item questionnaire, (3) the *BSEDS* 16-subtests battery and (4) parent 9-item questionnaire on family characteristics. For the family variables, we also computed a multiple-risk score to examine associations with Grade 9 outcomes. For each of these four instruments, we first used item-by-item univariate analysis (linear tendency chi-square and analyses of variance [ANOVA]) and second, ordinal logistic regression analysis (LOGISTIC procedure). The ordinal logistic procedure is based on the assumption that the regression coefficients are proportional across all levels of the dependent variable. Preliminary analyses revealed that this assumption held for all the ordinal logistic regressions performed in our study. In addition, this procedure provides a measure of the model's predictive power through the percentage of concordance  $c$  (i.e. the proportion of subject pairs in which the subject with the higher true category also has the higher predicted category), which can be interpreted as a generalized ROC area (Harrell, 2001).

The second set of analyses concerned only the variables from the first set of ordinal logistic regressions that were predictive of the Grade 9 outcomes at the  $p < .05$ . Three steps of ordinal logistic regressions were performed by adding cumulatively to the model the significant items from the parents and teachers' questionnaire (Step 1), followed by the *BSEDS* subtests (Step 2) and, finally, the family factors (Step 3). We aimed to examine if the effects of family characteristics remained significant once all the other child-related factors were controlled for in the model.

### Supplementary Analyses

We performed additional binomial logistic regressions by dichotomizing the Grade 9 outcomes ("Failure" vs. "Others") and conducted the same set of ordinal logistic regression analyses described previously in order to check the stability of the results.

## Results

### 1. Descriptive analyses of the Grade 9 outcomes

As seen in Table 30, among the 829 participants, 285 (34%) "Failed" to obtain the Grade 9 diploma, 165 (20%) obtained a "Pass" without any particular classification, 185 (22%) presented a "Satisfactory" performance and 194 (24%) had "Good or Very good" outcomes.

Table 30. Descriptive statistics of the study variables

	<i>Grade 9 Outcome</i>				<i>Total</i>	<i>Range</i>	<i>p</i>
	<i>Failed</i>	<i>Pass</i>	<i>Satisfactory</i>	<i>Good Very Good</i>			
<i>N</i>	285	165	185	194	829		
Gender (% boys)	62.81	56.97	45.95	46.39	54		.0001 <sup>†</sup>
Age (years)							
Kindergarten <i>M (SD)</i> <sup>‡</sup>	5.56 (.34)	5.60 (.30)	5.64 (.30)	5.63 (.32)	5.60 (.32)	4.89 - 6.91	.04 <sup>††</sup>
Middle school <i>M (SD)</i> <sup>‡</sup>	14.96 (.30)	15.02 (.28)	15.04 (.28)	15.03 (.28)	15.01 (.29)	14.44 - 15.49	.01 <sup>††</sup>

Note: <sup>†</sup> Linear tendency chi-square, <sup>††</sup> *F* (ANOVA); <sup>‡</sup> Post-hoc comparisons Failed < Pass, Satisfactory, Good/Very Good.

Gender was related to the Grade 9 outcomes, with an overrepresentation of boys in the two lower levels, and an overrepresentation of girls in the two higher levels (linear tendency chi-square = 17.02,  $p < .001$ ). Mean age was lower in the “Failure” group compared to the other three groups, both in kindergarten and in Grade 9. The correlation between age in kindergarten and in middle school was  $r = .92$ . Thus, in the ordinal logistic regressions described below, we entered gender and age in kindergarten as covariates.

## 2. Associations between child-related characteristics in kindergarten and Grade 9 outcomes

### 2.1. Parent questionnaire - Oral language skills

As shown in Table 31, five of the 10 items were significantly associated with the Grade 9 outcomes at  $p < .001$ . The results of the ordinal logistic regression indicated that two items were predictive of the Grade 9 outcomes. These items concerned the children’s difficulties in speech comprehension (“requests people to repeat so that he/she can understand”) and in sentence construction (“has difficulties assembling words to construct sentences”). This final model presented a percentage of concordance between the predicted probabilities and the observed responses of 62.1%.

### 2.2. Teacher questionnaire - Classroom behavior and cognitive skills

Ten items out of 16 were significantly associated with the Grade 9 outcomes at the  $p < .001$  level, as shown in Table 32. These items concerned the children’s attention skills, oral language in the classroom, figure reproduction, fine motor skills, and time orientation skills. The dominant pattern of associations for these items was a higher proportion of negative reports in the “Failure” group compared to the three remaining groups. In the ordinal logistic procedures, four items were predictive of the Grade 9 outcomes at the  $p < .05$  level. These items referred to children’s attention-related skills (“executes classroom activities”, “sustains attention during classroom activities”), non-verbal ability (“rhombus reproduction”) and temporal orientation (“recognizes the beginning and the end”). The percentage of concordance in the final equation was 67.9%.

Table 31. Associations between parents' questionnaire in kindergarten and Grade 9 outcomes

	<i>Grade 9 Outcome</i>				<i>Total</i>	<i>N</i>	<i>chi-square</i>	<i>p</i> <sup>†</sup>
	<i>Failed</i>	<i>Pass</i>	<i>Satisfactory</i>	<i>Good Very Good</i>				
<i>Oral language – Parent questionnaire</i>								
<i>(% of positive responses)</i>								
Pronounces words correctly	80.47	91.16	90.57	90.91	87.32	749	11.10***	.80
Is misunderstood by people who do not know him	12.94	8.84	4.38	4.26	8.13	750	13.59***	.57
Speaks little in group but more face to face	26.19	27.59	15.63	17.32	22.01	736	7.95**	.16
Stutters	3.92	.68	1.25	1.60	2.14	749	2.86 <i>ns</i>	.98
Requests people to repeat so that he/she can understand	26.27	17.01	11.32	9.63	17.11	748	24.40***	.002
Enjoys talking about books, pictures and toys	95.74	95.92	98.75	98.94	97.21	753	5.61*	.20
Asks numerous questions	94.57	94.56	94.30	96.26	94.93	750	.47 <i>ns</i>	.93
Has difficulties assembling words to construct sentences	19.84	8.28	3.14	4.79	10.28	749	32.55***	.0002
Speaks very little	7.39	2.03	3.77	2.66	4.39	752	5.16 <i>ns</i>	.44
We are worried about the way our child speaks	9.41	2.70	2.52	2.66	4.93	750	11.38***	.15

*Note: Chi-square (Linear tendency chi-square); ns = non significant, \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ ; <sup>†</sup> Significance values ( $p$ ) for each item in the ordinal logistic regression.*

Table 32. Associations between teachers' questionnaire in kindergarten and Grade 9 outcomes

	<i>Grade 9 Outcome</i>				<i>Total</i>	<i>N</i>	<i>chi-square</i>	<i>p</i> <sup>†</sup>
	<i>Failed</i>	<i>Pass</i>	<i>Satisfactory</i>	<i>Good Very Good</i>				
<i>Classroom behavior and cognitive skills - Teacher questionnaire</i>								
<i>(% of positive responses)</i>								
Executes classroom activities	84.07	95.20	100	100	93.57	653	47.09***	.002
Sustains attention and concentration during classroom activities	68.72	88.8	94.04	96.03	84.71	654	60.98***	.001
Plays along with other children at recess	97.37	98.39	98.01	99.34	98.17	654	1.61 <i>ns</i>	.86
Verbally intervenes in classroom when asked	87.67	94.31	99.33	98.68	94.16	651	26.26***	.09
Speech: correct grammar	77.33	93.50	94.70	93.33	88.14	649	26.41***	.92
Speech: appropriate use of subordinate clauses	72.32	92.68	92.05	92.67	85.49	648	33.38***	.09
Climbs stairs alternating feet	99.12	100	99.34	100	99.54	655	.99 <i>ns</i>	.23
Catches a bouncing ball	92.98	96	98.68	96.69	95.73	655	4.99*	.78
Cuts with scissors following a straight line	88.60	96	95.36	98.01	93.74	655	13.78***	.63
Square reproduction	96.04	97.60	100	100	98.17	654	10.6***	.78
Rhombus reproduction	68.86	79.20	84.77	84.77	78.17	655	16.88***	.05
Knows how to situate himself in the daytime	77.09	88.71	92.05	96	87.12	652	31.92***	.14
Recognizes the top, the bottom	95.59	96.77	98.01	100	97.39	652	7.19**	.43
Recognizes the front, the back	96.48	99.19	99.34	100	98.47	652	7.99**	.25
Recognizes over, under	96.04	97.58	97.35	98.67	97.24	652	2.13 <i>ns</i>	.06
Recognizes the biggest, the smallest	96.93	96.80	99.34	100	98.17	654	6.25 *	.95
Recognizes the beginning, the end	74.89	90.32	96.69	96.67	87.88	652	49.75***	.002

Note: *Chi-square* (Linear tendency chi-square); *ns* = non significant, \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ ; <sup>†</sup> Significance values ( $p$ ) for each item in the ordinal logistic regression.

### 2.3. *BSEDS* battery

As seen in Table 33, all the 16 cognitive tasks were related to Grade 9 outcomes at a significance level of  $p < .001$  with performances increasing from the “Failure” group to the “Good/Very good” group in all the subtests. The five subtests significantly predictive of the Grade 9 outcomes in the ordinal logistic regression concerned Expressive vocabulary, Oral comprehension, Word repetition, Letter reading and Figure reproduction. Respectively, these tasks reflect children’s skills in expressive and receptive language, short-term verbal memory, letter knowledge and non-verbal ability. The assumption that the Word repetition subtest reflects short-term verbal memory is supported by a principal component analysis of the *BSEDS* subtests (results not shown), where the Word repetition subtest loaded on the same factor as the subtests of Digit span, as well as Pseudo-word and Sentence repetition. The percentage of concordance in the final equation using the *BSEDS* subtests as predictors was 76.5%.

Post hoc comparisons of the means showed that the “Failure” group presented lower performances on the majority of the subtests, compared to the other three groups. Conversely, the performances of the “Good/Very good” group were significantly higher than the remaining three groups on six of the *BSEDS* subtests, namely Rhymes, Syllabic deletion, Expressive vocabulary, Letter reading, Rapid naming and Verbal fluency.

### 3. Associations between family-related variables in kindergarten and Grade 9 outcomes

All nine family characteristics were significantly related to the outcomes at the  $p < .05$  level, and six of them at  $p < .001$ , as displayed in Table 34. Overall, there was a clear ordering of the scores from the least to the most favorable level of the Grade 9 outcomes. Lower parental educational level, early childcare provided exclusively by the mother, absence of bedtime routines and children not living with both parents presented particularly strong associations with less favorable outcomes. To a lesser magnitude, father’s foreign nationality, the presence of familial antecedents of reading difficulties and the child’s significant medical history were also significantly associated with poorer outcomes. These seven variables corresponded to the items that significantly predicted the Grade 9 outcomes in the ordinal logistic regression and the percentage of concordance of this model was of 69.2%.



Table 33. Associations between *BSEDS* subtests in kindergarten and Grade 9 outcomes

	<i>Grade 9 Outcome</i>								<i>M</i>	<i>SD</i>	<i>Range</i>	<i>N</i>	<i>F</i>	<i>p</i> <sup>†</sup>
	<i>Failed</i>		<i>Pass</i>		<i>Satisfactory</i>		<i>Good Very good</i>							
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>						
<i>BSEDS subtests</i>														
Rhymes <sup>1</sup>	3.82	2.53	4.9	2.51	5.45	2.28	6.24	2.14	4.97	2.56	0 - 8	818	42.43***	.43
Syllabic counting <sup>2</sup>	4.03	1.46	4.47	1.07	4.59	.93	4.74	.67	4.41	1.15	0 - 5	820	17.74***	.81
Syllabic deletion <sup>1</sup>	4.47	3.53	6.51	3.23	6.61	3.45	7.92	2.50	6.17	3.49	0 - 10	818	46.27***	.06
Expressive vocabulary <sup>3</sup>	7.25	3.38	8.78	3.81	10.01	4.25	11.50	4.02	9.18	4.16	0 - 25	811	50.49***	.0001
Receptive vocabulary <sup>4</sup>	17.52	3.66	18.52	3.64	20.08	3.61	20.78	3.66	19.05	3.88	1 - 29	817	36.95***	.08
Oral comprehension <sup>2</sup>	6.65	1.81	7.49	1.57	7.87	1.52	8.24	1.41	7.47	1.73	1 - 10	819	42.43***	.05
Word repetition <sup>5</sup>	7.76	2.04	8.51	1.47	8.78	1.34	9.08	1.41	8.45	1.73	0 - 10	823	28.48***	.01
Pseudo-word repetition <sup>5</sup>	8.48	1.82	8.94	1.33	9.13	1.30	9.24	1.28	8.89	1.53	0 - 10	822	12.27***	.42
Rapid naming (seconds) <sup>6</sup>	24.34	7.31	23.53	7.59	22.21	6.31	20.24	5.46	22.73	6.93	10 - 60	816	15.20***	.10
Letter reading <sup>1</sup>	14.58	3.57	15.5	3.17	16.21	2.91	17.19	2.34	15.74	3.24	0 - 20	820	29.24***	.02
Sentence repetition <sup>5</sup>	12.43	3.59	13.78	2.46	14.16	2.26	14.75	2.06	13.63	2.93	0 - 16	820	30.45***	.72
Digit span <sup>2</sup>	3.67	.66	3.93	.59	4.02	.52	4.05	.58	3.89	.62	0 - 5	820	19.98***	.42
Verbal fluency <sup>1</sup>	4.52	1.94	5.19	2.08	5.38	1.97	6.04	2.07	5.21	2.08	0 - 13	816	22.27***	.06
Cancellation task <sup>7</sup>	12.01	3.93	12.97	4.06	13.93	4.15	14.19	3.99	13.14	4.12	1 - 26	700	12.19***	.62
Figure reproduction <sup>4</sup>	3.09	2.07	4	1.78	4.74	1.50	4.80	1.69	4.06	1.95	0 - 6	654	36.18***	.0003
Rhombus reproduction <sup>7</sup>	.58	.50	.69	.46	.77	.42	.83	.38	.70	.46	0 - 1	788	13.49***	.19

Note: *F* (Generalized Linear Model); *ns* = non significant, \*  $p < .05$ , \*\*\*  $p < .001$ ; Post hoc mean comparisons <sup>1</sup> Failed < Pass, Satisfactory < Good/Very good; <sup>2</sup> Failed < Pass, Satisfactory, Good/Very good; <sup>3</sup> Failed < Pass < Satisfactory < Good/Very good; <sup>4</sup> Failed < Pass < Satisfactory, Good/Very good; <sup>5</sup> Failed < Pass, Satisfactory, Good/Very good and Pass < Good/Very good; <sup>6</sup> Failed, Pass, Satisfactory > Good/Very good and Failed > Satisfactory; <sup>7</sup> Failed < Satisfactory, Good/Very good; <sup>†</sup> Significance values (*p*) for each item in the ordinal logistic regression.

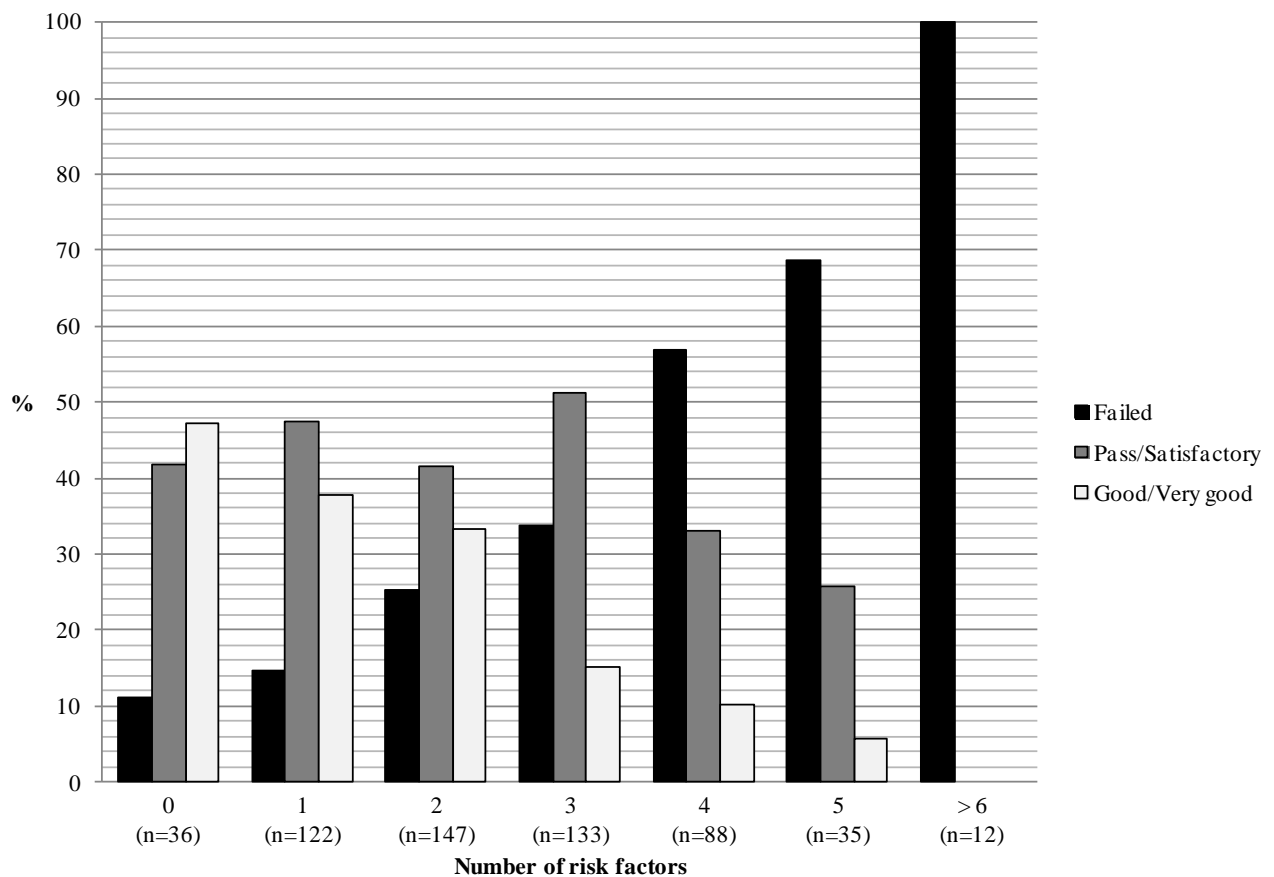
Table 34. Associations between family background in kindergarten and Grade 9 outcome

	<i>Grade 9 Outcome</i>				<i>Total</i>	<i>N</i>	<i>chi-square</i>	<i>p</i> <sup>†</sup>
	<i>Failed</i>	<i>Pass</i>	<i>Satisfactory</i>	<i>Good Very Good</i>				
<i>Family characteristics questionnaire - Parents</i>								
Father's nationality (% of foreign fathers)	16.04	9.09	9.29	6.71	10.80	648	8.12**	.02
Mother's nationality (% of foreign mothers)	12.62	9.02	7.91	6.71	9.38	650	4.06*	.25
Familial history of reading difficulties (% of cases reported)	25.73	17.32	14.49	12.66	18.28	629	11.19***	.03
Medical history (% of significant health problems)	9.63	6.15	4.86	4.52	6.65	647	4.42*	.03
Family situation (% children not living with both parents)	24.88	10.61	9.21	9.09	14.56	666	20.52***	.003
Bedtime routines (% of affirmative responses)	43.69	57.89	62.33	69.94	57.08	664	27.69***	.004
Early childcare (% of exclusively maternal care)	63.76	48.85	45.89	35.19	49.77	657	30.67***	.003
Parental educational level (% high)	29.91	44.70	57.64	70.55	49.16	653	66.61***	.0001
Family size ( <i>M (SD)</i> of number of sisters and brothers)	1.85 (1.43)	1.69 (1.51)	1.44 (1.02)	1.35 (.89)	1.60 (1.26)	672	6.13*** <sup>††</sup>	.95

Note: *Chi square* (Linear tendency chi-square); \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ ; <sup>†</sup> Significance values ( $p$ ) for each item in the ordinal logistic regression; <sup>††</sup> Generalized Linear Model *F*.

A risk index score was computed using gender (being a boy) and the seven family-related conditions abovementioned. This multiple risk index score was significantly associated with the Grade 9 outcomes (linear tendency chi-square = 101.97,  $p < .0001$ ). Figure 7 shows the distribution of the Grade 9 outcomes according with the number of risk factors, which varied from 0 to equal or above 6 (max.=8). For instance, the proportion of “Failure” outcomes was of 69% and 100% in the presence of five and six or more risk factors, respectively, but only of 11% and 15% in the absence or presence of only one risk factor, respectively.

Figure 7. Distribution of Grade 9 outcomes according to the number of risk factors in kindergarten



#### 4. Predicting Grade 9 outcomes from the child and family variables selected in kindergarten

The second set of ordinal logistic regressions examined the predictive power of the variables selected from each kindergarten assessment instrument, controlling for the effects of the items retained from the other assessment measures. These analyses were performed in three steps and only the variables significantly predictive of the Grade 9 outcomes in the first set of analyses were introduced into these models. A significance level of  $p < .05$  was used as a criterion to determine if a variable was included in the model at each step. The results of these analyses are summarized in Table 35. In all these ordinal regression analyses, gender and age were used as covariates.

In the first step, we included the two items from the parent questionnaire in the regression model together with the four items selected from the teacher questionnaire. The results indicated that only the four items from the teacher questionnaire remained significant. The percentage of concordance between the predicted probabilities and the observed responses for this model was 67.5%.

In the second step, the four teacher items were introduced into the model together with the five *BSEDS* subtests. Results revealed that the five subtests remained significant, together with two items from the teacher questionnaire (“executes classroom activities” and “sustains attention and concentration during classroom activities”). The percentage of concordance reached 75.8% for this model estimating the simultaneous effects of the cognitive subtests and the teacher questionnaire items.

In the third step, the abovementioned seven items were entered into the model concomitantly with seven family-related characteristics, namely father’s nationality, familial antecedents of reading difficulties, child’s medical history, family situation, bedtime routines, early childcare and parental educational level. From the initial set of 14 variables introduced into the model, only seven were significant at the  $p < .05$  in the final equation: one item from the teacher questionnaire (“executes classroom activities”), four variables from the cognitive assessment (Expressive vocabulary, Word repetition, Letter reading and Figure reproduction) and two family-related characteristics (family situation and parental educational level).

Table 35. Ordinal logistic regression of Grade 9 outcomes according to the kindergarten variables

	<i>Grade 9 outcome</i>		
	$\beta$	$S(\beta)$	$p$
<i>Step1. Parent and teacher questionnaires (n = 589)</i>			
Executes classroom activities	1.50	.55	.007
Sustains attention and concentration during classroom activities	1.04	.29	.0003
Rhombus reproduction	.69	.20	.0006
Recognizes the beginning, the end	1.19	.31	.0001
<i>Step2. Teacher questionnaire and BSEDS subtests (n = 506)</i>			
Executes classroom activities	1.30	.63	.04
Sustains attention and concentration during classroom activities	.59	.29	.05
Expressive vocabulary	.14	.02	.0001
Oral comprehension	.13	.06	.03
Word repetition	.16	.06	.009
Letter reading	.09	.03	.006
Figure reproduction	.18	.05	.0005
<i>Step 3. Teacher questionnaire, BSEDS subtests and family characteristics (n = 362)</i>			
Executes classroom activities	2.03	.88	.02
Expressive vocabulary	.12	.03	.0001
Word repetition	.14	.07	.053
Letter reading	.14	.04	.0002
Figure reproduction	.21	.06	.0007
Family situation	-.82	.36	.02
Parental educational level	.93	.23	.0001

Collectively, the inclusion of the family related-characteristics, together with the cognitive subtests and the teacher attention-related item, contributed to increase the percentage of concordance of the final model to 78.9%. The family variables referring to father's nationality, familial antecedents of reading difficulties, child's medical history, bedtime routines and early childcare, together with the cognitive subtest of Oral comprehension and the teacher's questionnaire item "sustains attention and concentration during classroom activities" failed to reach statistical significance the final model. These results indicate that, among the family related characteristics, only family situation and parental educational level remained significantly associated with the Grade 9 outcomes after controlling for the effects of the cognitive-academic skills in kindergarten.

### Supplementary analyses

We conducted the same ordinal logistic regressions, this time using a dichotomous measure of the Grade 9 outcomes ("Failure" vs. "Others") as the dependent variable. The variables selected were the same for parent and teacher questionnaires and family characteristics. These final models exhibited percentages of concordance of 66%, 74%, and 68%, respectively. Four items were selected from the *BSEDS* subtests. Three subtests were in common with the previous ordinal logistic regressions: Expressive vocabulary, Oral comprehension and Figure reproduction. The subtest of Syllabic deletion was specific to this model, in comparison to the Word repetition subtest specific of the regression model performed with the four categories of the Grade 9 outcomes. A plausible explanation of this result is that Syllabic deletion is a phonological processing task, which is strongly related with short-term verbal memory (Melby-Lervåg, Lyster, & Hulme, 2012). The percentage of concordance in this ordinal logistic equation was 80%. In the final step of the ordinal regression analyses, six variables were retained: Expressive vocabulary, Figure reproduction and parental education were the same as in the ordinal regressions using the four categories of the Grade 9 outcomes. Three items were specific, namely the Syllabic deletion subtest and two teacher items, one relating to attention skills ("sustains attention and concentration during classroom activities") and the other to grammar-related abilities ("speech: appropriate use of subordinate clauses"). The percentage of concordance in this final equation was 83%.

In summary, the third set of analyses of the present work aimed to examine the extent to which family-related characteristics were associated with academic achievement at the end of middle school, while controlling for cognitive-academic skills in kindergarten. For this purpose, a community-based of 829 French-speaking adolescents was followed from kindergarten (5 years) to the end of middle school (15 years). Kindergarten measures included children's assessment (5-6 years) of oral language, pre-reading skills, non-verbal reasoning and classroom behavior, as well as family contextual characteristics. At age 15, children sat a national diploma typically used as an indicator of general academic achievement in Grade 9.

The results indicated that children's oral language, short-term verbal memory, letter knowledge, non-verbal reasoning, and attention skills at school entry were specifically related to academic outcomes, as were parental educational level, family situation, family immigrant status, type of early childcare, familial antecedents of reading difficulties and language-based bedtime routines. A cumulative risk index composed with these family factors was negatively and strongly associated with unfavorable academic outcomes at Grade 9. When both cognitive-academic skills at school entry and family factors were taken into account, children's oral language, short-term verbal memory, letter knowledge, non-verbal reasoning and attention-related skills remained as the most significant predictors of academic outcome in Grade 9, together with parent's educational level and family situation.

These results suggest that familial antecedents of reading difficulties and language-based bedtime routines should be considered as additional familial factors influencing academic achievement. These findings point directly to the definition of targeted groups of preschoolers who might be at familial risk of later underachievement and to the selection of the type of cognitive-academic assessments to be performed at school entry.

## IV. Discussion

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The main objective of the present work was to analyze the extent to which child- and family-level factors contributed to the prediction of children's later reading achievement at the end of elementary school and general academic achievement at the end of middle school. This main goal encompassed specific objectives aimed at responding to the research questions arose from the scientific literature. In accordance with the objectives delineated for the present work, the results of the analyses described formerly can be synthesized in two axes of discussion: one referring to the cross sectional results and one pertaining to the longitudinal findings.

The cross-sectional axis refers to concurrent associations observed within kindergarten and Grade 5 among the study's measures available for Cohort 3. In this axis, we discuss the concurrent associations observed between the child-level factors (cognitive-academic skills and behavior problems), as well as the relations between the child-level factors (cognitive-academic skills and behavior problems) and family characteristics at kindergarten and at Grade 5.

The longitudinal axis comprises the analyses aimed at exploring the contribution of the study's measures at kindergarten to the prediction of later word reading achievement at Grade 5 (Cohort 3) and general academic achievement at Grade 9 (Cohort 1). In this axis we discuss the main findings regarding the contributions of children's cognitive-academic skills, behavioral problems and family characteristics to the prediction of word reading achievement at Grade 5, and of general academic achievement at Grade 9. Finally, we outline the contribution of the present findings to the research questions derived from the review of the scientific literature.



## Cross sectional analyses

### Behavior problems and cognitive-academic skills or reading achievement

#### Kindergarten: *Cognitive-academic skills and behavior problems*

The results concerning the associations of distinct *behavior problems* with children's *cognitive-academic skills* in kindergarten revealed that the dimensions of *Hyperactivity*, *Inattention*, *Conduct problems* and *Unsociability* were significantly correlated (univariate analyses) with children's overall performance on the *BSEDS* battery. The frequent association of externalizing behavior problems and cognitive-academic skills is present during the kindergarten period, which is in accordance with previous studies reporting that preschool children evidencing lower performances in tasks evaluating cognitive-academic competency, in particular emergent literacy skills, tend to exhibit concurrently behavior problems (Doctoroff et al., 2006; Giannopulu et al., 2008; Lonigan et al., 1999; Spira et al., 2005; Trzesniewski et al., 2006; Walcott et al., 2010).

However, when all four behavioral dimensions were included in the linear regression model to explain the *BSEDS* overall score, Hyperactivity failed to reach statistical significance, Conduct Problems had a unexpected positive effect, Unsociability presented a small, albeit statistically significant, negative effect and Inattention evidenced a strong negative effect. Interestingly, children evidencing a higher score of Conduct problems concomitantly with Inattention or Unsociability symptoms exhibited higher performances on the overall measure of cognitive-academic skills, when compared with children for whom teachers' reported either Inattention or Unsociability symptoms solely. A similar pattern of results has been described in the scientific study conducted by Lazaratou and colleagues (2014) and educational implications of these findings are noteworthy regarding the appropriate screening of children evidencing inadequate levels of attention and socio-emotional behaviors. As suggested by Barriga and colleagues (2002), children that manifest attention difficulties, but whose behavioral problems do not disturb and disrupt the classroom environment, might be more difficult to detect adequately by the teacher, which might carry significant implications for further assessment and remediation during children's achievement trajectories. Applied to our analyses, a plausible interpretation for these results is that children who evidenced conduct problems concomitantly with inattention or unsociability difficulties had been

referred to pedagogic support and, consequently, might have benefited from appropriate intervention strategies aimed to their specific needs resulting, ultimately, in improved performances in the overall measure of cognitive-academic skills at kindergarten. Conversely, children who manifested exclusively symptoms associated with inattention or unsociability difficulties might have not been referred to pedagogical support and, thus, did not benefited from educational interventions justifying, thus, their lower performances on the tasks assessing cognitive-academic skills. However, this interventional hypothesis remains to be confirmed. An alternate possibility is that inattentive children with some degree of conduct problems have distinct cognitive profiles from children that manifest inattention symptoms without conduct problems.

Moreover, our results replicate previous findings reported in the extant literature concerning the preponderance of the Inattention dimension as a robust correlate of kindergartener's cognitive-academic ability, including emergent literacy skills. These results align with the growing body of literature emphasizing that children's inattentive behavior is the dimension that correlates the most with children's under-development of cognitive-academic skills (Dally, 2006; Duncan et al., 2007, for a meta-analysis of longitudinal research; Giannopulu et al., 2008; Lonigan et al., 1999; Rabiner & Coie, 2000) Because our results evidenced that the Inattention factor contributed largely to the proportion of variance explained in the overall measure of cognitive-academic skills compared with the other behavioral factors, and because we were interested in the specific association of inattentive behavior with the measure of familial antecedents of reading difficulties, only the Inattention dimension was considered in the regression analyses performed taking into account the simultaneous effects of the family-related factors (i.e. familial antecedents of reading difficulties and parental educational level). However, several researchers have cautioned that the effects of the behavioral dimensions referring to children's socio-emotional development, which include conduct problems and unsociability difficulties, on children's early cognitive-academic competency, in general, and emergent literacy skills, in particular, should not be neglected (Bracken & Fischel, 2007; Doctoroff et al., 2006; Giannopulu et al., 2008; Trzesniewski et al., 2006). The results obtained in the analyses here reported lend support to the contention of considering the influence of both children's socio-emotional behavior and attention difficulties on children's development of cognitive-academic skills during preschool.

### Grade 5: *Word reading achievement and behavior problems*

The pattern of concurrent associations at Grade 5 between teachers' reports of *behavioral problems* and the *word reading achievement outcome* revealed that only the Inattention factor was significantly correlated with word reading during the same school period, and is in line with the results obtained in the kindergarten period. This result seems to reflect the cross-sectional association found in numerous studies between inattention and word reading achievement in elementary school children (Billard et al., 2009; Dally, 2006; Giannopulu et al., 2008; McGee et al., 2002; Rabiner & Coie, 2000; Roy & Rutter, 2006). Reading difficulties were shown to be more strongly associated with the inattentive subtype of ADHD (Giannopulu et al., 2008; Hinshaw, 1992; Lundervold, Heimann & Manger, 2008; Willcutt & Pennington, 2000a) and the association between conduct problems and reading difficulties was mediated by the co-morbid inattention symptoms typical of ADHD (Carroll et al., 2004; Willcutt & Pennington, 2000b).

### Family characteristics, cognitive-academic skills and behavior problems

Kindergarten: *Familial antecedents of reading difficulties, parental educational level, cognitive-academic skills and behavior problems*

Children whose parents indicated the presence of *familial antecedents of reading difficulties* presented consistently lower performances on the overall score of cognitive-academic skills at kindergarten, specifically in what concerns emergent literacy skills. This result parallels the longitudinal findings reported in two familial studies, which documented that preschool children whose families were characterized by the presence of a familial risk of reading difficulties exhibited lower scores on measures of emergent literacy skills, when compared with children whose families were absent of this familial risk (Puolakanaho et al., 2007; Snowling et al., 2003). Importantly, these studies demonstrated that the presence of a familial risk of reading difficulties during preschool contributed significantly to the prediction of children's subsequent reading difficulties during elementary school. The result here reported allow to extend the above-cited findings by confirming the negative association between familial antecedents of reading difficulties and kindergartener's emergent literacy skills in a community-based sample drawn from the general population.

Furthermore, the present work contributed to corroborate the findings of similar studies regarding the concurrent associations among the presence of *familial antecedents of reading difficulties*, *inattentive behavior* and children's lower performances on measures of *emergent literacy skills* (Doyen et al., 2004). The presence of familial antecedents of reading difficulties was significantly associated both with teacher's reports of inattentive behavior and children's lower scores on cognitive-academic tasks, specifically in what concerned the emergent literacy measures. Indeed, children whose parents reported the presence of a family history of difficulties in learning to read tended to manifest not only lower performances on the tasks evaluating emergent literacy skills, but also were identified by their teachers as manifesting more inattentive behaviors, when compared with children whose parents did not reported the presence of familial antecedents of reading difficulties. It is important to notice that the effect of the measure of familial antecedents of reading difficulties was specific to the Inattention dimension. None of the associations between familial antecedents of reading difficulties and the behavioral dimensions of Hyperactivity, Conduct problems and Unsociability were significant.

Taken together, these results suggest that kindergarteners with a familial history of reading difficulties (i.e. the presence of difficulties in learning to read in at least one of the members of the nuclear family) not only represent a group at-risk of subsequent reading difficulties during elementary school, but might also be particularly vulnerable to the co-occurrence of inattentive behaviors during kindergarten. These results support the contention that the co-occurrence of reading difficulties and inattentive behavior is highly familial (Friedman et al., 2003; Pennington et al., 2009, for a review). For instance, the study conducted by Paloyelis and colleagues (2010) pinpointed the significant contribution of family-specific factors in the co-occurrence of reading difficulties and inattentive behavior. In the same vein, the results obtained in twin studies have advanced the hypothesis that the association between pre-reading skills and inattention symptoms is established early during the preschool period and is largely attributable to genetic and environmental factors (Ebejer et al., 2010; Willcutt et al., 2007). Importantly, our results were obtained in a community-based sample of kindergarten children derived from the general population contributing, thus, to the extension of the previous findings obtained mainly from samples derived from clinical populations (Friedman et al., 2003; Paloyelis et al., 2010; Puolakanaho et al., 2007; Snowling et al., 2003; Willcutt et al., 2007).

The results concerning the effects of *parental educational level* on children's *cognitive-academic skills* indicated that children's whose families were characterized by a low parental educational level tended to exhibit lower performances on the overall composite score of cognitive-academic skills. This result concurs with an extensive body of studies corroborating the crucial role that parental educational level plays on children's development of early cognitive-academic ability, including emergent literacy skills, at preschool and on later reading achievement at elementary school (Billard et al., 2008; Dellatolas et al., 2007; Hecht et al., 2000; Whitehurst & Lonigan, 1998).

Moreover, our results indicated that *parental educational level* was significantly associated with children's *inattentive behavior*. Children whose families were characterized by a lower parental educational level were evaluated by their teachers as exhibiting a higher proportion of inattentive behaviors. This association of parental educational and behavioral problems was exclusive to teacher's reports of inattentive behavior. None of the Hyperactivity, Conduct problems and Unsociability dimensions evidenced significant associations with parental educational level. These results follow empiric evidence documented in several studies which indicate that the presence of early inattentive behavior problems at school entry is associated with parental educational level (Billard et al., 2009; Dellatolas et al., 2007; Pennington et al., 2009, for a review).

The association between *familial antecedents of reading difficulties* and *parental educational level* was significant. Parental reports of a familial history of difficulties in learning to read in at least one member of the nuclear family tended to be more frequent in families characterized by low parental educational levels (i.e. none of the parents obtained a high school diploma), when compared with families characterized by a median-high educational level. These findings invite the hypothesis that the co-occurrence of early reading difficulties and attention problems in children with a familial history of reading difficulties is particularly associated with environmental factors, such as parental education. Children from families characterized by low parental education levels and a family history of reading difficulties might be at increased risk of developing co-morbid reading difficulties and attention problems, due to the well established interference of inattentive behavior in reading acquisition (Dally, 2006), especially in disadvantaged environments (Velting & Whitehurst, 1997). Therefore, the significant association observed between familial antecedents of reading difficulties and

parent's educational level suggests that the presence of a history of difficulties in learning to read in a child's nuclear family might represent an additional risk factor for children's underdevelopment of emergent literacy skills in kindergarten, especially for children whose families are characterized by lower parental educational levels.

The regression analyses showed the independent contribution of *familial antecedents of reading difficulties* to the proportion of variance explained of children's performance in the overall measure of *cognitive-academic skills*, while controlling for the simultaneous effect of *parental educational level*. Previous studies with school-aged children have demonstrated the predictive power of a measure referring to familial history of reading difficulties on children's subsequent levels cognitive-academic ability during elementary school, specifically in what concerns emergent literacy skills, (Puolakanaho et al., 2007; Snowling et al., 2003).

Moreover, when the measure of *familial antecedents of reading difficulties* and *parents' educational level* were introduced simultaneously with *teachers' reports of inattentive behavior* in the regression model, all these three measures contributed significantly to explain 25% of the proportion of variance of children's performances in the overall measure of *cognitive-academic skills*, essentially constituted by measures of emergent literacy skills. These results align well with the findings described in the scientific literature regarding the unique and independent predictive power of attentive behavior (Doctoroff et al., 2006; Lonigan et al., 1999), familial antecedents of reading difficulties (Puolakanaho et al., 2007; Snowling et al., 2003).and parental educational level (Giannopulu et al., 2008; Hecht et al., 2000) in explaining children's emergent literacy skills during preschool.

The final set of cross-sectional analyses examined the specific relations of *Inattention*, *familial antecedents of reading difficulties* and *parental educational level* with each of the *BSEDS subtests*. The analyses indicated that the significant effect of these measures is widely generalized to the totality of the subtests and specifically to the *emergent literacy measures*. However, the measure of *familial antecedents of reading difficulties* failed to evidence significant associations with the subtests pertaining to *letter knowledge* and *figure reproduction*. This particular result reminds the conclusions of Vellutino (1977), that the differences between normal and poor readers are specifically related with children's phonological processing skills and lexical and semantic knowledge, but not with visual

perceptual skills. Applied to our results, these findings suggest that familial antecedents of reading difficulties are exclusively associated to reading achievement, due to its significant relations with emergent literacy skills specific to reading acquisition, such as children's phonological processing skills and oral language (Vellutino, 1977, *cit in* Viana, 2007).

In addition, these results can be interpreted taking into account the role that family contexts play in the development of emergent literacy skills. For instance, Whitehurst and Lonigan (1998), in their comprehensive review of the literature, highlighted that family characteristics represent a promotive and predictive factor of the development of children's early literacy skills during preschool. These family-related factors rang from structural features, such as the availability and exposure to verbally coded print materials, to process characteristics relative to the adult-child interactions established into these environments, such as shared book reading and storytelling. In the present analyses, the measure of parental educational level was associated with the totality of the subtests of the *BSEDS* battery pertaining to emergent literacy skills, as well as non-verbal abilities, such as visual and perceptual skills. Conversely, the measure of familial antecedents of reading difficulties was associated exclusively with children's emergent literacy skills, but not with non-verbal cognitive abilities. Because parents educational level, one of the components of socio economic status, is described to be strongly correlated with the availability of pedagogic and didactic materials at home (Whitehurst & Lonigan, 1998), we advance the hypothesis that the influence of familial antecedents of reading difficulties on children's emergent literacy skills is probably attributable to specific processes rooted in the dynamics of family functioning, rather than on the structural characteristics of family background. However, the specific nature and the processes through which the presence of a familial history of reading difficulties influence the development of emergent literacy skills are beyond the scope of the present analyses and should be considered in future research.

In conclusion, the cross-sectional analyses performed during kindergarten contributed to confirm the associations among cognitive-academic ability, in particular emergent literacy skills, oral language, behavior problems and family characteristics in a community-based sample of children drawn from the general population. In particular, the results revealed that children from families reporting a familial history of reading difficulties exhibited lower performances in emergent literacy measures and a higher proportion of inattentive behaviors during kindergarten. The educational implications of these findings are noteworthy.

On one hand, the observed associations between lower performances on the measures of cognitive-academic skills and behavior problems confirmed that these relations occur early during preschool and influence specifically the development of emergent literacy skills. These findings concur with an increasing body of scientific studies emphasizing the role of children's behavior and social competence on reading acquisition (Bracken & Fischel, 2007; Doctoroff et al., 2006; Spira et al., 2005). In particular, these studies have underlined that intervention programs should target simultaneously the promotion of skills in both the socio-behavioral and cognitive-academic domains. The argument of investing in children's socio-emotional and behavioral adjustment is justified taken into account the frequent comorbidity observed between behavioral problems and academic underachievement, which tend to persist during children's educational trajectories (Hinshaw, 1992).

On the other hand, the present work presented evidence of the significant role that familial antecedents of reading difficulties play on the co-occurrence of children's lower performances in measures of emergent literacy and inattentive behavior. The inclusion of information relative to a child's familial history of reading difficulties might contribute to the early screening of children who might develop subsequent reading difficulties during elementary school. In addition, the identification of a familial history of difficulties in learning to read might constitute an underlying risk factor contributing to the frequent co-occurrence of inattention problems and reading difficulties. This finding aligns well with Hinshaw's (1992) conclusions that the mechanisms explaining the frequent comorbidity between inattention problems and reading difficulties might be attributable to potential antecedent factors that plausibly explain this recurrent association.

*Grade 5: Familial antecedents of reading difficulties, parental educational level, word reading achievement and behavior problems*

*Familial antecedents of reading difficulties* were significantly associated with *word reading achievement* at Grade 5. Children whose parents indicated the presence of a family history of difficulties in learning to read exhibited lower scores on the word-reading outcome at Grade 5. This result concurs with previous studies referring the negative association between familial risk of reading difficulties and children's subsequent reading achievement during elementary school (Puolakanaho et al., 2007; Snowling et al., 2003).



In addition, the measure of *familial antecedents of reading difficulties* was associated with teacher's reports of *Inattention* symptoms, but not with *Hyperactivity*, *Conduct problems* or *Unsociability*. These results parallel the cross-sectional associations observed during kindergarten in previous scientific studies and lend support to the hypothesis referring to the shared familiarity between reading difficulties and inattentive behavior (Friedman et al., 2003; Paloyelis et al., 2010)

Conversely, *parent's educational level* was not related with *familial antecedents of reading difficulties*, teacher's reported *behavioral problems* and children's *word reading achievement* at Grade 5. A plausible explanation for the absence of relation between parent's educational level and the remaining study's measures, namely children's word reading achievement, lies on the size (relatively small,  $n=150$ ) and composition of the sample at Grade 5. As mentioned previously, the Grade 5 sample contained a significantly higher proportion of students with better performances in the cognitive-academic assessment and whose parents were characterized by a median-high level of education. Hence, the higher parental level of education observed at Grade 5 coupled with children's better cognitive-academic resources might have contributed to mask significant associations between the study measures at this grade level.

## Longitudinal analyses

Predicting *word reading achievement* at Grade 5 from *behavior problems* (kindergarten and Grade 5), *emergent literacy skills* and *family characteristics* in kindergarten

The results from the longitudinal analyses indicated that from the large span of measures assessed in kindergarten five were longitudinally correlated with children's *word reading achievement* at Grade 5. These measures referred to teachers' reports of *Inattention* at Grade 5, parental reports of *familial antecedents of reading difficulties*, and three *emergent literacy measures* from the *BSEDS* battery at kindergarten, namely *syllabic deletion*, *oral comprehension* and *letter reading*.

The longitudinal contribution of these measures to the prediction of the word reading outcome at fifth grade was assessed by means of regression analysis. The results revealed that both *familial antecedents of reading difficulties* and teachers' *Inattention* reports at Grade 5 made significant contributions to the prediction of the word reading outcome at fifth grade. However, neither of these variables explained a significant proportion of variance in word reading at fifth grade beyond that accounted by the measures of *syllabic deletion* and *letter reading* at kindergarten. These two measures embody often cited skills considered of major importance in reading development, namely phonological awareness and letter knowledge. The role of these early reading-related skills on the acquisition of word identification skills is well established, in accordance with an extensive body of literature (Castles & Coltheart, 2004; Hecht et al., 2000; Hulme et al., 2005; Sprenger-Charolles et al., 2003; Whitehurst & Lonigan, 1998).

The absence of significance of teacher's Inattention reports in the prediction of word reading achievement at Grade 5 merits some comment, due to recurrent evidence from several studies reporting the predictive power of attention skills on later reading ability (Giannopulu et al., 2008; Lonigan et al., 1999; Rabiner & Coie, 2000). As stated above, the relatively small size of the Grade 5 sample and its composition (children with better overall performances on cognitive-academic skills and whose parents were characterized by a median-high educational level) might have thwarted the manifestation of significant relations between teacher's reported inattention symptoms and word reading achievement at Grade 5.

Most importantly, the results from the longitudinal analyses confirmed that parents' reports of familial antecedents of reading difficulties were longitudinally associated both with lower word reading scores and teachers' Inattention reports at Grade 5. In the same line, group comparisons between normal readers and children who presented lower performances on the word reading outcome at Grade 5 lent support to these results by revealing that these groups were reliably different from one another on measures of syllabic deletion, letter reading, familial antecedents of reading difficulties and teachers' reports of Inattention problems. Taken together, these results confirm the pertinence of including these measures in screening procedures aimed to identify children at risk of developing reading difficulties. Puolakanaho and colleagues (2007) have demonstrated that a rough screening procedure including familial risk status and measures of phonological awareness, letter knowledge and rapid naming

provided a reliable method for estimating a child's individual risk for developing RD from the age of 3.5 years. The results of the present study extend these findings by demonstrating that preschoolers with a family history of reading difficulties might also be at increased risk of manifesting co-morbid attention problems at the end of elementary school together with reading difficulties. This assumption is contingent with the results obtained by Hynd and colleagues (1991) who indicated that children with Attention Deficit Disorder Without Hyperactivity (ADD/WO) were more likely to exhibit a family history of reading difficulties. Unique to the present study is the finding of the longitudinal association between reading difficulties and attention problems in children with a family history of reading difficulties in a non-diagnosed community sample followed from preschool to late elementary school, some of whom would have been expected to develop reading problems. These results concur with research evidence from family studies regarding the shared familiarity of RD and ADHD (Friedman et al., 2003) and suggest that family factors play a role in the co-occurrence of these two disorders. Furthermore, our results align well with twin studies that recently demonstrated that the association between RD and inattention symptoms is in place during kindergarten (Ebejer et al., 2010; Willcutt et al., 2007) and is largely driven by genetic and environmental factors (Paloyelis et al., 2010). Taken together, the findings presented here underline the importance of considering the contribution of family-specific factors as antecedent variables in the co-occurrence of reading difficulties and inattention problems from kindergarten onwards.

In summary, the present analyses have confirmed the crucial role that phonological awareness and letter knowledge play as developmental precursors of word reading skills in a sample of French students followed from kindergarten to fifth grade. In addition, our results suggest that familial antecedents of reading difficulties constitute an important risk indicator of those children who probably will develop reading difficulties. Most importantly, the current analyses presented evidence that children whose parents reported familial antecedents of reading difficulties were more likely to have lower performances on reading-related tasks, and to be rated by their teachers as inattentive, both at kindergarten and at the end of elementary school. Altogether, these findings emphasize the importance of considering familial antecedents of reading difficulties as a potential antecedent variable in the co-occurrence of reading difficulties and attention problems (Hinshaw, 1992).

## Predicting Grade 9 outcomes from *cognitive-academic skills* and *family characteristics* in kindergarten

In this study, we used multiple informants and instruments to assess children's cognitive-academic skills and family-related characteristics in kindergarten. Because the outcome measure was general academic achievement at the end of middle school, our selection of variables aimed to represent a diversified set of family background characteristics and distinct cognitive-academic skills from diverse domains of early competence frequently cited as strong correlates of general achievement, as opposed to domain-specific educational outcomes.

The participants' performances in the Grade 9 academic outcomes paralleled the nationally-representative results reported by the French National Education Department for the same indicator of academic achievement at the end of middle school (Ministère de l'Éducation, 2012). The large majority of the variables in kindergarten were associated with later achievement at Grade 9 but only certain factors in each assessment instrument contributed specifically to predicting academic outcomes at the end of middle school. The final results indicated that five child-related variables (four derived from direct cognitive assessment and one from the teacher questionnaire) and two family-related characteristic significantly predicted the Grade 9 outcomes, once the effects of the remaining child and family-related factors were controlled for. The measures of child-related factors reflected the children's performances on the subtests assessing oral language, short-term verbal memory, letter reading, non-verbal abilities, as well as teacher reports of attention-related skills. Among the family-related variables, only parental educational level and family situation were selected in the final model, suggesting that the effects of these family-related characteristics extend beyond its impact on children's cognitive-academic skills before school entry. These results are remarkably similar to previous findings regarding the persistent influence from kindergarten onwards of child-level factors pertaining to specific cognitive-academic skills (Duncan et al., 2007; Grimm et al., 2010; Grissmer et al., 2010; Hooper et al., 2010; Pagani et al., 2010; Romano et al., 2010) and of family-level factors, such as parental educational level and type of family, on children's subsequent educational outcomes in middle school (Entwisle et al., 2005; Gutman et al., 2003; Magnuson, 2007; Pungello et al., 2010; Schoon et al., 2002).

### *Gender and age in kindergarten and academic achievement at Grade 9*

A significant, albeit fairly weak, association between age in kindergarten and the children's subsequent Grade 9 outcomes was observed. Children who were older in kindergarten tended to exhibit higher performances in Grade 9 outcomes, compared to younger children. This result is partially explained by the association found between the children's age in kindergarten and school grade repetition during the 10-year span of the study follow-up. Younger children in kindergarten had a higher risk of being subsequently required to repeat at least one grade during elementary and middle school and were therefore overrepresented in the "Failure" group. This pattern of results concurs with national statistics reported by the French National Education Department (Miconnet, 2012).

Female gender was associated with more favorable educational outcomes at the end of middle school, in agreement with national figures in France (Ministère de l'Éducation, 2012). Moreover, this association concurs with the longitudinal findings of Entwisle et al. (2005), who reported a female advantage both at school entry and at age 22 on measures of educational attainment and years of schooling. Likewise, Grimm et al (2010) examined three large sets of longitudinal data and observed that girls consistently outperformed boys at school entry on measures of mathematical and reading achievement at Grade 8. Conversely, Pagani and colleagues (2010) presented evidence that, all other things being equal, girls with lower scores on receptive language tasks at school entry tended to perform lower than boys with the same characteristics on subsequent measures of mathematical achievement and classroom engagement. Overall, although gender differences in children's later achievement may be study- and country-specific, several reports emphasize that the effects of school entry skills on later academic achievement might differ between boys and girls, suggesting that different cognitive-academic skills might be more critical for later achievement in a specific gender (Entwisle et al., 2005; Grimm et al., 2010; Pagani et al., 2010).

### *Cognitive-academic skills and academic achievement at Grade 9*

All cognitive-academic subtests at kindergarten showed a clear linear tendency of association between children's performances in kindergarten and their later achievement across the four categories of the Grade 9 outcomes. Among the wide variety of child-related factors assessed in kindergarten, children's *expressive oral language*, *letter knowledge*, *short-term verbal*

*memory, non-verbal cognitive ability* and *attention-related skills* contributed the most to predicting the Grade 9 outcomes. These results speak directly for the importance of distinct domains of early cognitive-academic competency for children's overall academic achievement, and concur with a large body of literature underlining the robust predictive power of these specific school entry skills (La Paro & Pianta, 2000; Duncan et al., 2007).

The middle school effects of *short-term verbal memory* on later academic achievement observed in the present study align well with previous reports based on comprehensive reviews of the extant literature (Melby-Lervåg et al., 2012; Whitehurst & Lonigan, 1998).

In the same vein, *letter knowledge*, assessed in the present study through a letter reading task, contributed independently to the variance of Grade 9 outcomes. This result concurs with previous research emphasizing the importance of children's ability to recognize print symbols, in particular letter-name knowledge, in the prediction of later school outcomes during childhood and beyond (Cuningham & Stanovich, 1997; Whitehurst & Lonigan, 1998).

Our results confirm the well-established influence of children's *oral language skills* at school entry on subsequent achievement in elementary and middle school (Duncan et al., 2007; Cuningham & Stanovich, 1997). Moreover, these results lend support to the argument that the effects of oral language skills become increasingly strong in later stages of educational trajectories, compared to the effects of code-related skills, such as phonological awareness (Storch et al., 2002). Children need to mobilise their vocabulary repertoire and proficiency in verbal comprehension at later stages in their educational career, when cognitive resources are required for reading and understanding verbally-coded materials of increasing complexity.

Another domain that emerged as a robust predictor of later achievement is *attention-related skills*, independently from the effects of cognitive-academic skills and family background. Attention-related skills in kindergarten have been consistently reported as robust predictors of later achievement in elementary and middle school (Hinshaw, 1992; Rabiner & Coie, 2000; Spira & Fischel, 2005; Vitaro et al., 2005). More recently, two large population-based investigations have underscored the crucial role that school entry attention skills play in the prediction of high school graduation of young adults at age 21 (Pagani et al., 2008) and 22-23 (Pingault et al., 2011).

The association between the parental assessments of children's oral language and academic achievement failed to reach statistical significance once we controlled for the effects of teacher reports of oral language in the classroom. A possible explanation is that, compared to parents, teacher evaluations are probably based on a wider picture of the children's accomplishments, including their cognitive-academic skills and learning-related behaviors, such as whether they work autonomously, execute tasks on time, and show involvement in classroom activities. Teacher evaluations of children's cognitive skills tend to rely predominantly on their academic and learning-related performance during classroom activities (Aaron, Joshi, Palmer, Smith, & Kirby, 2002), which in turn is strongly associated with later achievement (McCelland, Acock & Morrison, 2006; Mischel, Shoda & Rodriguez, 1989; Yen, Konold & McDermott, 2004). Furthermore, teacher reports of oral language and time perception skills lost significance after the effects of the cognitive subtests were entered into the regression model. This result suggests that the effects of these teacher factors on the Grade 9 outcomes were mediated by the cognitive-academic skills measured by direct assessment. Teacher evaluations based on classroom observations of academic performance might not be as accurate and specific as children's performances on precise tasks aimed to evaluate targeted cognitive skills. These findings agree with Glascoe's recommendation (2001) that teacher ratings can provide valuable information, but they need to be supplemented with standardized test results in order to ensure accurate assessment of children's cognitive-academic achievement.

#### *Family-related characteristics and academic achievement at Grade 9*

*Father's nationality* (French vs. foreign), *family situation* (children living with both parents vs. other situations), *type of early childcare* (maternal childcare exclusively vs. others situations), *parental education level* (low vs. medium-high), *familial antecedents of reading difficulties* (absence vs. presence) and *language-based bedtime routines* (absence vs. presence) were significantly associated with the Grade 9 outcomes, together with parent's reports of significant health problems with possible impact on children's cognitive development (e.g. epilepsy). These results are in line with previous studies describing the association of these family-related characteristics with children's academic achievement.

*Family immigrant status*, operationally defined in the present work as parents born outside France, has been reported to influence children's academic trajectories, although the direction of the effects of this measure remains inconclusive due to conflicting evidence reporting both vulnerable and successful trajectories for children from distinct immigrant backgrounds (Crosnoe & Turley, 2011). In the present study, children with foreign-born fathers obtained lower scores on academic achievement outcome at Grade 9, which is in accordance with the results reported in the Programme for International Student Assessment ([PISA], OECD, 2010). However, caution is warranted in the interpretation of these results. Previous studies have demonstrated that it is the student's attitudes and behaviors towards education that influence the most their academic achievement, regardless of their ethnic and socioeconomic background (Fuligni, 1997). For instance, students of immigrant families tend to approach schooling with a strong motivation, which is normally supported by their parents and peers independently of the immigrant nationality. In the same line, the results of Hao and Woo (2012) underlined the promoting effect of immigrant optimism and the protective effect of immigrant families. Applied to our results, these findings advance the hypothesis that the students from immigrant families participating in the present study might lack a positive and motivated attitude towards schooling together with a limited emphasis of family on education. However, the processes through which family immigrant status influences children's academic achievement were beyond the range of the present work and additional studies are needed that focus on the mechanisms pertaining to family immigrant status that influence children's educational trajectories.

Children from intact families tended to exhibit better performances from kindergarten to the end of middle school, compared with children from families where one of the parents was absent. This result parallels the worldwide figures presented in the PISA report (OECD, 2010). *Family situation* has been consistently described as a significant factor in children's subsequent academic achievement because of its strong correlation with educational outcomes in adolescence and young adulthood (Gutman et al., 2003; Pagani et al., 2008; Pungello et al., 2010; Reynolds et al. 2004).

Children who had exclusively maternal care during infancy performed less well in middle school than did children who received non-maternal care. This factor remained significant even when parental educational level was taken into account. Geoffroy et al. (2010) evidenced that children of mothers with low levels of education exhibited a consistent pattern of lower



scores on cognitive-academic readiness and academic achievement than children of highly educated mothers, unless they received formal childcare. Our findings also concur with numerous studies describing the lasting effects of preschool participation in children's cognitive-academic achievement during middle childhood and early adolescence (Campbell et al., 2001; Pungello et al., 2010; Vandell et al., 2010).

The effects of *parental educational level* are in line with the widely documented influence of parental educational level on children's educational trajectories from kindergarten to middle school (Entwisle et al., 2005; Magnuson et al., 2007; Pagani et al., 2008).

Novel to our findings were the associations of *familial antecedents of reading difficulties* and *language-based bedtime routines* with children's academic achievement at the end of middle school. In the present analyses, parents reports indicating the presence of familial antecedents of reading difficulties in the participant's family was associated with lower scores on the academic outcomes at Grade 9. This result confirm the findings from previous studies indicating that information regarding the presence of familial antecedents of reading difficulties contributes to identify kindergartener's at risk manifesting academic difficulties at age 10 (Costa et al., 2013) and 12 (Snowling et al., 2007). We extend these findings by presenting evidence that the effects of familial antecedents of reading difficulties influence general academic achievement from kindergarten through the end of middle school (age 14).

In addition, *language-based bedtime routines* evidenced significant effects on children's cognitive-academic skills in kindergarten, which in turn was associated with their subsequent outcomes at Grade 9. The effects of this variable on children's school readiness skills have been reported in recent research (Hale et al., 2011). As suggested by the authors, a possible explanation could be that these routines might be proxies for access and exposure to book-sharing, which promotes positive cognitive development (Raikes et al., 2006; Whitehurst & Lonigan, 1998). Our results extend the findings of Hale and colleagues (2011) by demonstrating the lasting effects of language-based bedtime routines on children's academic achievement in middle school and by underlining the importance of considering this family characteristic as a factor influencing children's later academic achievement. However, caution is required when interpreting the effects of this variable on children's cognitive-academic achievement. Despite the major role played by parents in proposing and engaging children in

language-based bedtime routines, the children's characteristics must also be taken into account when interpreting the presence or absence of these routines. Children contribute with personal and temperamental attributes to adult-child interactions and verbal exchanges, which significantly influence the dynamics of proximal processes, the primary motors of human development (Bronfenbrenner & Morris, 2006). Thus, the interpretation of the effects of language-based bedtime routines should consider the role that children's characteristics play in the promotion and engagement in these routines, as opposed to considering it a familial attribute determined exclusively by the parents.

Additionally, the multiple risk index score summing up gender, the child's medical history and the six above-mentioned family characteristics, was strongly related to later achievement, in accordance with previous research (Sameroff et al., 1993). However, in contrast with past reports, our multiple risk index score included only the family characteristics that contributed with additional predictive power in explaining the academic outcomes at Grade 9 outcomes, while controlling for the simultaneous effects of the remaining family factors. As recommended by Evans, Li and Whipple (2013), this strategy allows determining exposure to a risk factor based on its relative robustness as a predictor of the outcome, as opposed to designating risk exposure based on statistical distribution or theoretical framework.

From the numerous familial variables analyzed in the present study, only *parental educational level* and *family situation* contributed significantly to predicting children's outcomes at Grade 9 in the regression analyses, when cognitive-academic performances at school entry were taken into account. This suggests that the effects of *family situation*, *type of early childcare*, *familial antecedents of reading difficulties* and *language-based bedtime routines* were channeled through children's school entry skills. In contrast, parental education level and family situation evidenced more persistent effects on children's academic achievement from school entry to the end of middle school. This result is in accordance with the conclusions presented by Entwisle et al. (2005), who suggested that the great stability of children's achievement trajectories from kindergarten onwards is associated with the strong probability that the conditions and circumstances of children's social environments, such as parental socioeconomic status, remain invariable. This result also concurs with the findings of Schoon et al. (2002), who reported that children's developmental outcomes are influenced by the context and the timing of their early exposure to risk factors. For instance, the effects of particular environmental conditions and circumstances might exert their upmost influence in

certain periods of children's development, such as kindergarten, although their effects tend to wear off as children enter adolescence and early adulthood. Conversely, the effects of some family factors on children's academic achievement tend to persist and have lasting implications from kindergarten through adulthood.

Taken as a whole, these results contribute to the extant literature regarding early childhood factors associated with later academic achievement. First, our findings confirmed the contribution of distinct domains of early cognitive-academic skills to the prediction of later academic achievement at the end of middle school. The second contribution was that family characteristics, such as family antecedents of reading difficulties and language-based bedtime routines, contributed to later achievement at the end of middle school through their effects on children's cognitive-academic skills in kindergarten, over and above the simultaneous effects of a original set of family background characteristics including parental educational level. To our knowledge, this is one of the first studies documenting the association of familial antecedents of reading difficulties and language-based bedtime routines with later academic achievement in middle school. The third contribution of the present study is the confirmation of the persistent effects of parental education level and family situation on children's academic achievement in the transition from childhood to early adolescence. Finally, the present findings add to the extant literature by presenting evidence that familial antecedents of reading difficulties represent a plausible antecedent variable for the frequent co-occurrence of reading difficulties and inattention problems.

In summary, the findings here reported add to the extant literature regarding the child and the family factors contributing to children's later academic achievement and provide complementary findings to the research questions delineated in the present work.

Firstly, although previous studies conducted in France have highlighted the significant influence of cognitive, familial and behavioral factors on children's reading achievement during elementary school (Billard et al., 2008, 2009; Fluss et al., 2008; Watier et al., 2006), the extant literature concerning the association of these factors during the preschool period and its effects on children's academic outcomes at the end of middle school is scarce. Furthermore, longitudinal studies aimed at analyzing these associations in community-based samples of typically developing children derived from the general population are still required

in France (INSERM, 2007). The present work contributes to the extant literature by demonstrating that children's academic achievement at the end of elementary and middle school is strongly influenced with particular constructs of children's cognitive-academic abilities, behavioral skills and family-related background characteristics. With respect to the child-level factors examined in the present study, children's proficiency in oral language, letter knowledge, non-verbal cognitive ability, working memory and attentive behavior in kindergarten were the most significant predictors of their subsequent general academic achievement at the end of middle school, in accordance with the findings of a large body of literature (Campbell et al., 2001; Duncan et al., 2007, for a review). Interestingly, these findings resemble the cognitive domains underlying more general measures of cognitive ability, such as the Intellectual Quotient (IQ). With the exception of letter knowledge, a skill largely associated with the academic environment, and attention-related skills, usually considered a behavioral attribute, all the other child-level factors represent cognitive domains usually used as indicators of children's IQ (verbal knowledge, working memory and non-verbal skills) which is strongly associated with later academic achievement (Campbell et al., 2001).

In addition, some child-level factors were specific to the prediction of word reading achievement at the end of elementary school, such as oral language, phonological awareness and letter knowledge. These measures of emergent literacy skills at kindergarten were the most robust predictors of the word reading outcome at Grade 5, in accordance with the large array of scientific studies demonstrating its powerful role on children's reading development (Whitehurst & Lonigan, 1998, for a review). These findings also contribute to the extant literature by indicating the differential importance of emergent literacy skills at different time points of reading development. Although in the initial stages of reading development children's oral language, letter knowledge and phonological processing skills are required to launch successful trajectories of reading acquisition, the effects of phonological awareness skills tend to wear off longitudinally once the mechanisms required for appropriate word identification and decoding are established (Storch & Whitehurst, 2002). However, the effects of oral language skills tend to persist longitudinally through the end of middle school, in accordance with scientific results indicating the lasting effects of these skills on children's achievement trajectories into adolescence (Cunningham & Stanovich, 1997).

The results of the present work also provide support to the contention that, among distinct dimensions of behavioral competence, it is children's attention-related skills that contribute the most to children's academic achievement, both concurrently and longitudinally (Spira & Fischel, 2005, for a review; Hinshaw, 1992, for a review; Pingault et al., 2011). The study's measures of Hyperactivity, Conduct problems and Unsociability failed to predict the word reading outcomes at the end of elementary school, which aligns with the results of previous research (Rabiner & Coie, 2000, Lonigan et al., 1999). However, the present results revealed that the dimensions of Conduct problems and Unsociability influenced children's emergent literacy skills at kindergarten, even after controlling for the concurrent effects of the Inattention factor, although its effect were significantly inferior to the ones observed for the Inattention factor. The results align with previous reports indicating the cross-sectional influence of disruptive behavior on children's emergent literacy skills (Doctoroff et al., 2006) and draw attention to the fact that the effects of children's disruptive and prosocial behavior on children's academic achievement should not be neglected in detriment of the well-documented effects of inattentive behavior (Romano et al., 2010; Pagani et al., 2010).

Interestingly, the results indicated that children's whose teacher's reported inattention symptoms together with conduct problems or unsociability tended to exhibit better performances on the global measure of cognitive-academic skills at kindergarten. This result aligns with previous research indicating that children manifesting attention difficulties, but whose behavioral problems do not disturb the classroom setting, might be more difficult to detect adequately by the teacher, when compared with children that evidence exclusively difficulties of inattention or unsociability (Barriga et al., 2002). Another interpretation of these results can be considered taking into account the empirical evidence reporting the negative impact of passive behavior (i.e. the presence of none or few externalizing problems) on children's academic achievement (Lazaratou et al., 2014). In a study conducted with the Conners Teacher Rating scale, the passive behavior factor loaded specifically on one of the items used to define attention/concentration problems (Fantuzzo, Grim, Mordell, McDermott & Miller, 2001). As suggested by Lazaratou and colleagues (2014), these findings suggest that activities in the classroom setting requiring passive engagement (silent reading, listening) are particularly problematic for children with attention difficulties with possible negative implications on cognitive-academic performance.

In addition to the effects of children's cognitive-academic and behavioral skills on later academic achievement, the results of the present study indicated that several family background factors were significantly associated with the participant's trajectories at the end of elementary and middle school. The analyses of the long term contribution of family-related characteristics to children's general academic achievement at the end of middle school indicated that parental educational level and family situation were the most significant familial predictors of later academic achievement once the effects of children's cognitive academic skills were accounted for. These results follow the findings reported in the scientific literature regarding the lasting effects of these measures on children's academic achievement and the importance of considering them in studies aimed at analyze the factors that place a child at risk of later academic underachievement (Hecht et al., 2000, Campbell et al., 2001).

Although the remaining family-related measures of family immigrant status, type of early childcare, familial antecedents of reading difficulties and language-based bedtime routines were significantly associated with the participants outcomes at the end of middle school, they failed to reach statistical significance once the effects of children's cognitive academic-skills was controlled. These results suggest that the effects of these family characteristics on children's academic achievement at the end of middle school were channeled through their effects on children's cognitive-academic skills in kindergarten. Taken together, these results underline that some family background characteristics have unique and lasting effects on children's long term achievement trajectories, while the effects of other familial characteristics is routed through their influence on children's cognitive-academic skills. As demonstrated by Vandell and colleagues (2010), the effects of some family characteristics are associated with the specific timings in which they occur during children's development. While some family characteristics exert their influence all along children's achievement trajectories, such as parental education level and family situation, the effects of other characteristics, such as language-based bedtime routine or type of early childcare, are significantly stronger at specific periods of children's development, namely the kindergarten period. Importantly, our findings underline the importance of considering these family characteristics as risk factors for subsequent academic underachievement. If the effects of early child care and family immigrant status have been reported in extant scientific literature, the results pertaining to the influence of familial antecedents of reading difficulties and language-based bedtime routines add to the literature regarding the risk factors to be considered when examining the factors that place a child at risk of later underachievement.

Unique to our findings was the analysis of the longitudinal contribution of language-based bedtime routine to children's academic achievement at the end of middle school. Although previous research had demonstrated the effect of this measure on children's cognitive-academic competence in kindergarten (Hale et al., 2011), we extend these findings by demonstrating that the effects of language-based bedtime routine persist through the end of elementary school although its influence is mediated by children's cognitive academic skills at kindergarten.

In the same vein, the effects of familial antecedents of reading difficulties on general academic achievement at the end of middle school were not significant after controlling for the effects of children's cognitive-academic skills, indicating that this measure influenced children's academic achievement at the end of middle school through its effects on children's cognitive-academic skills in kindergarten. We extend the findings of prior research (Snowling et al., 2007) by demonstrating that children whose families are characterized by a history of reading difficulties are at increased risk of presenting lower performance on measures of general academic achievement at the end of middle school (age 15-16 years)..

In addition, the results pertaining to the measure of familial antecedents of reading difficulties indicated that this measure contributed significantly to predict the study's overall measure of cognitive-academic skills at kindergarten and children's word reading achievement at the end of elementary school. These findings suggest that the presence of familial antecedents of reading difficulties is a specific risk factor of later reading difficulties. As discussed earlier, familial antecedents of reading difficulties were associated specifically with the cognitive subtests assessing phonological processing and oral language skills, which constitute developmental precursors of later reading acquisition (Wagner et al., 1997; Torgesen et al., 1997). The early screening of children with familial antecedents of reading difficulties, together with measures of letter knowledge and phonological awareness, has been shown to constitute a parsimonious and efficient method to detect early children who might be at risk of later reading difficulties.

Other the influence of familial antecedents of reading difficulties on children's later reading achievement, the results here reported also indicated that this measure was significantly related with teacher's reports of inattention problems. This particular finding adds to the

scientific literature by demonstrating in a community-based sample derived from the general population that children characterized by a familial history of reading difficulties are at increased risk of manifesting concurrent reading difficulties and attention problems at kindergarten and at the end of elementary school. These findings support the argument of the shared familiarity between reading difficulties and inattention problems and suggest that familial antecedents of reading difficulties might represent an antecedent variable to the frequent co-occurrence between reading difficulties and inattentive behavior.

## Strength, limitations and future research directions

A number of strengths support the validity and reliability of the findings reported in the present work. The sample sizes of Cohort 3 at kindergarten and of Cohort 1 from kindergarten to Grade 9 were considerable and were drawn from a representative population of typically developing children in suburban and rural communities in France. The study's longitudinal nature allowed the collection of prospective data obtained from multiple informants and assessment methods, and covered an extended period of time from kindergarten to the end of elementary and middle school. Finally, the analyses investigated a comprehensive and unique set of early child and family-related measures as plausible predictors of a nationally representative measure of middle school outcomes over a 10-year time span.

However, some limitations need to be considered in interpreting the findings from the present study. First, the samples used in the present study were drawn from a general population representative of suburban and rural communities matriculated in French general education classrooms. Therefore, it does not constitute a nationally representative sample of children enrolled in kindergarten and, thus caution is warranted regarding the generalizability of the present findings to other populations.

Second, with respect to Cohort 3, logistic constraints limited the follow-up of a larger sample of children from preschool through Grade 5, which explains the high attrition rate verified between the two school years. Consequently, despite the important size of the kindergarten sample, the size of the fifth grade sample constrained the power of the data analysis performed at this grade level. The presence of missing data coupled with our reliance in the treatment of complete cases may have obscured significant relations between variables,



namely the association between inattentive behavior at kindergarten with subsequent inattentive behavior and word reading achievement at Grade 5. Similarly, the fifth grade sample size limited the analysis of the group comparisons between normal readers and the reading difficulties group. The significantly reduced proportion of students at-risk of experiencing reading difficulties in the fifth grade sample restricted the examination of the extent to which the prediction patterns would hold up for this particular group.

Thirdly, the definition of behavior problems into Hyperactivity, Inattention, Conduct problems and Unsociability for Cohort 3 was based on teacher's responses to four questions and, consequently, does reflect neither true diagnostic categories nor the full range of symptoms characteristics of these distinct behavioral dimensions. In addition, the assessment of inattentive behavior in Cohort 1 and 3 relied exclusively on teacher's questionnaires and some authors have underlined the problematic associated with teacher's reports of behavioral problems. For instance, teachers tend to report more frequently inattentive symptoms in children that exhibit difficulties in tasks evaluating cognitive-academic skills, since both problems manifest themselves in lower academic performance (Aaron et al., 2002). Teacher's identification of inattentive behavior might be related with the observation of children's lower performances in cognitive-academic activities at the classroom and, thus, do not reflect specific deficits associated with inattentive behavior (Giannopulu et al., 2008). Indeed, the correlation between teachers reported inattention and direct assessments evaluating attention skills might not be accurate or specific, (Castellanos & Tannock, 2002), despite evidence that both assessment methods for attention skills are related to academic performance (Sims & Lonigan, 2012). Furthermore, the study of the association between behavioral problems, such as inattention and reading difficulties, implies the consideration of several external correlates of both disorders, namely: IQ, socio cultural background, family environment, among others. In the present study, only parents' level of education was considered.

Fourth, the battery used in kindergarten did not included numeracy-related skills so that the extent to which early mathematical abilities contributed to predicting later outcomes could not be estimated (Duncan et al., 2007). In addition, we only controlled for the effects of non-verbal cognitive ability (perceptual reasoning). Other measures referring to children's general cognitive ability, such as IQ, need to be considered when examining the effects of children's early competency before school entry on later academic achievement.

Although the study's measure of familial antecedents of reading difficulties was based on parent's responses to two questions, the results clearly demonstrated it shared association with both reading difficulties and attention problems. However, this measure did not allowed to uncover the nature of familial antecedents of reading difficulties, particularly if its influence on children's emergent literacy and attention skills is related to specific characteristics and processes of the familial environment or if they reflect a genetic familial risk. Further studies are needed that focus in more detail on the mechanisms by which the presence of familial antecedents of reading difficulties operate simultaneously on reading difficulties and attention problems from kindergarten onwards. As suggested by Ramus (2006), although family and twin studies have contributed to unravel the genetic nature of reading difficulties and attention problems, the phenotypic characterization of these disorders needs to consider the role of specific environmental factors influencing the development of the cognitive profiles typically associated with co morbid reading difficulties and attention problems.

In addition, the present analyses focused on the role of behavior problems on children's later achievement. An increasing body of researchers has begun to explore distinct dimensions of behavioral and social skills, other than externalizing behavior problems. For instance, extant research has indicated the positive impact of children's prosocial skills, learning-related behaviors that reflect focus, independence and task orientation, and self-discipline on later academic achievement (Pagani et al., 2010; Romano et al., 2010). Further studies should include measures of children's social competence, school engagement and learning-related behavior before school entry when analyzing the influence of children's behavior on academic achievement.

The present work reinforces the importance of the kindergarten period for children's subsequent achievement trajectories. Several longitudinal studies have highlighted the critical domains of early competency that matter the most for children's later academic achievement (Duncan et al., 2007, for a review). Future studies should be oriented towards the compilation and synthesis of the results reported in longitudinal research in order to establish more comprehensive patterns of the child- and environmental-level factors influencing later achievement, especially in France. Ultimately, this comprehensive analysis has the potential to identify the strategic domains to be integrated in intervention programs aimed at promoting children's developmental trajectories with important implications for their academic achievement.



## V. Conclusion

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The present work adds to the extant scientific literature regarding the primordial role that children's cognitive-academic and behavioral skills play on later academic achievement from kindergarten through middle school. The results were derived from a French-speaking population of kindergarteners followed through the end of elementary and middle school and contribute to confirm the robustness of specific child-level factors in explaining children's achievement trajectories, in accordance with previous studies developed in English-speaking countries. Children's oral language, phonological processing abilities, short-term memory of verbally-coded materials, knowledge of print concepts, non-verbal perceptual reasoning and attentive behavior were the strongest predictors of children's later word reading at the end of elementary school and of general academic achievement at the end of middle school.

These results indicated a significant overlap between the predictors of word reading acquisition at the end of elementary school and of general academic achievement at the end of middle school. The study measures of oral language (expressive vocabulary and oral comprehension) and letter knowledge (letter reading) were significantly associated both with the word reading outcome at Grade 5 and with general academic achievement at Grade 9. These could be explained by the fact that our measure of general academic achievement at the end of middle school was partially constituted of children's performances in a written exam evaluating French subject matter. These findings emphasize the crucial role that reading-related skills play on children's overall academic achievement, since reading ability not only represents itself a typical indicator of academic achievement, but also is a necessary condition to perform adequately in the increasingly demanding classroom activities required throughout elementary and middle school.

Furthermore, the above-mentioned results add to the debate regarding the role of reading-related skills at different time points of reading development. For instance, phonological awareness skills were significantly associated with word reading achievement at the end of elementary school, but not with later general academic achievement. In the initial stages of reading development, children must invest their cognitive resources in phonological segmentation and word decoding tasks which allow them to understand the structure and

processes of reading. However, once children consolidate these building-blocks of literacy development and as they progress in their educational careers, children are requested to place a greater focus on reading for meaning, i.e., understanding and extracting significance of printed materials of increasing complexity. As a consequence, some reading-related skills, such as phonological processing abilities, are more important during the initial stages of reading development while others, such as oral language skills, are important in the initial stages of reading development but also are influential in subsequent phases of reading development and academic achievement.

Children's cognitive-academic development is largely influenced by family background characteristics. Parental educational level, family situation, family immigrant status, type of early childcare, familial antecedents of reading difficulties and language-based bedtime routines were significantly associated with children's academic trajectories from kindergarten through the end of middle school. Among this set of family-related characteristics, parental level of education and family situation evidenced persistent and lasting effects on children's academic achievement from kindergarten through middle school in accordance with previous longitudinal studies reporting the lasting effects of these factors on subsequent academic achievement. Some family background characteristics exert their influence all along children's achievement trajectories and are likely to represent familial circumstances that tend to remain unchangeable throughout children's development. Other family characteristics exert their upmost influence early in children's development and their lasting effects are channeled through children's initial levels of cognitive-academic competency before school entry. Importantly, all children exhibiting the totality of the family risk factors operationally-defined in the present work failed to obtain their diploma at the end of middle school. Early environmental risk factors, such as family characteristics associated with unfavorable outcomes, represent powerful inhibitors of subsequent academic achievement and increase remarkably the probability of negative outcomes on children's developmental trajectories. Examining the familial circumstances affecting children's early development is a resourceful tool for identifying those who, without adequate intervention, are at increased risk of academic underachievement.

Novel to our findings were the results indicating that familial antecedents of reading difficulties and language-based bedtime routines at kindergarten were significantly associated

with children's academic achievement at the end of middle school. The inclusion of these two novel factors in a multiple-risk score was related with a significant proportion of underachievement outcomes. To our knowledge, this is the first empirical work demonstrating the longitudinal effects of these measures on children's general academic achievement in a sample derived from the general population. In addition, the presence of familial antecedents of reading difficulties was associated with an increased risk of manifesting not only reading difficulties but also attention problems. Due to the frequent association between reading difficulties and inattentive behavior and due to the adverse effects of this association on children's later achievement, familial history of reading difficulties should be regarded as a meaningful risk factor that increases the probability of co morbid reading difficulties and attention problems. Altogether, these findings extend previous research regarding the early environmental risk factors that hinder children's subsequent academic trajectories and speak directly to the importance of considering children's characteristics and active role in the transactions established with its environmental contexts.

The educational implications of the findings here reported are noteworthy and speak directly to both the type of cognitive-academic assessment to be performed at school entry and the definition of target groups of preschoolers who might be at academic risk of later reading and academic difficulties. Literacy-related skills (phonological awareness, letter knowledge), expressive and receptive oral language, verbal working memory and non-verbal ability were shown to represent robust predictors of subsequent reading and academic achievement throughout children's educational trajectories, in accordance with the conclusion of two previous comprehensive meta-analyses (Duncan et al., 2007; La Paro & Pianta, 2000). Importantly, extant research has underlined that intervention programs aimed at promoting these skills in kindergarten account for children's gains on measures of cognitive-academic achievement through childhood and adolescence, when compared with children that did not participate in early educational interventions (Campbell et al., 2001; Campbell & Ramey, 1994; Pungello et al., 2010; Vandell et al., 2010). In this vein, early screening procedures aimed at identifying kindergarten children with inadequate levels of development in these domains of competency are crucial as a means to provide adequate educative responses and promoting efficient interventions to children manifesting early difficulties during kindergarten.

Moreover, the assessment of the domains of early childhood competency that affect subsequent educational performances and development should take into consideration children's socio-emotional behavior. Attention-related behavior has been repeatedly demonstrated to predict children's subsequent cognitive academic achievement (Pingault et al., 2011; Rabiner & Coie, 2000) and extant studies have emphasized that the role of disruptive behaviors associated with conduct problems and unsociability should not be neglected (Doctoroff et al., 2006; Trzesniewski et al., 2006; Spira et al., 2005). However, as reviewed by Algozzine, Wand and Violette (2011), despite the frequent co-occurrence between academic difficulties and disruptive behavior during elementary school, there is little evidence demonstrating that an intervention aimed to improve disruptive behavior will translate into academic gains and vice-versa. For this reason, children who manifest concurrent cognitive-academic difficulties and disruptive behavior problems should benefit from intervention strategies focused on the development of both the cognitive-academic and the socio-emotional domains. As suggested by Algozzine and colleagues (2011), teaching behavior and academics to young children represents a preventive and promising venue underlying effective intervention programs across multiple domains of childhood competency.

The implications of this work also address the definition of targeted groups of preschoolers who might be at familial risk of later reading difficulties and academic underachievement. The early screening of the presence of familial antecedents of reading difficulties contributes to improve the early identification of children that might develop reading difficulties at the end of elementary school. Furthermore, these children are also at increased risk of manifesting concurrent attention problems from kindergarten to Grade 5. In other words, children evidencing a family history of reading difficulties represent an especially vulnerable group for later academic underachievement due to the increased risk of presenting concurrent reading difficulties and attention problems throughout elementary school.

Children from families characterized by low levels of parental education, limited resources referring to language-based interactions, not living with both parents and not having been enrolled in formal early childcare are at increased risk of subsequent reading difficulties and academic underachievement. Importantly, the accumulation of these risk factors increases dramatically the probability of later academic difficulties during elementary and middle

school. These findings align with a host of studies that have confirmed the detrimental effects of early environmental risk factors on children's subsequent achievement pathways (Gutman et al., 2003; Pungello et al., 2010; Schoon et al., 2002; Vandell et al., 2010). Information regarding specific characteristics of children's family background provides teachers with useful indicators for the early detection and prevention of children with significantly increased risk of later academic underachievement. In sum, teacher's observations of children's behavior and cognitive-academic performance in the school setting, together with family background information, represent a valuable and parsimonious resource for first-line screening procedures aimed at detecting children in need of age-appropriate cognitive assessment. Ultimately, these assessments contribute to the early detection of children's strengths and weaknesses allowing the implementation of interventions tailored to the child's specific needs in order to ensure adaptive and adjusted developmental pathways.

In conclusion, the present work reinforces the importance of investing early in children's development before formal schooling. Due to the deleterious and lasting implications of academic underachievement for children, investing early in children's education represents a preventive and effective approach with high return rates both for individuals and societies (Heckman, 2006). Although children's achievement trajectories are not deterministically shaped by their early abilities, the cumulative nature of children's skill formation implies that those exhibiting poor skills at school entry are at increased risk of underachievement trajectories throughout their educational careers. However, it is important to note the large individual variability of the achievement patterns of students with inadequate levels of cognitive-academic skills at school entry, as well as the positive effects of intervention programs aimed to promote these skills. Educational and social policies towards early childhood should aim at identifying the early factors that place a child at risk of later school failure and the conditions that promote or hinder children's development before kindergarten. These programs must acknowledge the importance of integrating adult caregivers in these practices in order to promote potentially greater impacts on children's early learning. Knowledge of the early factors associated with academic later achievement constitutes a key element for developing creative evidence-based intervention programs combining both cognitive-linguistic enrichment and protective factors that enhance and strengthen the developing child (Shonkoff, 2011).





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## APPENDIXES

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## Appendix 1

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### Published results issued from the Creusot study

Parental screening of oral language difficulties in preschool children (Callu, Jacquier-Roux, Cusin, Giannopulu & Dellatolas, 2003)

The main objective of this study was to examine the role of parents as informants in the early identification of preschool children with difficulties in oral language. At Preschool Grade 2 and 3 (Cohort 1 and 2, ages 4 to 6 years) parents were addressed questionnaires regarding children's oral language and behavior. Concomitantly, information concerning children's cognitive-academic skills was collected using the ERTL 4 questionnaire, the *BREV* battery (for the Cohort 2,  $n=782$ ) and the *BSEDS* battery (Cohort 1,  $n=923$ ). The results evidenced that parent's information regarding children's oral language was significantly associated with the cognitive-academic subtests evaluating oral expression (word repetition, phonological awareness, verbal fluency). This association was specific for the cognitive-academic subtests evaluating oral language skills, since the associations between parental information and the subtests evaluating non-verbal skills were not significant. These results indicate that parents represent an inexpensive and adequate resource for screening purposes aimed at identifying children manifesting difficulties in oral language skills during preschool.

Familial antecedents of reading difficulties and children's cognitive-academic skills in kindergarten (Doyen et al., 2004)

This study aimed to analyze the associations between the presence of difficulties in learning to read reported by the parents during their childhood and children's cognitive-academic skills at kindergarten (Cohort 2,  $n=769$ , ages 5 to 6 years). Parents were addressed questionnaires assessing the presence or absence of reading difficulties during their childhood and children were administered the *BSEDS* in order to assess their cognitive-academic skills. The results indicated that the presence of reading difficulties by at least one of the parents was related with children's lower performance in the majority of the subtests of the *BSEDS*. This particular result revealed that familial antecedents of reading difficulties might constitute a



risk factor for children's academic underachievement. However, the authors concluded that further analyses should be performed in order to disentangle the effects of parents' educational level from the effects of familial antecedents of reading difficulties.

Association between smooth pursuit eye movements and phonological awareness in preschool children (Callu et al., 2005)

The main goal of this study was to explore the associations between children's pursuit eye movements (being able to follow a moving object whose trajectory forms a lying "8") and their performances on the *BSEDS* battery assessing cognitive-academic skills. Data from cohort 1 ( $n=838$ ) and cohort 2 ( $n=732$ ) regarding the outcomes was collected during kindergarten (ages 5 to 6 years). The results pointed out the significant association between children's lower performances in the pursuit eye movements' task and their lower scores in the subtests evaluating phonological awareness and copy of visually presented patterns. The authors discussed the main findings in terms of the factors that could underlie this association, such as working memory and/or anticipation skills during the tracking of visual stimulus, and emphasized that children who manifest poor performances in eye pursuit and phonological awareness tasks are at risk of developing subsequent reading difficulties during elementary school.

Cognitive associations of bimanual haptico-visual recognition in preschoolers (Giannopulu, Cusin, Escolano & Dellatolas, 2007)

The purpose of this work was to investigate the relation between haptico-visual recognition of objects and cognitive tasks in preschoolers (Preschool Grade 2 and kindergarten) derived from the third ( $n=534$ ) and the second ( $n=750$ ) cohort of the Creusot study (ages 5 to 6 years). Children were evaluated with a task of haptico-visual recognition of objects (ability to identify an object by handling it without visual contact), as well several tests assessing phonological awareness, oral comprehension and figure reproduction. The results revealed that children's ability to recognize objects only by grasping them was positively associated with their performances on the cognitive tests, suggesting that haptico-visual recognition skills are associated with the cognitive development of preschoolers. Importantly, these results indicate that haptico-visual recognition tasks should be included in screening

instruments aimed at identifying children at risk of learning difficulties. Moreover, as discussed by the authors, these findings are in line with empirical evidence presented in the scientific literature that describe the positive effects of the exploration of haptico-visual abilities in the development of phonological awareness skills. In this sense, haptico-visual recognition skills have the potential to promote reading development through its effects on phonological awareness and should be considered as a candidate activity to be included in intervention programs addressed to reading difficulties.

Teachers' reporting of behavioral problems and cognitive academic performance in children aged 5-7 years (Giannopulu, Escolano, Cusin, Citeau & Dellatolas, 2008)

In this study the associations between teacher's evaluations of children's behavior and their cognitive academic performances were examined in two samples of children drawn from the second cohort (n=475, ages 5 to 6 years) and the third cohort (n=462, ages 6 to 7 years) during kindergarten and the first grade of elementary school (Grade 1). A subset of 265 children from the second cohort was followed from kindergarten through Grade 1. Teachers were asked to complete questionnaires regarding children's behavior at kindergarten and Grade 1. In addition, children were administered the *BSEDS* battery in kindergarten and reading-related tests in Grade 1 in order to evaluate children's cognitive-academic skills.

The results of the cross sectional analyses indicated that, among the four factors of behavioral problems derived from the teachers questionnaires (hyperactivity, inattention, conduct problems and unsociability), only the inattention factor was significantly associated with children's cognitive-academic performances at both school grades (kindergarten and Grade 1). Moreover, the results of the longitudinal analyses revealed that the inattention factor significantly predicted children's performances in the reading-related tests at Grade 1. The authors discussed these results in line with empirical evidence from other longitudinal studies indicating that 1) it is the factor inattention, when compared to hyperactive, disruptive or social behavior, which is most strongly associated with subsequent learning difficulties during elementary school, and 2) inattention and hyperactivity should be considered as two separate identities within the Attention Deficit Hyperactivity Disorder (ADHD).



## Appendix 2

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Contents lists available at SciVerse ScienceDirect

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## Emergent literacy skills, behavior problems and familial antecedents of reading difficulties: A follow-up study of reading achievement from kindergarten to fifth grade

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## ABSTRACT

This study examined the relation between emergent literacy skills, teachers' reports of behavioral problems, and word reading achievement in a community sample of French students. Family background was investigated and included familial antecedents of reading difficulties (Fa/Rd) and parents' educational level. The analyses explored the pattern of concurrent relations between behavioral, familial and emergent literacy measures in a sample of 812 preschoolers, and their predictive power in explaining word reading achievement in a sub-sample of 150 children followed from kindergarten to fifth grade. Word reading at fifth grade was predicted by kindergarten measures of phonological awareness and letter knowledge. Teachers' reports of inattention symptoms at each grade level were associated with early reading skills and with subsequent word reading. Fa/Rd were concurrently and longitudinally associated with emergent literacy skills, teachers' reported inattention and word reading. These results indicate that children with a family history of reading difficulties are at increased risk for the co-occurrence of reading difficulties and attention problems from kindergarten onward. These findings confirm the shared influence of Fa/Rd on the comorbidity between inattention symptoms and reading difficulties in a non-diagnosed community sample of preschool children followed through late elementary school.

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## 1. Introduction

Reading acquisition is a central challenge in children's developmental trajectories and a key determinant to overall educational success during elementary school (Cunningham & Stanovich, 1997; Duncan et al., 2007; Stanovich, 1986). As a result, children who manifest early difficulties in learning to read represent a vulnerable group at high risk of underachievement trajectories throughout childhood and beyond, with long lasting consequences and costs for individuals and societies (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001; Heckman, 2006; Maughan et al., 2009).

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The concept of emergent literacy postulates that the development of reading ability is associated with a range of skills displayed by the preliterate child that are considered developmental precursors of conventional forms of reading and writing, as well as the social environments that allow the emergence of these developments (Whitehurst & Lonigan, 1998). Within the set of emergent literacy skills, the existing literature has highlighted three main constructs strongly associated with preschool children's subsequent word identification abilities: oral language skills, print knowledge and phonological processing abilities. An extensive body of research has supported the predictive value of these skills for preschoolers' later word reading outcomes (Jordan, Snow, & Porche, 2000; Lonigan, Burgess, & Anthony, 2000; Storch & Whitehurst, 2002; Spira, Bracken, & Fischel, 2005; Wagner et al., 1997). Importantly, extant longitudinal analyses have shown that individual differences in these early literacy skills are relatively stable from kindergarten onward and contribute to later discrepancies in reading ability throughout elementary school (Billard et al., 2009; Cunningham & Stanovich, 1997; Hecht, Burgess, Torgesen, Wagner, & Rashotte, 2000; Watier, Dellatolas, & Chevrie-Muller, 2006). Preschoolers' oral language skills, such as vocabulary knowledge and oral comprehension, were found to be powerful predictors of early and later reading achievement suggesting their crucial role in learning to read for beginning readers (Muter, Hulme, Snowling, & Stevenson, 2004; Storch & Whitehurst, 2002; Watier et al., 2006). Print knowledge, which refers to children's understanding of the conventions of prints (e.g., knowing that writing goes from left to right and top to bottom across a page), letter names and print to sound correspondences, was shown to explain a substantial proportion of variability in the growth of reading outcomes (Hecht et al., 2000; Wagner et al., 1997). However, letter knowledge has been pointed as the most powerful single predictor of short and long-term literacy success, when compared with other aspects of print knowledge (Lonigan et al., 2000; Muter et al., 2004; Storch & Whitehurst, 2002). Finally, phonological awareness, the ability to explicitly represent and manipulate the sounds of language, is considered a developmental precursor of critical importance in the initial stages of reading acquisition, particularly in children's ability to decode words into their linguistic units (Hulme, Snowling, Caravolas, & Carroll, 2005; Wagner & Torgesen, 1987, for a review). Poor readers have been consistently found to perform below the level of normal readers on phonological awareness tasks (Hecht et al., 2000; Shaywitz et al., 1999) and longitudinal studies have demonstrated its unique contribution to later reading progress during elementary school (Billard et al., 2008, 2009; Spira et al., 2005; Storch & Whitehurst, 2002; Sprenger-Charolles, Siegel, Béchennec, & Serniclaes, 2003; Sprenger-Charolles, Colé, Béchennec, & Kipffer-Piquard, 2005; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997; Wagner et al., 1997). Moreover, the relation between phonological awareness and learning to read appears to be reciprocal, as demonstrated in several studies regarding the crucial role of early reading skills in the acquisition of phonological awareness (de Santos Loureiro et al., 2004; Dellatolas et al., 2003). Thus, a substantial body of evidence suggests the developmental continuity between preschoolers' emergent literacy and oral language skills with later reading and word decoding abilities. As a consequence, children who fail to develop proficient levels of emergent literacy skills at preschool are at increased risk of experiencing inadequate reading abilities during elementary school (Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998).

In order to increase understanding of the factors that influence early academic achievement, researchers have called for a broader perspective that recognizes the importance of behavioral correlates in subsequent learning (Duncan et al., 2007; Entwisle & Alexander, 1998). Notably, the association between reading achievement and behavior problems during early and middle childhood has been well documented (Hinshaw, 1992, for a review). Numerous studies at the preschool level have presented evidence regarding the intersection between emergent literacy skills and early behavior problems prior to school entry (Lonigan et al., 1999; Rabiner & Coie, 2000; Spira & Fischel, 2005, for a review; Velting & Whitehurst, 1997). Moreover, evidence from longitudinal research has demonstrated a link between early behavior problems and academic underachievement from kindergarten to elementary school (Al Otaiba & Fuchs, 2006; Bub, McCartney, & Willet, 2007; Dally, 2006; Hinshaw, 1992, for a review; Rabiner & Coie, 2000; Trzesniewski et al., 2006; Vaughn, Zaragoza, Hogan, & Walker, 1993). Therefore, children who meet criteria for reading disabilities (RD) are reported to be at increased risk of comorbidity with psychiatric disorders, in particular with externalizing disorders such as Attention Deficit Hyperactivity Disorder (ADHD), both inattentive and hyperactive-impulsive subtype (Hinshaw, 1992), and Conduct Disorder (CD) (Angold, Costello, & Erkanli, 1999). However, it has been proposed that the significant overlap of RD, ADHD and CD is related with shared associations between these diagnostic entities. Indeed, reading difficulties and CD were shown to be unrelated except by their common correlation with the attention deficits reported in ADHD (Rappaport, Scanlan, & Denney, 1999; Carroll, Maughan, Goodman, & Meltzer, 2004). Furthermore, despite the well-documented association between ADHD and reading problems (Merrell & Tymms, 2001; Hinshaw, 1992), a growing literature has documented that it is the inattentive subtype of ADHD, when compared with the hyperactive subtype, which correlates more strongly with the reading difficulties of school-aged children (Willcutt & Pennington, 2000a; McGee, Prior, Williams, Smart, & Sanson, 2002). Importantly, longitudinal studies have presented evidence that inattentive behavior during kindergarten predicted reading achievement by the end of elementary school (Duncan et al., 2007; Rabiner & Coie, 2000), and that inattention reported at elementary school significantly predicted long-term educational attainment at age 22–23 (Pingault et al., 2011). In France, existing literature has revealed similar patterns concerning the association between behavior problems and reading difficulties. Inattention symptoms reported by the teacher, but not hyperactivity-impulsivity or conduct problems, were significantly related with early reading skills in preschool children (Dellatolas, Watier, Giannopulu, & Chevrie-Muller, 2006; Giannopulu, Escolano, Cusin, Citeau, & Dellatolas, 2008), and predicted reading achievement on measures of word identification and reading comprehension (Billard et al., 2010; Giannopulu, Cusin, Escolano, & Dellatolas, 2007). Although existing literature has reported a significant association between reading achievement and behavior problems on children in elementary school, the relationship between emergent literacy skills and behavioral difficulties in young children before school entry remains

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understudied (Doctoroff, Greer, & Arnold, 2006). In addition, longitudinal studies that examine the influence of separate dimensions of behavioral problems on emergent literacy skills and subsequent reading outcomes are needed, due to existing evidences presented in several studies regarding the predictive value of distinct dimensions of behavior problems, other than inattentive behavior, on reading acquisition (Bracken & Fischel, 2007; Spira et al., 2005; Trzesniewski et al., 2006).

In addition to the significant role that emergent literacy and behavior problems play on preschoolers' later reading ability, the impact of family background on children's reading development is well established (Entwisle & Alexander, 1998; Sénéchal & LeFevre, 2002; Whitehurst & Lonigan, 1998). For instance, parents' education level has been consistently associated with children's performances on measures of emergent literacy skills and with later reading performance (Billard et al., 2008; Bradley & Corwyn, 2002; Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Hecht et al., 2000; Watier et al., 2006). Of particular interest in this field of research is the finding that difficulties in learning to read are significantly familial: children reared in families where at least one relative had a history of RD are at increased risk of developing the disorder, when compared to children without familial antecedents of RD (Puolakanaho et al., 2007; Snowling, Gallagher, & Frith, 2003). These studies have put forward the notion of a familial risk in the development of reading difficulties, which is conventionally conceptualized as the presence of a history of RD antecedents in at least one of the child's relatives (i.e. parents and/or siblings). Moreover, these studies have highlighted that the inclusion of measures of familial antecedents of reading acquisition in screening procedures during kindergarten, in addition to measures of oral language, letter knowledge and phonological awareness, improved significantly the probability of identifying a child at risk of developing RD later on elementary school. Importantly, a study conducted by Doyen et al. (2004) extended the previous findings by demonstrating that a parsimonious screening procedure aimed to examine the presence of parental antecedents of reading difficulties was related with both lower scores on early literacy skills and with teachers' reports of inattention symptoms during kindergarten. This result is in line with evidences from family studies concerning the significant familial nature of RD and ADHD (Pennington et al., 2009, for a review), and concurs with the findings from a twin study regarding the shared familiarity between these two disorders (Friedman, Chhabildas, Budhiraja, Willcutt, & Pennington, 2003). However, there remains a dearth of information relative to the association between familial antecedents of reading acquisition, children's emergent literacy skills and inattentive behavior before school entry, as well as its impact on subsequent reading performance at the end of elementary school in non-diagnosed samples. Therefore, as suggested by Hinshaw (1992), the present study examines the role of familial antecedents of reading acquisition as a background variable implied in the covariation between reading achievement and behavior problems, specifically inattentive behavior. Although previous studies conducted in France have shed some light over the factors implied during reading development, longitudinal studies aimed to analyze the developmental precursors and correlates of reading acquisition are still required (INSERM, 2007). The mid-term contribution of emergent literacy skills, behavior problems and family background on the mid-term reading outcomes of French-speaking children remains to be examined in the general population.

The objectives of the present study were (a) to examine the concurrent associations between emergent literacy skills, oral language, behavioral problems and familial background at kindergarten and (b) to determine the predictive value of this broad constellation of factors as explanatory variables of word reading achievement at fifth grade. Additionally, this study aimed to extend previous research concerning the association of familial antecedents of reading difficulties, teachers' reports of behavioral problems and emergent literacy skills with later word reading achievement at the end of elementary school.

For these purposes, the present study used a community-based sample drawn from a larger prospective study in a general population of French preschoolers. Some of these preschoolers would have been expected to develop reading problems during elementary school, given the reported prevalence of reading disabilities in the general population (e.g., 7.5%, according to Shaywitz, Shaywitz, Fletcher, & Escobar, 1990). Information concerning children's early literacy, oral language, behavioral difficulties and familial factors was gathered during the kindergarten year, and a sub-sample of this kindergarten group was followed through the end of elementary school, where children's behavior and word reading performances were assessed at fifth grade. Furthermore, we isolated a subset of children at fifth grade whose word reading performances fell significantly below the sample mean, in order to examine how the study's kindergarten variables related with lower performances in the word reading outcome at the end of elementary school. Because significant studies have systematically shown that deficits in word identification constitute the basic source of poor reading, notably in the case of specific reading disability or dyslexia, and that measures of word reading are typically used in the study of clinically significant reading difficulties (Vellutino, Fletcher, Snowling, & Scanlon, 2004, for a review), we are focusing on difficulties in learning to read associated with inadequate word reading efficiency in the current study.

## 2. Material and methods

### 2.1. Participants

The participants were selected from a larger ongoing prospective longitudinal study aimed to identify child and environmental factors related to learning and behavioral difficulties in a community-based sample followed from kindergarten to the end of elementary school (Callu, Jacquier-Roux, Cusin, Giannopulu & Dellatolas, 2003; Callu et al., 2005; Giannopulu, Escolano, & et al., 2008). This general population study began during the 2001–2002 school year and included all children aged 3–6 years who attended the preschools of the Creusot Montceau-les-Mines community (Saône-et-Loire) in the central-east region of France. A total of 48 preschools that served families from socioeconomically diverse backgrounds were

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**Table 1**  
Descriptive statistics of the study variables at kindergarten.

Kindergarten variables	<i>N</i>	%	<i>M</i>	<i>SD</i>	Min	Max
Sociodemographic background	812					
Sex (boys)		52				
Age (years)			5.84	.34	5.07	7.19
Parents educational level						
At least one parent has high school diploma	382	47				
Familial antecedents of reading difficulties (cases reported)	171	21				
BSEDS						
Global composite score	677		.71	.14	.24	.99
Phonological awareness composite score	789		15.70	5.85	0	23
Rhymes	796		5.37	2.41	0	8
Syllabic counting	794		4.38	1.17	0	5
Syllabic deletion	789		5.89	3.63	0	10
Vocabulary	753		20.18	4.29	1	30
Pseudoword repetition	796		12.55	3.13	1	16
Oral comprehension	798		7.53	1.74	1	10
Letter reading	786		5.82	3.38	0	12
Sentence repetition	766		13.78	2.89	0	16
Figure reproduction	781		4.24	1.88	0	6
Teachers' questionnaire	590					
Kindergarten hyperactivity			1.05	1.99	0	8
Kindergarten inattention			1.22	1.98	0	8
Kindergarten conduct problems			.64	1.49	0	8
Kindergarten unsociability			.31	.95	0	7

enrolled in the study. As required by ethical imperatives, parents and school administrators were contacted and invited to participate in the study and informed consent was obtained in order to conduct this research.

The data presented here spanned a 6-year period and refers to two samples of children derived from two school levels, kindergarten and fifth grade (see Tables 1 and 2, for descriptive statistics of the study samples). The kindergarten sample was composed of all the children attending the community's preschools during the 2003–2004 school year, when children were in the final year of the preschool period, for whom we had outcome data in at least one of the study's measures at kindergarten (parents' sociodemographic background and familial antecedents of reading difficulties questionnaire, emergent literacy skills and teachers' behavioral questionnaire). A total of 812 children, 422 boys and 390 girls, aged 5–6 years (mean 5.8 years, SD 3 months) constituted the kindergarten sample of the present study. The fifth grade sample was a subset of the kindergarten sample. Due to limited resources regarding research staff to collect data at fifth grade in the present study, a representative set of 10 elementary schools was selected across a total of 34 schools from the Creusot Montceau-les-Mines community. This selection procedure aimed to ensure the representativeness of the community's population according with the geographic area of implementation of each elementary school and its suburban or rural condition. For each of the selected elementary schools, data on reading performance and teachers' behavioral reports was collected for all children enrolled in fifth grade classrooms during the 2008–2009 school year. To be included in the fifth grade sample, children were required to (a) be part of the kindergarten sample during the 2003–2004 school year, and (b) to have outcome data in at least one of the study measures at fifth grade (reading performance or teachers' behavioral reports).

**Table 2**  
Descriptive statistics of the study variables at fifth grade.

Fifth grade variables	<i>N</i>	%	<i>M</i>	<i>SD</i>	Min	Max
Sociodemographic background	150					
Sex (boys)		51				
Age			10.77	.33	10.08	11.42
Parents educational level						
At least one parent has high school diploma	59	39				
Familial antecedents of reading difficulties (cases reported)	21	14				
ODEDYS	150					
Word reading composite score			-.0006	.84	-2.56	1.41
Teachers' questionnaire	114					
Kindergarten hyperactivity			.85	1.60	0	7
Fifth grade hyperactivity			.95	1.82	0	8
Kindergarten inattention			1	1.71	0	8
Fifth grade inattention			.97	1.65	0	7
Kindergarten conduct problems			.71	1.37	0	8
Fifth grade conduct problems			.66	1.32	0	7
Kindergarten unsociability			.14	.46	0	2
Fifth grade unsociability			.40	.91	0	4

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From the initial kindergarten sample of 812 children, 19% had outcome data on reading performance and 14% had data on teachers' behavioral reports at fifth grade. This resulted in a fifth grade sample composed of 150 students, 77 boys and 73 girls, with ages ranging from 10 to 11 years old (mean 10.7 year, SD 3 months). The resulting samples were composed of children from diverse sociocultural backgrounds of a general population of suburban and rural communities in France. Note however that the participants in the present community-based study do not constitute a nationally representative sample since children from large urban areas were absent. All participants attended general education classrooms and there were no gender differences in the group composition of the kindergarten and fifth grade samples. Only 5% of the parents reported being of a different nationality other than French, and no significant differences between and within samples were found when parents' nationality was taken into account.

### 2.2. Procedure

Data collection began during the final year of the preschool period. Behavioral and cognitive assessment was conducted with all children enrolled in the preschools included in our study. Through collaboration with school medical staff, parents were assigned questionnaires concerning sociodemographic and familial characteristics, and teachers completed questionnaires regarding children's classroom behavior at preschool. Concomitantly, school doctors conducted a health check exam. In France, it is standard procedure to perform a systematic examination of all children aged between 5 and 6 years old that are enrolled in kindergarten. This examination includes a visual and audition exam, as well as the assessment of cognitive and language development. All measures were obtained between January and June in the 2003–2004 school year. At fifth grade, cognitive assessment occurred during the spring semester of the 2008–2009 school year. All measures were individually administered in one session per child by trained staff of the research team. In addition, teachers were asked to complete a questionnaire concerning children's classroom behavior and reports were collected during the same period of the cognitive assessment. Fifth grade teachers were unaware of the results of the cognitive and behavioral testing performed at kindergarten.

### 2.3. Measures

#### 2.3.1. Kindergarten assessment (2003–2004 school year)

Parents were asked to provide background information relative to their families by means of questionnaires. These included questions concerning parents' level of education, defined as the final school grade completed by each parent, as well as information concerning familial reading acquisition background, such as the presence of difficulties in learning to read in any of the child's siblings.

**2.3.1.1. Familial antecedents of reading difficulties.** Parents completed a questionnaire aimed at examining the presence of reading-related difficulties during their childhood. Each parent was asked to respond separately to the following question: "During your childhood did you manifest one or several of the following problems that frequently worried your parents or teachers: (1) "difficulties in expressing yourself orally or making yourself understand"; and (2) "difficulties in learning to read". Each of these items was scored zero (no) or one (yes). Note that the generic term "reading difficulties" includes parental reports of oral language difficulties.

Because the purpose of the present study was to identify the presence or absence of a history of reading difficulties in children's family, we considered simultaneously parents' responses to this questionnaire as well as their responses to the familial background questionnaire regarding the presence of reading difficulties in at least one of the child's siblings. In this way, familial antecedents of reading difficulties were defined as a binary variable in which at least one of the parents reported the presence of oral or written language difficulties in one of the members of the family (i.e., the parents and/or the siblings) or not.

**2.3.1.2. BSEDS (*Bilan de Santé: Evaluation du Développement pour la Scolarité de 5 à 6 ans*).** The BSEDS battery ([Health Examination: School Developmental Assessment for Children aged 5–6 years], Zorman & Jacquier-Roux, 2001) is a standardized screening instrument widely used with French preschool population that assesses children's cognitive, motor and social development. For the purpose of the current study, nine subtests were selected from the large collection of tasks that compose this battery, namely: Rhyme identification (8 items), Syllabic counting (5 items), Syllabic deletion (10 items), Vocabulary (15 items), Pseudoword repetition (10 items), Oral comprehension (8 items), Letter reading (12 items), Sentence repetition (16 items) and Figure reproduction (6 items); for further details see Giannopulu, Cusin, & et al. (2008). These subtests were chosen based on their psychometric soundness and evidence that these measures of emergent literacy and language skills predict later reading acquisition and allow for the early identification of children at risk of developing later reading difficulties (Zorman & Jacquier-Roux, 2001).

#### 2.3.2. Fifth grade assessment (2008–2009 school year)

The assessment performed at fifth grade included the l'Alouette reading test (Lefavrais, 2006), the ODEDYS battery (Outil de Dépistage des Dyslexies – Version 2 [Dyslexia Screening Instrument – Version 2], Jacquier-Roux, Valdois, & Zorman, 2002) and the teachers' behavioral questionnaire. The l'Alouette is a standardized reading test commonly used by clinicians and



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researchers in France to identify children that exhibit reading difficulties. This instrument assesses children's reading fluency and accuracy and provides a standardized reading age according with the child's chronological age or school level. The ODEDYS battery allowed us to assess the word reading outcome at fifth grade by means of a large span of reading and spelling tasks. For the purpose of the present study, eight subtests from the ODEDYS battery were considered in addition to the *l'Alouette*: Word Reading (Irregular, Regular and Pseudoword Reading), Word Dictation (Irregular, Regular and Pseudoword Dictation) and Sentence Dictation (Accordance and Use Sentences). The selection of these subtests was based on their reported reliability and sensitivity to identify children with reading difficulties at the end of the elementary school (Jacquier-Roux et al., 2002). Moreover, these selected subtests represent the components of the ODEDYS battery aimed to assess the ability to read words at the end of elementary school.

**2.3.2.1. *l'Alouette*.** In this test, the child has to read a 265-word text as quickly and as accurately as possible. The text is composed of rare words, as well as some spelling and semantic traps, and reading comprehension is not taken into account. The child has 3 min to complete the task. The total score corresponds either to the number of correct words read in 3 min or to the reading time (if fewer than 3 min), once the number of errors is computed. This score is then converted into a standardized reading age that spans from 6 to 16 years.

**2.3.2.2. Word reading (irregular, regular and pseudoword reading).** In this task, the child was provided a list of 20 irregular, 20 regular and 20 pseudowords and was asked to read each list of words as quickly as possible. A score of one was attributed for each word correctly read and three scores were generated, one for words, one for irregular words and another for pseudowords (max = 20 for each set of words). In addition, children's reading speed was recorded as the number of seconds required to read each of the lists of regular, irregular and pseudowords. This scoring system yielded a minimum and maximum score of 37 and 188 s, respectively.

**2.3.2.3. Word dictation (irregular, regular and pseudoword dictation).** This task evaluates children's phonological and orthographic ability. Three sets of 10 irregular, 10 regular and 10 pseudowords each were presented orally to the child. The child was required to write each of the presented words. The total score was the number of words correctly written and three scores were generated for each set of 10 words (max = 10 for each category of words). For pseudowords, a correct answer was also attributed if a child presented an orthographic form that was phonologically correct (ex. «nagul», «nagule», «nagulle» = one point).

**2.3.2.4. Sentence dictation (use and accordance sentences).** The child was required to write a text composed of five sentences. The main aim of this task was to measure the phonological and orthographic processing of two sets of 10 words each, according to their spelling accuracy (use sentences) and grammatical accordance (accordance sentences). The total score was the sum of the correct answers for each set of 10 words (max = 10 for use sentences and max = 10 for accordance sentences).

### 2.3.3. Common assessment at kindergarten and fifth grade

**2.3.3.1. Teachers' behavioral questionnaire.** Teachers completed a 21-item questionnaire used to assess children's classroom behaviors during preschool and fifth grade. Each item stated a particular behavior (e.g. "the child can't concentrate") and was rated on a three-point scale to denote whether the child displayed the particular behavior (i.e., 0 – no, 1 – sometimes, 2 – yes). A previous study conducted by Giannopulu, Escolano, and et al. (2008) has reported the usefulness of this questionnaire as a screening instrument for the identification of behavioral problems by the classroom teachers. Therefore, according with the methodology employed in the abovementioned study, we performed a principal component analysis of the 21 questions of the questionnaire at kindergarten and at fifth grade. Four factors were defined and each factor was composed of four questions. These factors were named according to the specificity of the questions they were based on, namely: F1, 'hyperactivity'; F2, 'inattention'; F3, 'conduct problems' and F4, 'unsociability'. We generated new variables, one for each factor, by summing up the teachers' answers to the questions that composed each specific factor. These four factors accounted for 61% of the variance in the teachers' behavioral reports at kindergarten and for 64% at fifth grade. The internal consistency of each factor was good with Cronbach's alpha values of .87, .82, .78, .74 at kindergarten, and .87, .81, .80, .63 at fifth grade for 'hyperactivity', 'inattention', 'conduct problems' and 'unsociability', respectively.

### 2.4. Data reduction and design of statistical analysis

The statistical analyses were conducted with the SAS 9 software<sup>®</sup> (SAS, Institute Inc. Cary, NC, USA). For the purpose of the present study we generated a BSEDS global score by summing the standard scores obtained in all the nine subtests administered from the BSEDS battery. Reliability for the BSEDS global score was good (Cronbach's alpha reliability = .78).

Similarly, given the multiple measures derived from the ODEDYS battery at fifth grade, we aimed to combine them into a composite score of word reading in order to increase reliability and reduce the number of comparisons. For this purpose, we began by combining the standard scores of the three word reading subtests, the reading speed scores for each of the word reading subtests, and the five dictation subtests of words and sentences, into three aggregated measures, respectively.

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Correlation analysis procedures were then performed to examine the pattern of concurrent relations between these three aggregated measures together with the remaining subtests of the ODEDYS battery. The three aggregated scores were substantially correlated among each other ( $r > .50, p < .001$ , in all cases), but were only weakly correlated with the remaining subtests of the ODEDYS battery. Subsequently, we conducted a principal component analysis of these aggregated measures and all the subtests from the ODEDYS battery. The first factor was composed of these three aggregated measures and accounted for 70% of the variance in the ODEDYS overall performance at fifth grade (the factor loadings of these aggregated measures were .86, .82 and .83 for the word reading score, the word reading speed and the dictation score, respectively). Therefore, we considered it appropriate to combine them into a composite score. Raw scores of the tasks that composed each of the three aggregated measures were transformed into z scores and we generated a normally distributed composite score by summing the z scores across these three measures. Hence, the word reading composite score represents the combination of eight subtests from the ODEDYS battery, as well as children's reading speed in the word reading subtests. Note that this "word reading" composite includes the scores of spelling tasks. Reliability of this composite was good (Cronbach's alpha reliability = .78) and its correlation with l'Alouette, a standardized measure of reading fluency and accuracy, was high ( $r = .77, p < .001$ ). Consequently, only this composite score was taken into account in the present study as the word reading outcome at fifth grade. In addition, we used this composite score to discriminate children experiencing reading difficulties and normal readers at fifth grade. Children who evidenced significantly lower performances on the word reading outcome at fifth grade (defined by a cut off score of one standard deviation below the sample mean) were defined as a reading difficulties group, while children whose performances were above this cut off score composed the normal readers group. This cut off point selected approximately 11% of the fifth grade sample, a prevalence that is congruent with estimates from epidemiological studies (Fluss et al., 2008; Watier et al., 2006).

In our data analysis, we used chi-square tests and independent-samples *t* tests at each grade level to uncover any differences within the kindergarten and the fifth grade sample according with all the study measures. In addition, these same procedures were used to perform group comparisons between the kindergarten and the fifth grade sample, as well as between children with lower word reading performances at fifth grade, defined as a reading difficulties group, and normal readers at the same school period.

The teachers' behavioral questionnaire was analyzed through concurrent and longitudinal correlation analysis procedures (CORR procedure). The concurrent analyses assessed the association between teachers' reported behavioral problems, children's cognitive skills and familial factors at kindergarten, as well as the relation between teacher's behavioral reports and word reading at fifth grade. The longitudinal analyses included the correlation of teachers' factors at preschool with word reading at fifth grade, and the correlation among the teachers' factors from kindergarten to fifth grade.

Finally, linear regressions (REG and GLM procedures of SAS) were used to examine the concurrent contributions of familial antecedents of reading difficulties and teachers' behavioral factors in the prediction of the BSEDS overall score at kindergarten, as well as to test for the longitudinal effects of these variables in the word reading outcome at fifth grade, while controlling for the effects of children's emergent literacy skills. These regression analyses allow to estimate the degree to which the aforementioned variables (predictors) explained independent variance (type III sum of squares) in children's outcomes at kindergarten (BSEDS score) and at fifth grade (ODEDYS score). Only the measures significantly related with children's outcomes at kindergarten and at fifth grade were considered for inclusion in the regression analyses. It should be mentioned that, in these regression analyses, we adjusted for the potential effects of background demographic confounds, namely gender and parents' level of education. In addition, we controlled for the effects of the months of testing of the emergent literacy skills at kindergarten (from January to June). For parents' educational level, we generated a binary variable defining whether none or at least one of the parents had obtained a high school diploma and we included this variable in the regression analyses.

### 3. Theory

The general conceptual model (see Fig. 1) presents the hypothesized relationships among emergent literacy skills, oral language, behavior problems, familial antecedents of reading difficulties and word reading achievement from kindergarten to fifth grade. According with the literature, preschoolers' oral language and emergent literacy skills, such as phonological awareness and letter knowledge, may each facilitate the ability to read words during elementary school (Hecht et al., 2000; Lonigan et al., 2000; Storch & Whitehurst, 2002). In addition, inattentive behavior, when compared with other externalizing problems, has an adverse influence on the development of emergent literacy skills and contributes to the prediction of reading acquisition during elementary school (Bub et al., 2007; Dally, 2006; Rabiner & Coie, 2000). Likewise, the presence of familial antecedents of reading difficulties is associated with measures of emergent literacy skills at kindergarten and with later word reading achievement at elementary school (Puolakanaho et al., 2007; Snowling et al., 2003). A new component of Fig. 1 that has been added in this model is the association of familial antecedents of reading difficulties with teachers' behavioral reports of inattention symptoms at kindergarten and at the end of elementary school. This assumption is based on a previous study regarding the concurrent association found during kindergarten among parental antecedents of reading difficulties, early literacy skills and teachers' reports of inattention symptoms (Doyen et al., 2004). In addition, evidence suggests that school-aged children that exhibited a family history of reading difficulties were more likely to manifest attention-deficit disorder without hyperactivity (ADD/WO; Hynd, Lorys, Semrud-Clikeman, & Nieves, 1991). More recently, twin studies have advanced the argument of shared familiarity between RD and ADHD (Friedman et al., 2003) and

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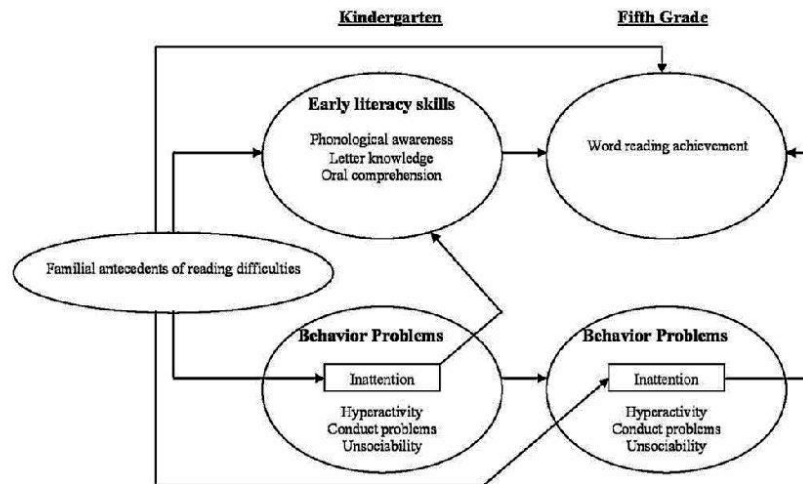


Fig. 1. General model for analysis: relations among emergent literacy skills, familial antecedents of reading difficulties, behavioral problems, and word reading.

underscored that the association between inattention and reading is in place from kindergarten onwards and is partially attributable to common genetic and environmental influences (Ebejer et al., 2010; Paloyelis, Rijdsdijk, Wood, Asherson, & Kuntsi, 2010; Willcutt et al., 2007). Therefore, it is proposed that the presence of familial antecedents of reading difficulties will be associated with emergent literacy skills, teachers' reports of inattention symptoms, and word reading from kindergarten to fifth grade. The hypotheses of the current study were that:

1. Teachers' reports of attention problems would be substantially and consistently associated with measures of emergent literacy skills in kindergarten and with word reading at fifth grade, when compared with teachers' reports of hyperactivity, conduct problems and unsociability;
2. Children whose parents reported antecedents of reading difficulties in the family would obtain a higher frequency of teachers' reports of attention problems and lower performances on measures of reading-related skills in kindergarten and in fifth grade, when compared with children without a family history of difficulties in learning to read;
3. Word reading at fifth grade would be best predicted by kindergarten measures of emergent literacy skills. Family history of reading difficulties, teachers' reports of attention problems, and emergent literacy skills at kindergarten would contribute independently to the prediction of the word reading outcome.

#### 4. Results

##### 4.1. Descriptive statistics and preliminary analyses

Demographic and descriptive statistics for all measures at kindergarten and fifth grade are presented in Tables 1 and 2. It is informative to note that the number of observations ( $N$ ) available for some of the study's variables differed according with the assessment measures used to collect data at kindergarten and at fifth grade. Therefore, due to the presence of missing data for some of the participants in the present study, the data analysis here reported was based on the total of participants that presented complete data in each of the measures included in the statistical analyses described subsequently.

As previously mentioned, reliabilities for the teachers questionnaire, the BSEDS battery and the ODEDYS word reading composite score were in the acceptable range. Performances in the BSEDS subtests were free from floor and ceiling effects on almost all tasks, with the exception of modest ceiling effects on two of the dictation tasks. However, there was sufficient variability on these measures to allow us to examine their association with the word reading outcome and the behavioral variables. We begin by presenting the results of the cross-sectional analysis of the study's variables at kindergarten and at the fifth grade school period. Subsequently, we report the results of the longitudinal analysis performed between the teachers' behavioral questionnaire from kindergarten to the fifth grade, and we indicate the relative contribution of each of the study variables to the prediction of the word reading outcome at fifth grade. Finally, we present the results of the group comparisons performed between the group of children defined as experiencing reading difficulties and normal readers.

In order to examine group differences between the participants followed and non-followed from kindergarten through fifth grade, chi-square and  $t$  test comparisons were conducted for all the study's variables. Results of these analyses are

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**Table 3**

Group differences between the children non-followed and followed from kindergarten through fifth grade according to sociodemographic and familial variables.

	Non-followed		Followed		Chi-square	df	p
	N (%)	N (%)	N (%)	N (%)			
Sociodemographic background							
Sex							
Boys	343 (52.13)		79 (51.30)		.03	1	.85
Girls	315 (47.87)		75 (48.70)				
Parents educational level							
One parent has high school diploma	293 (49.16)		57 (38.26)		5.69	1	.01
Both parents have high school diploma	303 (50.84)		92 (61.74)				
Familial antecedents of reading difficulties							
Absent	514 (77.88)		133 (86.36)		5.51	1	.02
Present	146 (22.12)		21 (13.64)				

**Table 4**

Group differences between the children non-followed and followed from kindergarten through fifth grade according to the BSEDS composite score and teachers' ratings of behavioral problems.

	Non-followed			Followed			t	p
	M	SD	N	M	SD	N		
BSEDS								
Global composite score	.69	.14	536	.73	.11	141	-3.45	.0006
Teachers' questionnaire								
Kindergarten hyperactivity	1.08	2.06	498	.83	1.58	89	1.32	.18
Kindergarten inattention	1.25	2.02	491	1.01	1.71	88	1.20	.23
Kindergarten conduct problems	.61	1.52	501	.73	1.36	89	-.70	.48
Kindergarten unsociability	.33	1.01	499	.13	.45	88	3.03	.003

summarized in Tables 3 and 4. The group followed through fifth grade contained a significantly higher proportion of students whose at least one parent had a high school diploma, than the kindergarten group. Students in the non-followed group came from families with a significantly higher proportion of parents that reported reading difficulties in the family, as compared to students in the fifth grade group. Moreover, *t* test comparisons revealed that children followed from kindergarten through fifth grade obtained significantly higher global scores in the BSEDS battery and a lower proportion of 'unsociability' symptoms reported by the teacher, than the non-followed group. However, both groups were equivalent concerning gender and teachers' reports of hyperactivity, 'inattention' and 'conduct problems'. The significant differences found between the groups of participants followed and non-followed through fifth grade may be partially explained by grade retention (i.e. two subsequent years at the same grade) of some students with academic difficulties from kindergarten onwards. In the French educational system, children showing low educational achievement can be retained throughout the course of elementary school. Therefore, students retained during elementary school were not in fifth grade during the school year where data collection took place. Preschoolers with lower performances on the measures of early reading skills and whose parents had lower educational levels presented a significantly higher probability of being retained during elementary school, due to the often-cited influence of these variables on children's school achievement (for a review, see Duncan et al., 2007). Hence, grade level retention of participants from kindergarten to fifth grade contributed to the sample attrition observed between the two grade levels and provides a plausible justification for the over-representation of children in the fifth grade sample with better cognitive resources and a family background characterized by a higher educational level of the parents.

#### 4.2. Cross-sectional analyses

##### 4.2.1. Correlations among factors of the teachers' behavioral questionnaire at kindergarten and at fifth grade

To assess the concurrent association among the four factors derived from the teachers' behavioral questionnaire, correlation analyses were conducted both within the kindergarten and the fifth grade sample. Results in the kindergarten period indicated that teachers' behavioral reports were all significantly associated with each other at the .001 level. Teachers' reports of 'hyperactivity' were significantly correlated with 'inattention' ( $r = .51$ ), 'conduct problems' ( $r = .55$ ) and 'unsociability' ( $r = .52$ ). Furthermore, teachers' reports of 'conduct problems' correlated significantly with 'unsociability' ( $r = .52$ ), and 'inattention' was correlated both with 'conduct problems' ( $r = .39$ ) and 'unsociability' ( $r = .41$ ).

This pattern of results between teachers' reports of behavioral difficulties was reproduced at the fifth grade level. Hence, teachers' reported 'hyperactivity' was significantly correlated with 'inattention' ( $r = .49$ ,  $p < .0001$ ), 'conduct problems' ( $r = .45$ ,  $p < .0001$ ) and 'unsociability' ( $r = .53$ ,  $p < .0001$ ). In addition, results indicated a statistically significant relationship

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between teachers' reports of 'conduct problems' and 'unsociability' ( $r = .45, p < .001$ ), as well as between teachers' reports of 'inattention' and 'conduct problems' ( $r = .26, p < .004$ ) and 'unsociability' ( $r = .33, p = .0002$ ).

#### 4.2.2. Relations of reading-related skills and teachers' behavioral questionnaire at kindergarten and at fifth grade

As a first step, we aimed at examining the concurrent associations between children's performance in the BSEDS battery and teachers' behavioral reports at kindergarten, as well as the relationship between the word reading outcome and teachers' behavioral reports at fifth grade. For this purpose, we conducted correlation analyses between children's performance in the BSEDS battery and teachers' behavioral reports at kindergarten, and between the word reading outcome and teachers' behavioral reports at fifth grade. At the kindergarten level, the results indicated that the BSEDS global score was correlated with teachers' reports of 'inattention' ( $r = -.43, p < .001$ ), 'hyperactivity' ( $r = -.24, p < .001$ ), 'unsociability' ( $r = -.23, p < .001$ ) and 'conduct problems' ( $r = -.10, p < .05$ ).

In fifth grade, the results revealed that only 'inattention' reported by the teacher was concurrently related with word reading at fifth grade ( $r = -.34, p < .001$ ). Neither 'hyperactivity', 'conduct problems' or 'unsociability' were significantly correlated with the word reading composite score in the fifth grade ( $p > .05$  in all cases).

#### 4.2.3. Relations of emergent literacy skills, familial antecedents of reading difficulties and teachers' behavioral questionnaire at kindergarten

We aimed to examine the pattern of concurrent relations between teachers' reports of behavioral problems, familial antecedents of reading difficulties and the overall performance in the BSEDS battery. For this purpose,  $t$  tests were conducted in order to analyze group differences in the BSEDS global score and teachers' behavioral reports according to parents' educational level and familial antecedents of reading difficulties. The results revealed significant group differences in BSEDS global scores and teachers' behavioral reports according to parents' educational level and familial antecedents of reading difficulties. Students that had parents with lower education levels presented lower BSEDS global scores ( $t = -7.11, p < .001$ ) and a higher proportion of 'inattention' symptoms reported by the teacher ( $t = 2.98, p = .003$ ). Similarly, students whose parents had reported familial antecedents of reading difficulties presented lower BSEDS global scores ( $t = 3.16, p = .002$ ) and a higher frequency of 'inattention' reports from the teacher ( $t = -3.07, p = .002$ ). Teachers' reports of 'hyperactivity', 'conduct problems' or 'unsociability' did not differ significantly according to parents' educational level or familial antecedents of reading difficulties ( $p > .05$  in all cases). Moreover, chi-square comparisons revealed that reports of antecedents of reading difficulties in the family came from parents who had significantly lower educational levels (chi-square (1) = 28.03,  $p < .001$ ).

Finally, we performed a series of regression analyses to examine the unique contribution of the behavioral and familial variables to the proportion of variance explained in the BSEDS global composite score at kindergarten. For this purpose, teachers' reports of behavioral problems were entered in the first set of analysis, and familial antecedents of reading difficulties and parents' educational level were progressively added to the statistical model. Only the variables predicting the BSEDS global score were retained in the final model. As seen in Table 5, results from our first set of analysis (Step 1) indicated that the four teachers' factors accounted for 20% of the BSEDS overall performance in kindergarten ( $r^2 = 20\%$ ). When considering each of the teachers' factors, 'inattention', 'conduct problems' and 'unsociability' had a significant impact on BSEDS overall performance, whereas 'hyperactivity' had no significant effect. It is worth noting that the coefficient of 'conduct problems' is positive and significant ( $p = 0.04$ ) suggesting that absence of such "problems" has a negative effect on BSEDS when 'inattention' and 'unsociability' are taken into account. Due to the marginal values of statistical significance evidenced by these factors, teachers' reports of 'hyperactivity', 'conduct problems' and 'unsociability' were eliminated from

**Table 5**  
Regression analysis of the BSEDS composite score at kindergarten.

	Kindergarten BSEDS composite				
	$r^2$	$\beta$	$S(\beta)$	$t$	$p$
(Step 1)					
Teachers' questionnaire					
Kindergarten hyperactivity	.20	-.003	.004	-.61	.54
Kindergarten inattention		-.03	.004	-8.07	<.0001
Kindergarten conduct problems		.01	.005	2.07	.04
Kindergarten unsociability		-.02	.008	-2.24	.03
(Step 2)					
Teachers' questionnaire					
Kindergarten Inattention	.20	-.03	.003	-10.10	<.0001
Familial antecedents of reading difficulties		-.04	.02	-2.46	.014
(Step 3)					
Teachers' questionnaire					
Kindergarten inattention	.25	-.03	.003	-9.41	<.0001
Familial antecedents of reading difficulties		-.03	.01	-2.05	.04
Parents educational level		.06	.01	5.14	<.0001

$r^2$ : R-square;  $\beta$ : parameter estimate;  $S(\beta)$ : parameter estimate/standard error.

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the model. Therefore, in the second step of analysis (Step 2), we entered in the regression the teachers' 'inattention' factor together with the measure of familial antecedents of reading difficulties. The results indicated that these two variables had a significant influence on the proportion of variance of the BSEDS global score ( $r^2 = 20\%$ ). In the final set of analysis (Step 3), parents' educational level, teachers' reports of 'inattention' and familial antecedents of reading difficulties were simultaneously added to our model. Collectively, these three variables accounted for 25% of the unique variance of the BSEDS global score at kindergarten.

#### 4.2.4. Relations of familial antecedents of reading difficulties with teachers' behavioral questionnaire and word reading at fifth grade

In order to examine group differences in the word reading score and teachers' reports of behavioral problems at fifth grade according to familial antecedents of reading difficulties and parents' educational level, *t* test comparisons were performed. Results revealed that parental reports of familial antecedents of reading difficulties were related with lower word reading scores ( $t = 3.33, p = .001$ ) and with a higher frequency of teachers' reports of 'inattention' ( $t = -2.75, p = .007$ ). Conversely, parents' education level was not related neither with the word reading outcome and teachers' reports of 'inattention' at fifth grade, nor with the parental reports of familial antecedents of reading difficulties ( $p > .05$ ). Similarly, teachers' reports of 'hyperactivity', 'conduct problems' and 'unsociability' were not significantly related with parents' educational level and familial antecedents of reading difficulties ( $p > .05$  in all cases).

#### 4.3. Longitudinal analyses

##### 4.3.1. Relations of emergent literacy skills, familial antecedents of reading difficulties and teachers' behavioral questionnaire (kindergarten and fifth grade) with word reading at fifth grade

The longitudinal contribution of the variables included in the present study to the prediction of the word reading outcome at fifth grade was assessed by means of regression analysis. The results of these analyses are presented in Table 6 and depict the coefficient attributed to each study variable in the prediction of word reading at fifth grade and the proportion of variance uniquely accounted by each variable included in the statistical model. These results were obtained from different sets of

**Table 6**  
Regression analysis of the ODEDYS word reading composite score at fifth grade.

	Fifth grade ODEDYS word reading composite				
	$r^2$	$\beta$	$S(\beta)$	<i>t</i>	<i>p</i>
(Step 1)					
Teachers' questionnaire					
Fifth grade inattention	.15	-.15	.05	-3.24	.002
Familial antecedents of reading difficulties		-.43	.20	-2.10	.04
(Step 2)					
BSEDS subtests					
Syllabic deletion	.18	.06	.02	2.56	.012
Oral comprehension		.09	.05	1.99	.048
Letter reading		.07	.03	2.67	.008
(Step 3)					
BSEDS subtests					
Syllabic deletion	.20	.05	.02	2.29	.02
Oral comprehension		.08	.05	1.69	.09
Letter reading		.06	.02	2.62	.009
Familial antecedents of reading difficulties		-.42	.20	-2.13	.04
(Step 4)					
BSEDS subtests					
Syllabic deletion	.25	.05	.03	2.18	.03
Oral comprehension		.05	.05	1.05	.30
Letter reading		.08	.03	2.65	.009
Teachers' questionnaire					
Fifth grade Inattention		-.09	.05	-1.75	.08
(Step 5)					
BSEDS subtests					
Syllabic deletion	.26	.05	.03	2.11	.04
Letter reading		.08	.03	2.77	.006
Familial antecedents of reading difficulties		-.37	.21	-1.76	.08
Teachers' questionnaire					
Fifth grade inattention		-.08	.05	-1.66	.10

$r^2$ : R-square;  $\beta$ : parameter estimate;  $S(\beta)$ : parameter estimate/standard error.

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regression analysis and only the variables significantly correlated with fifth grade word reading were included in these analyses. This eliminated all variables except teachers' reports of 'inattention' at fifth grade ( $r = -.34, p = .0002$ ), parental reports of familial antecedents of reading difficulties ( $r = -.26, p = .001$ ), and three emergent literacy measures from the BSEDS battery at kindergarten, namely syllabic deletion ( $r = .30, p = .0002$ ), oral comprehension ( $r = .24, p = .003$ ) and letter reading ( $r = .31, p = .0001$ ).

The first set of regression analyses (Step 1) examined the unique influence of familial antecedents of reading difficulties and teachers' reports of 'inattention' at fifth grade on the word reading outcome, without controlling for the effects of the literacy-related variables measured at kindergarten. The results indicated that these two variables uniquely accounted for 15% of the proportion of variance of the word reading outcome at fifth grade. In a second stage (Step 2), we entered the abovementioned BSEDS subtests into our analysis as possible predictors of word reading at fifth grade. The results indicated that the subtests of syllabic deletion, oral comprehension and letter reading made significant independent contributions to the prediction of fifth grade word reading ( $r^2 = .18$ ).

Subsequently, familial antecedents of reading difficulties (Step 3) and teachers' reports of 'inattention' at fifth grade (Step 4) were progressively added to the model one at a time, while controlling for the effects of the three BSEDS subtests on word reading at fifth grade. This allowed us to assess the unique contribution of familial antecedents of reading difficulties and teachers' reports of 'inattention' at fifth grade in the proportion of variance of word reading. The inclusion of familial antecedents of reading acquisition in the statistical model contributed to increase the proportion of total variance explained by these four variables ( $r^2 = .20$ ). Despite the reasonably low, although statistically significant, proportion of variance explained by familial antecedents of reading acquisition, the results of this model demonstrate the unique contribution of familial antecedents of reading difficulties in the word reading outcome at fifth grade, even after the emergent literacy variables were entered into the model. In contrast (Step 4), despite the unique contribution of fifth grade teachers' reports of 'inattention' in the proportion of variance explained in the word reading outcome ( $r^2 = .25$ ), its value has failed to reach significance once the emergent literacy skills measured at kindergarten were taken into account. This result suggests that the emergent literacy skills measured at kindergarten accounted for the association between teachers' reports of 'inattention' and word reading at fifth grade. Therefore, we conducted a correlation analysis to examine the association between teachers' reports of 'inattention' at fifth grade and the BSEDS subtests administered during kindergarten that significantly predicted the word reading outcome at fifth grade. Results evidenced that only the subtest of letter reading was significantly correlated with teachers' report of 'inattention' at fifth grade ( $r = -.30, p = .001$ ). This result suggests that the association between teachers' reported 'inattention' and word reading at fifth grade was mediated by the study's measure of letter reading skills.

The final set of regression analyses (Step 5) included the simultaneous entry of all the abovementioned variables as explanatory variables of the fifth grade word reading outcome. In these analyses, the measure of oral comprehension failed to approach statistical significance and was not included in the final model ( $p = .30$ ). Results revealed that the variables of syllabic deletion, letter reading, familial antecedents of reading difficulties and teachers' reports of 'inattention' accounted for 26% of the proportion of variance of the word reading outcome at fifth grade. However, in this regression, both familial antecedents of reading difficulties and teachers' reports of 'inattention' only marginally contributed to the prediction of the word reading outcome in fifth grade ( $p = .08$  and  $p = .10$ , respectively).

Overall, these results suggest that emergent literacy skills at kindergarten mediate to some extent the effect of familial antecedents of reading difficulties and teachers' reports of 'inattention' on the reading outcome at fifth grade.

Lastly, chi-square and *t* tests were used to compare children with reading difficulties and normal readers according with sociodemographic background and the variables significantly correlated with word reading at fifth grade. As seen in Tables 7 and 8, the results of these analyses corroborated largely the findings from the regression analysis, with the exception of teachers' reports of 'inattention'. The reading difficulties group presented lower performances on the subtests of syllabic deletion, oral comprehension and letter reading and there was a large effect of these variables in the differences observed between groups (Cohen, 1992). In addition, this group also presented a higher frequency of parental reports of familial

**Table 7**  
Group differences between children with reading difficulties and normal readers at fifth grade according to sociodemographic and familial variables.

	Reading difficulties	Normal readers	Chi-square	df	p
	N (%)	N (%)			
Sociodemographic background					
Sex					
Boys	6 (37.5)	72 (52.94)	1.4	1	.24
Girls	10 (62.5)	64 (47.06)			
Parents educational level					
One parent has high school diploma	6 (37.5)	50 (38.17)	.002	1	.95
Both parents have high school diploma	10 (62.5)	81 (61.83)			
Familial antecedents of reading difficulties					
Absent	10 (62.5)	121 (88.97)	8.42	1	.004
Present	6 (37.5)	15 (11.03)			

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*H.C. Costa et al./Research in Developmental Disabilities 34 (2013) 1018–1035***Table 8**

Group differences between children with reading difficulties and normal readers at fifth grade according to the ODEDYS' subtests and teacher's ratings of inattention problems.

	Reading difficulties			Normal readers			<i>t</i>	<i>p</i>	<i>es</i>
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>			
ODEDYS subtests									
Syllabic deletion	4.19	3.15	16	6.71	3.19	134	−3.03	.007	.77
Oral comprehension	6.56	1.63	16	7.79	1.45	135	−2.87	.01	.81
Letter reading	4.31	2.27	16	6.19	2.79	131	−3.04	.006	.68
Teachers' questionnaire									
Fifth grade inattention	1.87	2.26	15	.80	1.48	102	1.76	.09	.65

*es* = Effect sizes.

antecedents of reading difficulties when compared with the normal readers group. However, there were no significant differences between these two groups concerning teachers' reports of 'inattention' ( $p = .09$ ).

## 5. Discussion

The purpose of the present study was to investigate the longitudinal associations between a host of early literacy-related and behavioral variables with word reading achievement in a sample of French students followed from kindergarten to the fifth grade. A second aim of the study was to extend previous findings concerning the association of familial antecedents of reading difficulties, teachers' reports of behavioral problems and emergent literacy skills at kindergarten with word reading achievement at the end of elementary school. Although previous studies in France have examined the role of cognitive, familial and behavioral factors in the subsequent reading achievement of French children (Billard et al., 2008, 2009; Fluss et al., 2008; Watier et al., 2006), few longitudinal studies have focused on the developmental precursors of mid-term reading achievement in a non-diagnosed community sample. The longitudinal analysis reported here is one of the first works comprising a time period as long as 6 years of formal school instruction.

The cross-sectional analyses performed at kindergarten between teachers' reports of behavioral problems and the overall performance in the BSEDS battery revealed that 'hyperactivity' 'inattention', 'conduct problems' and 'unsociability' were significantly associated with the BSEDS global score, in accordance with the often-cited link between externalizing behavior problems and reading achievement (Hinshaw, 1992, for a review). However, the results from the regression analysis revealed that teachers' reports of 'inattention', when compared with the remaining reports of classroom behavior, were most consistently associated with the global performance in the BSEDS battery. These results corroborate previous findings concerning the significant association between attention problems and emergent literacy skills in preschool children (Giannopulu, Cusin, & et al., 2008; Lonigan et al., 1999). Interestingly, the results of the present study indicated that children rated by their teachers as 'inattentive' and unsociable presented lower scores in the BSEDS battery, when compared with children whose teachers reported 'inattention' and unsociability symptoms concurrently with 'conduct problems'. This particular finding has important educational implications. As pointed out by Barriga et al. (2002), children who do not exhibit symptoms that cause some disturbance in the classroom can be hard to detect by their teachers and to be referred for further assessment and remediation. In what concerns the current study, a reasonable explanation for these findings is that the children who manifested both inattentive and disruptive behaviors during the preschool period, had already been referred to educational supervision due to their disruptive problems and, thus, might have benefited from adequate intervention strategies compared with children who exhibited inattention and unsociability symptoms exclusively.

Furthermore, the pattern of concurrent associations at fifth grade between teachers' reports of behavioral problems and the word reading outcome revealed that only 'inattention' was significantly correlated with word reading in the same school period, and is in line with the results obtained in the kindergarten period. This result seems to reflect the cross-sectional association found in numerous studies between inattention and word reading achievement in elementary school children (Billard et al., 2009; Dally, 2006; Giannopulu, Cusin, & et al., 2007; McGee et al., 2002; Rabiner & Coie, 2000; Roy & Rutter, 2006). Reading difficulties were shown to be more strongly associated with the inattentive subtype of ADHD (Giannopulu, Cusin, & et al., 2007; Hinshaw, 1992; Lundervold, Heimann, & Manger, 2008; Willcutt & Pennington, 2000a) and the association between conduct problems and reading difficulties was mediated by co-morbid ADHD (Carroll et al., 2004; Willcutt & Pennington, 2000b).

In addition, the findings of the cross-sectional analyses performed in the kindergarten period revealed that teachers' reports of 'inattention', together with parents' educational level and familial antecedents of reading difficulties independently accounted for 25% of the variance in the BSEDS global score, even after controlling for all the other behavioral and background variables. Furthermore, the results at the kindergarten period revealed significant group differences in the BSEDS global performance and teachers' reports of 'inattention' when parents' education level was taken into account. This result corroborates the findings from several studies indicating that parents' level of education influences considerably the development of early reading skills (Billard et al., 2008; Dellatolas et al., 2006; Hecht et al., 2000) and that attention skills are highly associated with parental education (Billard et al., 2010; Dellatolas et al., 2006;



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Pennington et al., 2009, for a review). In the same vein, children whose parents reported familial antecedents of reading difficulties presented lower BSEDS' global scores and a higher frequency of 'inattention' symptoms reported by the teacher. These results provide support to the contention that both reading difficulties and ADHD are highly familial (Pennington et al., 2009, for a review). Several studies have reported that children at family risk of dyslexia, where at least one member of the family was reported to be dyslexic, presented lower scores in key early reading-related skills during kindergarten and were at increased risk of developing literacy problems (Snowling et al., 2003; Puolakanaho et al., 2007). The results from the present study regarding the shared association of familial antecedents of reading difficulties with both emergent literacy skills and teachers' inattention reports provide an extension of the above-cited findings by presenting evidence that children at familial risk of developing reading difficulties might also be at increased risk for attention problems. Moreover, these results replicate the findings obtained by Doyen et al. (2004) from their analyses of the relationship among familial antecedents of reading difficulties, early literacy skills and teachers' reports of inattention symptoms during kindergarten. In this sense, children raised in families characterized by a history of difficulties in learning to read are not only at risk of developing reading difficulties, but might also be especially vulnerable to the development of attention problems. Importantly, the results of the current study highlight the significant association between parental reports of familial antecedents of reading difficulties and parents' educational level at kindergarten. Families where only one of the parents had a high school diploma more frequently reported the presence of difficulties in learning to read in at least one member of the family (i.e. a sibling and/or the parents). These findings invite the hypothesis that the co-occurrence of early reading difficulties and attention problems in children with a familial history of reading difficulties is particularly associated with environmental factors, such as parental education. Children from families characterized by low parental education levels and a family history of reading difficulties might be at increased risk of developing co-morbid reading difficulties and attention problems, due to the well established interference of inattentive behavior in reading acquisition (Dally, 2006), especially in disadvantaged environments (Velting & Whitehurst, 1997).

The results from the longitudinal analyses indicated that both familial antecedents of reading difficulties and teachers' 'inattention' reports at fifth grade made significant contributions to the prediction of fifth grade word reading. However, neither of these variables explained a significant proportion of variance in word reading at fifth grade beyond that accounted by the measures of syllabic deletion and letter reading at kindergarten. These two measures embody often-cited skills considered of major importance in reading development, namely phonological awareness and letter knowledge. The role of these early reading-related skills on the acquisition of word identification skills is well established, in accordance with an extensive body of literature (Castles & Coltheart, 2004; Hecht et al., 2000; Hulme et al., 2005; Sprenger-Charolles et al., 2003; Whitehurst & Lonigan, 1998). Most importantly, the results from the longitudinal analyses confirmed that parents' reports of familial antecedents of reading difficulties were longitudinally associated both with lower word reading scores and teachers' 'inattention' reports at fifth grade. In the same line, group comparisons between normal readers and children who presented lower performances on the word reading outcome at fifth grade lent support to these results by revealing that these groups were reliably different from one another on measures of syllabic deletion, letter reading, familial antecedents of reading difficulties and teachers' reports of 'inattention' problems. Taken together, these results confirm the pertinence of including these measures in screening procedures aimed to identify children at risk of developing reading difficulties. Puolakanaho et al. (2007) have demonstrated that a rough screening procedure including familial risk status and measures of phonological awareness, letter knowledge and rapid naming provided a reliable method for estimating a child's individual risk for developing RD from the age of 3.5 years. The results of the present study extend these findings by demonstrating that preschoolers with a family history of reading difficulties might also be at increased risk of manifesting co-morbid attention problems at the end of elementary school together with reading difficulties. This assumption is contingent with the results obtained by Hynd et al. (1991) who indicated that children with attention-deficit disorder without hyperactivity (ADD/WO) were more likely to exhibit a family history of reading difficulties. Unique to the present study is the finding of the longitudinal association between reading difficulties and attention problems in children with a family history of reading difficulties in a non-diagnosed community sample followed from preschool to late elementary school, some of whom would have been expected to develop reading problems. These results concur with research evidences from family studies regarding the shared familiarity of RD and ADHD (Friedman et al., 2003) and suggest that family factors play a role in the co-occurrence of these two disorders. Furthermore, our results align well with twin studies that recently demonstrated that the association between RD and inattention symptoms is in place during kindergarten (Ebejer et al., 2010; Willcutt et al., 2007) and is largely driven by genetic and environmental factors (Paloyelis et al., 2010). Taken together, the findings here presented underline the importance of considering the contribution of family-specific factors as antecedent variables in the co-occurrence of reading difficulties and inattention behavioral problems from kindergarten onwards.

Finally, teachers' 'inattention' reports at kindergarten and at fifth grade were not predictive of the word reading outcome at fifth grade over and beyond the study's measures of syllabic deletion and letter knowledge. This result is concurrent with the findings of Castellanos and Tannock (2002) who concluded that teachers' reported inattention is not necessarily specific, as the relation between it and specific attention tests is not necessarily strong or even significant (Castellanos & Tannock, 2002). Likewise, it is possible that teachers tend to systematically report inattention in pupils with reading problems, since both reading difficulties and the inattentive subtype of ADHD often manifest themselves in poor reading performance (Aaron, Joshi, Palmer, Smith, & Kirby, 2002). Hence, the association between teachers' judgments of classroom inattention and children's cognitive and academic performance puts forward the assumption that teachers' reported inattention might rely on the observation of low cognitive and academic performances (Giannopulu, Cusin, & et al., 2007).

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In summary, the present study has confirmed the crucial role that phonological awareness and letter knowledge play as developmental precursors of word reading skills in a sample of French students followed from kindergarten to fifth grade. In addition, our results suggest that familial antecedents of reading difficulties constitute an important risk indicator of those children who probably will develop reading difficulties. Most importantly, the current study presented evidence that children whose parents reported familial antecedents of reading difficulties were more likely to have lower performances on reading-related tasks, and to be rated by their teachers as inattentive, both at kindergarten and at the end of elementary school.

There are a number of limitations to this study that should be mentioned. The community sample used in the present study was drawn from a rural and suburban total population enrolled in general education classrooms and therefore caution is warranted in the interpretation of our results with respect to generalization of the findings to other populations. In addition, logistic constraints limited the follow-up of a larger sample of children from preschool through fifth grade, which explains the high attrition rate verified between the two school years. Consequently, despite the important size of the kindergarten sample, the size of the fifth grade sample constrained the power of the data analysis performed in the present study and hindered the use of alternative statistical models, such as structural equation modeling. Similarly, the fifth grade sample size limited the analysis of the group comparisons between normal readers and the reading difficulties group. The significantly reduced proportion of students at-risk of experiencing reading difficulties in the fifth grade sample restricted the examination of the extent to which the prediction patterns would hold up for this particular group. Second, the classification of behavioral problems as 'hyperactivity', 'inattention', 'conduct problems' and 'unsociability' relied on teachers' responses to four questions by category and thus do not reflect true diagnostic categories. Additionally, the study of the association between behavioral problems such as inattention and reading difficulties implies the consideration of several external correlates of both disorders, namely: IQ, socio cultural background, family environment, among others. In the present study, only parents' level of education was considered. Moreover, the presence of missing data coupled with our reliance in the treatment of complete cases may have obscured significant relations between variables, namely the association between inattentive behavior at kindergarten with subsequent inattentive behavior and word reading achievement at fifth grade. Finally, our results do not indicate the specific nature of the familial history of reading difficulties and were based on parent's responses to two questions. Although these caveats restrained the power and extension of the data analysis conducted in the present study, these limitations do not exclude the validity and pertinence of the findings regarding the shared influence of familial antecedents of reading difficulties on both reading and inattentive behavior.

## 6. Implications and future research directions

The educational implication of the findings here presented is noteworthy. The inclusion of information about familial antecedents of reading difficulties in screening procedures during preschool improves the early identification of children that might develop reading difficulties at the end of elementary school. Importantly, the results indicated that children characterized by a familial history of reading difficulties might represent a vulnerable group in risk of manifesting concurrent attention problems from preschool to fifth grade. Moreover, emergent literacy skills at kindergarten mediated to some extent the effect of familial antecedents of reading difficulties and teachers' reports of 'inattention' on the reading outcome at fifth grade. Taken all together, these findings emphasize the importance of considering familial antecedents of reading difficulties as an antecedent variable in the co-occurrence of reading difficulties and attention problems.

Further studies are needed that focus in more detail on the mechanisms by which familial antecedents of reading difficulties operate in learning difficulties in general and in reading development specifically. These studies should include additional measures of parental testing aimed at confirming and uncovering the specific nature of familial reading difficulties, as well as attention problems. This could allow the improvement of our understanding of which domains of familial antecedents of reading difficulties are related specifically with children's reading difficulties and attention problems.

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