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CICLO XXII

LISTENING TEXT COMPREHENSION IN PRESCHOOLERS: CONCURRENT AND LONGITUDINAL CONTRIBUTION OF COGNITIVE AND LINGUISTIC COMPONENTS

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Riassunto

L'obiettivo del presente lavoro era quello di analizzare il ruolo giocato da alcune abilità componenti di natura cognitiva e linguistica e di alto o basso livello nella comprensione del testo orale in bambini di età prescolare. Bambini con sviluppo tipico di età compresa tra i 4 ed i 6 anni hanno preso parte a quattro studi trasversali ed a uno studio longitudinale. Scopo dei primi quattro studi era analizzare a) le relazioni concorrenti tra abilità di comprensione del testo orale e componenti cognitive e linguistiche di basso ed alto livello, e b) il pattern di sviluppo di queste relazioni tra i 4 ed i 6 anni. Scopo del quinto studio era analizzare le relazioni longitudinali e causali tra i predittori concorrenti individuati negli studi trasversali e la comprensione del testo orale valutata a distanza di 6-8 mesi.

I quattro studi trasversali hanno dimostrato che l'intelligenza verbale, il vocabolario recettivo, la memoria verbale a breve termine e di lavoro, l'abilità di utilizzare il contesto linguistico e le abilità inferenziali sono precettori specifici della comprensione del testo orale e che queste relazioni sono stabili tra i 4 ed i 6 anni. Diversamente, l'intelligenza non verbale e l'abilità di comprendere frasi non sono relate alla comprensione del testo orale. I risultati dello studio longitudinale hanno dimostrato che l'intelligenza verbale, il vocabolario recettivo e l'abilità di usare il contesto linguistico sono relati in modo causale alla comprensione del testo orale, inoltre le abilità inferenziali influenzano la successiva comprensione del testo orale.

In conclusione, i risultati della presente indagine dimostrano che componenti di basso livello quali l'intelligenza verbale e il vocabolario recettivo, e componenti di alto livello quali l'abilità di utilizzare il contesto linguistico e le abilità inferenziali, giocano un ruolo cruciale nella comprensione del testo orale in età prescolare.

Abstract

The present investigation aimed to indentify some of the lower- and higher- level linguistic and cognitive skills responsible for individual differences in listening text comprehension in preschoolers. Four- to six-year-old typically developing children participated in four cross-sectional and one longitudinal study. The first four studies aimed to identify a) concurrent specific relations between listening text comprehension and lower- and higher- level linguistic and cognitive component skills, and b) the developmental path of these relations between 4- and 6-years. The fifth study aimed to analyze longitudinal and causal relations between the specific concurrent predictors identified in the cross-sectional studies, and listening text comprehension evaluated at six-to-eight-months of distance.

Results of the four cross-sectional studies showed that verbal intelligence, receptive vocabulary, verbal short-term and working memory, the ability to use linguistic context and inferential skills concurrently contribute to listening text comprehension and that these relations were stable between 4- and 6- years. On the other hand, non verbal intelligence and sentence comprehension did not specifically account for preschoolers' text understanding. Results of the longitudinal study showed that verbal intelligence, receptive vocabulary and the ability to use the linguistic context were causally related to listening text comprehension, moreover inferential skills influenced later text comprehension.

Overall, findings showed that lower-level components, namely verbal intelligence and receptive vocabulary, and higher-level components, namely the ability to use the linguistic context and inferential skills, are the most relevant factors in accounting for preschoolers' listening text comprehension.

Introduction

The three-year investigation presented in this work focused on listening text comprehension in preschoolers; the main aims of the work were to explore the concurrent relations between text comprehension and a set of linguistic and cognitive component skills and to identify, among these set of skills, predictors that were longitudinally and causally related to text comprehension.

Psychological research on text comprehension has a long tradition; the interest in this topic arose in the 1930s with Bartlett's studies on the role of background knowledge in text understanding, reached its climax in the 1970s with the ascendance of cognitive psychology and persisted in the last two decades when a new interest on individual differences in text comprehension emerged. Psychological research on text comprehension has originally focused on adults and in a second time has been extended to children. In the latter case, the analysis of the linguistic and cognitive skills that contribute to the understanding of texts (i.e., narrative texts) has mainly considered concurrent relations and focused on written text and school age-children, namely children, mainly English speakers, that are already exposed to formal instruction. The predominant interest on the comprehension processes involved in written texts might be explained considering that literacy skills are vital to academic success and learning. Indeed learning activities at school are mainly based on books and it is possible to learn new knowledge from a text only if its meaning has been adequately elaborated and understood. On the other hand there is little research on text comprehension in younger children, specifically in children speaking languages other than English. The new contribution of the present investigation is that it extends the systematic analysis of the factors responsible for individual differences in text comprehension to younger children, specifically Italian preschool children that are not yet exposed to formal instruction.

There are different reasons that can explain the interest for the topic of text comprehension in general and in young children in particular. First of all, texts or discourses are pervasive phenomena in human lives, indeed they represent the unit of human communication. In fact human communication is not constituted by single words and sentences but rather it is based on texts and discourses. Texts and discourses might be described as complex linguistic structures characterized by the presence of a central theme or topic around which series of related events are coherently organized in a whole. Narrative texts and discourses are a commonplace in the lives of young children; they are a source of entertainment but also vehicles for the transmission of sociocultural information about the values and attitudes of a community. The ability to understand short simple texts represents a structural foundation

for the overall cognitive development, it develops from the third year of life and keeps on developing all life long. Even though most of the investigation on this area have focused on school-age children, recently, a growing number of researches has recognized that many of the foundation skills that contribute to children's text comprehension emerged before the literacy process/formal instruction begins. Very young children are able to engage in the complex activities involved in text understanding, therefore the study of text comprehension in preschoolers permits the analysis of a complex process in an age group in which the phenomenon of text comprehension has not been analyzed in a systematic way. The theoretical implications are that the development of text comprehension is analyzed since the first phases of its acquisition, leading to the identification of the components involved in the process and their role at different points of development. This analysis has also important educational implications; in fact it is now widely recognized that comprehension skills developed during preschool years are fundamental for later written comprehension and therefore for academic success. The previous statement, is based on an underlying assumption that is crucial for the present work; listening and reading comprehension with the exception of translating written symbols on the page into their spoken form, are based on the same general component skills. Moving form this assumption the present work refers to the literature that analyzed the role played by these components in reading comprehension and explored their role with reference to listening text comprehension. Assuming an involvement of the same components in older children's reading comprehension and younger children's listening comprehension, does not mean that these components play the same role, rather their relative importance might change during development.

The present investigation, like research on reading comprehension, focused on developmental aspects of text comprehension and individual differences. Two main research questions guided this work: which components account for individual differences in listening text comprehension in preschoolers and which components are causally related to this ability? The answer to the first research question required the adoption of a cross-sectional design and to consider the relation between text comprehension and each component skill with reference to the role played by other relevant components. The analysis of the relation between text comprehension and each component allowed the skills that account for variability in text comprehension level reached by each child to be identified. The answer to the second question required the adoption of a longitudinal design that allowed the analysis of the relations between text comprehension and its components skills to be investigated across time. In this way it was possible to identify the component skills or predictors evaluated at an earlier time point that were related to later text comprehension and/or that play a causal role in its

development. Moreover, the identification of causal relations between early predictors and later text comprehension, required that also the relation between the same components and early text comprehension was taken into account. In sum, the present investigation aimed to extend the study on text comprehension to oral texts in preschool children analyzing both the concurrent and causal role played by some relevant cognitive and linguistic component skills.

A methodological aspect relevant for the present work should also be mentioned; in this investigation the relation between text comprehension and the various component skills was analyzed in a group of unselected typically developing Italian children aged 4-to 6-years, rather than considering selected groups of children with good or poor text comprehension. Therefore, participants were children without any known behavioural, emotional or language difficulties for whom text comprehension level varied along a continuum. As far as individual variables are considered, only the effect of variables such as age and gender was analyzed.

The present investigation is constituted by a set of studies that have been carried out during three years: from 2007 to 2009. All the studies focused on text comprehension, however each study deal with a specific aspect related to this topic. The first chapter is a theoretical introduction and aims to review the most important literature on text comprehension in typically developing children. This chapter is mainly based on the literature on individual differences in text comprehension of written texts and in school-aged children, however where available, findings on listening comprehension and younger children were also reported. The subsequent chapters are devoted to the description of the investigation carried out for the present work. Five studies are described in which the concurrent and longitudinal relations between listening text comprehension and relevant component skills are considered. The first four studies adopted a cross-sectional design. Each study focused on the concurrent relation between a specific skill and text comprehension, taking also into account the role of possible mediators. In addition, the stability of the concurrent relations between a specific skill and text comprehension in the age range considered (4- to 6- years) was also analyzed. The first three studies (Chapters 2, 3, 4) took into account more basic cognitive and lower-level linguistic component skills. The first study (Chapter 2) analyzed the role played by general non verbal and verbal intelligence and receptive vocabulary. The second study (Chapter 3) considered the role played by verbal short-term and working memory, that is the capacity and efficiency with which verbal information is stored and processed in memory. The role played by verbal memory, was analyzed taking into account the role played by verbal ability, that is verbal intelligence and receptive vocabulary. The third study (Chapter 4) is formed by two parts: the first part (Study 3A) analyzed the role of syntax, namely the ability to

understand isolated sentences, taking into account the role of possible mediators namely verbal ability and verbal working memory. In the second part (Study 3B), the investigation was extended to a more complex text-level component, namely the ability to use linguistic context to understand sentences. The role played by text-level components was further investigated in the fourth Study (Chapter 5) in which inferential skills were considered and a distinction between the ability to understand explicit and implicit information in a text was also made. Specific predictors identified in the first four cross-sectional investigations, were considered in the last longitudinal study (Chapter 6); in this study the cross-sectional predictors and listening text comprehension were evaluated at two time points at a 6- to 8- months of distance in order to identify longitudinal and causal predictors of text comprehension. Finally, the last chapter (Chapter 7) provides a general discussion which sums up the most relevant results emerged from the four cross sectional and the longitudinal studies, discusses theoretical and practical implications and future perspectives for the present investigation.

Chapter 1

Individual Differences in Text Comprehension: The Role of Cognitive and Linguistic Component Skills

1.1 Introduction

Text comprehension, starting form the first (Huey, 1908) to the more recent accounts (Kintsch & Kintsch, 2005), is described as a non unitary and complex construct. Even though models of text comprehension differ in some important respects, there is a consensus that efficient text understanding requires the construction of a coherent mental representation or picture of what the text is about. Such a construction, whether the text is written or oral, involves the interaction of several cognitive and linguistic component skills and requires the processing of linguistic information at different levels (e.g., Britton & Graesser, 1996; Gernsbacher, 1990; Hannon & Daneman, 2001; Johnson-Laird, 1983; Kintsch, 1994; Oakhill & Cain, 2007a; van den Broek at al., 2005). The reader/listener must identify and access the meaning of single words (word-level) and work out the syntactic structure and meaning of each sentence (sentence-level). Deriving the meanings of individual words and sentences is not sufficient to understand a text, in fact the reader/listener needs to integrate the information from different sentences to establish local coherence, and to incorporate background knowledge and ideas to make sense of the details that are not explicitly mentioned in the text (text-level). Finally, text comprehension requires the reader/listener to check, reflect and repair his/her comprehension.

The present chapter reviews the most important studies on the component skills that have been shown to be responsible for individual differences in text comprehension in childhood. This research has mainly explored the association, but also the causal relations between various components skills and text comprehension focusing on written text and school-age children. In structuring this review a categorization is proposed which distinguished between (a) cognitive and linguistic component skills and (b) the different levels at which linguistic information in a text has to be processed: word-, sentence- and text or discourse-level[1].

This chapter constitutes the theoretical and methodological framework of the investigation presented in the next chapters which aimed to explore the components involved in listening text comprehension in preschool children aged 4- to 6- years. The ability to understand short simple texts

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[1]The categorization adopted in the chapter does not imply that: (a) the above mentioned skills are applied in sequential way, rather it is likely that these types of processing are going on in parallel; (b) the processing of linguistic information in a text takes place within a modular system, instead the processing of information at each level can affect performance in another level in both a bottom-up and top-down manner (Oakhill & Cain, 2004)

develops from the third year of life (Levorato, 1988; Skarakis-Doyle, & Dempsey, 2008) and the current investigation aimed to extend the analysis to listening text comprehension in young children who were not yet exposed to formal instruction; it is assumed that the components investigated with reference to reading comprehension might play a role in listening comprehension as well (Hoover & Gough, 1990; Kendeou, van den Broek, White, & Lynch, 2007). It is worth underlining that assuming an involvement of the same skills in the comprehension of written and oral text in older and younger children, does not mean that the role played by these components is stable during development (e.g., Scarborough, 2005)

Before focusing on the literature that has analyzed the involvement of specific components in text comprehension, a brief description of the methods used in the research on individual differences in text comprehension is provided.

1.2 Research on text comprehension: Methodological issues

Research on text comprehension has considered selected or unselected groups of children and adopted methodologies that allow the analysis of associative links or causal relations between relevant component skills and text comprehension to be realized.

Most of the studies have considered selected groups of children, namely have compared groups of good (or skilled) and poor (or less-skilled) comprehenders (e.g., De Beni Palladino & Pazzaglia, 1995; Nation & Snowling, 1998a; Oakhill, Cain, & Yuill, 1998). These studies have been focused on children whose reading skills (i.e., word or non word reading), general intelligence and/or vocabulary are appropriate for their age, but the ability to understand a text is considerably behind what would be predicted from their chronological age or reading skills. The performance of poor comprehenders on one or more component skills that are meant to play a relevant in role in text comprehension has been compared to that of a group of good comprehenders matched for age and reading skills. If poor comprehenders obtain significantly lower performance than good comprehenders on one skill or more skills, it is concluded that this skill is one of the factors that accounted for poor comprehenders' text comprehension difficulties. More recently, unselected or relatively unselected groups of children have also been considered (e.g., Goff, Pratt, & Ong, 2005; Oakhill, Cain, & Bryant, 2003). Groups of children whose text comprehension ability varies along a continuum and without any known behavioural, emotional or learning difficulties participated in these studies. Children have been tested on a variety of skills related to text comprehension in order to analyze the specific and unique contribution made by each skills to text comprehension.

Most of the investigations on text comprehension have been correlational in nature, since they have relied on the concurrent evaluation of text comprehension and relevant components; this correlational analysis has led to the identification of the skills that are related or associated to text comprehension. One limit of this analysis is that the direction of such a relation can not be identified. In fact a skill might be related to text comprehension in different ways; it might be a prerequisite, a facilitator, or a consequence of text comprehension (Ehri, 1979). In order to analyze the nature of the relation, and specifically the existence of causal relations, other methods should be applied (Cain, Oakhill & Bryant, 2000; Oakhill & Cain, 2007b). These methods are: the Comprehension Match Design (CAM), training or intervention studies and longitudinal studies. These method are briefly described below. The Comprehension Match Design (CAM) and training or intervention studies, involve selected groups of children.

1. The Comprehension Match Design involves three groups of participants: poor and good comprehenders matched for reading skills and chronological age, and a younger group of children whose text comprehension ability is appropriate for age and is at the same level of that of the older group of poor comprehenders. The crucial comparison is the one between older poor comprehenders and the younger group; if the younger children show better performance than the group of poor comprehenders on some component skills taken into account in the investigation, it is possible to rule out the possibility that performance on that skill is due to superior text comprehension or greater experience with texts, whereas it is possible to conclude that the difficulties experienced by poor comprehenders in the considered skill are at least in part the cause of their poor text comprehension;

2. in the training or intervention studies, groups of poor comprehenders are trained on a skill thought to be a possible causal candidate of text comprehension and are compared to a group of good comprehenders who participated in the same training or a group of poor comprehenders who participated in a different but comparable training. If the comprehension level of poor comprehenders is found to improved more than the one of the comparison groups, it is concluded that the trained skill is causally implicated in the improvement of text comprehension ability;

3. longitudinal studies track the course of changes in text comprehension ability and can provide important information about longitudinal relations but mainly about causal relations between the component skills and text comprehension. Longitudinal studies test the existence of a causal relation between a component skill, evaluated at an earlier point in time, and text

comprehension, evaluated later. In the statistical analysis (i.e., regression analysis, structural equation models) a measure of text comprehension evaluated at an earlier point in time, i.e., the *autoregressor*, is included. The inclusion of the autoregressor is crucial in testing for causality because rules out the possibility that a relation between the considered component and later text comprehension is simply due to its association with early text comprehension. Any further or direct contribution of the component skills after the inclusion of the autoregressor supports the existence of a causal relation between the component skill and text comprehension. Longitudinal investigations are also crucial to analyze the presence of reciprocal causal relations between component skills and text comprehension.

1.3 Overview of the chapter

The most relevant literature on the skills that have been shown to be involved in text comprehension is presented in the next paragraphs. The component skills considered are:

a) word- and sentence-level or lower-level linguistic component skills, namely vocabulary and syntax;

b) text or discourse- level or higher-level component skills, namely inferential skills, the use of linguistic context, knowledge of story structure and metacomprehension;

c) cognitive components, namely non verbal and verbal intelligence, short-term and working memory and the inhibition of irrelevant information.

1.4 Word-level linguistic components: The role of vocabulary

In most cases, vocabulary has been shown to be a good indicator of text comprehension skills (Carroll, 1993; Davis, 1944; 1968; Thorndike, 1973), however, the relation between vocabulary and text comprehension is no straightforward but rather seems to be complex. There are at least three ways in which the relation between vocabulary and text comprehension may be described.

An efficient processing of linguistic information at the word level it is not just due to vocabulary size but also to the automaticity in accessing the meaning of the words. The first and most intuitively description which is supported by evidence of a causal link between the two skills (e.g., de Jong & van der Leij, 2002; Verhoeven & Leeuwe, 2008) is that individuals who do not know the meanings of most of words in a text or are unable to access word meanings rapidly and efficiently, have trouble in text understanding (Dufva, Niemi & Voeten, 2001; Levorato & Nesi, 2001; Oakhill et al., 1998; Perfetti, 1985).

A second description claims that text comprehension is an important source of vocabulary acquisition (Bishop, 1997; Cunningham, 2005; Nagy & Scott, 2000; Phythian-Sence & Wagner, 2007; Sènéchal, LeFevre, Hudson, & Lawson, 1996); in fact there is evidence that the sophisticated, rich and complex language used in written but also oral texts (see Sénéchal et al., 1996) contributes to vocabulary development. Findings obtained by Eldredge, Quinn and Butterfield (1990) supported this second interpretation showing that in second graders, reading comprehension is a stronger cause of general vocabulary growth than vice versa. The authors used a cross-lagged panel design and path analysis to identify the best model to explain the relation between text comprehension and vocabulary during the second year of school and found that the best fitting model is one in which text comprehension skills evaluated at the beginning of the second year predicted growth in vocabulary knowledge. Eldredge et al.'s (1990) findings support the existence of a relation in which text comprehension causes vocabulary growth, but not the existence of a reciprocal relation between vocabulary knowledge an text comprehension. However, recent evidence form other longitudinal studies on children in the early years of schooling suggested the a more reciprocal relation between the two skills might exist (e.g. Bast & Reitsma, 1998; Oakhill & Cain, 2007b; Seigneuric & Ehrlich, 2005)

Finally, a third description claims that vocabulary and reading comprehension are not directly related to each other but through a third factor: verbal intelligence has been proposed as such possible mediator (Anderson & Freebody, 1981; Daneman, 1988; Ouellette, 2006; Sternberg & Powell, 1983). In fact it may be that the more intelligent individuals are, the greater is the ability to learn form context and this ability might favour the acquisition of an extensive vocabulary. This interpretation, however, has been questioned by recent studies showing that the effects of vocabulary are not entirely intertwined with those of verbal intelligence (Oakhill & Cain, 2007b).

In conclusion, the literature reviewed in the present section showed that findings concerning the nature of the relation between vocabulary and text comprehension are mixed; some studies support the existence of a direct relation, others the existence of a reciprocal relation and others the existence of an indirect link. Overall, however, it may be argued that vocabulary knowledge is necessary but not sufficient to ensure comprehension of larger units of the text (e.g., Cain & Oakhill, 2004; Ehrlich & Remond, 1997).

1.5 Sentence-level linguistic components: The role of syntax

Once the meaning of single words in a text has been processed, the meaning of the sentence must be established using the knowledge of the syntactic structure of a language.

Studies that took into account the role of syntax have measured both syntactic knowledge and syntactic awareness. Syntactic knowledge is hypothesized to be implicit and is necessary to work out the syntactic structure of the sentence in order to construct its meaning. Syntactic awareness, instead, is regarded as an explicit knowledge in that it involves deliberate and controlled reflection on language (Cain, 2007). Syntactic awareness therefore is a metalinguistic skill that concerns the ability to consider the structure rather than the meaning of a sentence (other metalinguistic skills are described in the next paragraphs on story knowledge and metacomprehension).

Given that the understanding of linguistic information at the sentence level is thought to be necessary for text understanding, the existence of a positive relation between sentence comprehension or syntactic knowledge, and text comprehension may be expected (Nation & Snowling, 1998a). To date, however, few studies have investigated the relation between this implicit knowledge and text comprehension and, more importantly, those studies which have been carried out have reported mixed and contradictory results. The existence of a relation between text comprehension and syntactic knowledge has been demonstrate in groups of adults (e.g. Long, Oppy & Seely, 1997) and in groups of children (e.g. Catts, Adlof & Weismer, 2006; Goff et al., 2005). Other work has suggested that poor comprehenders might showed difficulties in specific areas of syntactic knowledge, such as the understanding of singular/plural of nouns and pronouns, anaphoric devices and inter-sentence conjunctions (Cain, Patson & Andrews, 2005; Yuill & Oakhill, 1991). These difficulties may influence their ability to construct the linguistic cohesion and the global coherence of a text. However, not all the children with text comprehension difficulties demonstrate deficits in understanding the meaning of sentences (e.g. Oakhill & Yuill, 1996), even when the criteria adopted for participants selection and the assessment used for the evaluation of sentence and text comprehension were similar (e.g., Stothard & Hulme, 1992; Yuill & Oakhill, 1991). The evidence is clearly equivocal, however work in this area also indicated several aspects which consideration might help to clarify the relation between sentence and text comprehension such as the age of participants. In fact, there is evidence of the existence of developmental differences in the influence of syntactic knowledge on text comprehension (Oakhill et al., 2003). Some other studies underlined the necessity to take into account the role played by several "third factors" that might mediated the relation between the two skills; these factors include verbal ability and verbal working memory (e.g., Oakhill et al., 2003; Stothard & Hulme, 1996)

To our knowledge and, perhaps due to the mixed findings obtained on the role played by sentence comprehension in text comprehension, few investigations have tested the existence of a causal relation between these two skills (Johnston, Barnes, & Desrochers, 2008). However, the few studies

that tested for causality obtained consistent results; syntactic knowledge it is not causally related to text comprehension. Convergent evidence has been provided by work in which the CAM design was used (Stothard & Hulme, 1996) and by recent longitudinal studies (Oakhill & Cain, 2007b). Specifically, Stothard & Hulme (1996) showed that the performance of poor comprehenders aged 7- to 8- years on a sentence comprehension test, was similar to performance obtained by younger children matched for comprehension level (CAM group); this result rules out the possibility that poor comprehenders' deficits in sentence comprehension are a cause of text comprehension difficulties.

Several studies have analyzed the role played by syntactic awareness in text comprehension (Cain, 2007). Syntactic awareness is thought to influence text comprehension by facilitating the integration between sentences and text and supporting the ability to monitor the comprehension process (Tunmer & Bowey, 1984). Some work that has analyzed the relation between syntactic awareness and reading comprehension has shown that syntactic awareness is concurrently and longitudinally related to reading comprehension (Muter, Hulme, Snowling, & Stevenson, 2004; Nation & Snowling, 2000) however this conclusion is not supported by other studies which did not find a link between the two skills (e.g., Vellutino, Tunmer, Jaccard, & Chen, 2007). Also in this case, the mixed set of findings might be explained considering various factors that include the age-groups considered or the different tasks used for the evaluation of syntactic awareness which may tap on a different extent on other skills that may mediate the relation between syntactic awareness and text comprehension. In support of this hypothesis, there is evidence that the role of syntactic awareness in text comprehension is mediated by vocabulary, syntactic knowledge and working memory (Cain, 2007; Vellutino et al., 2007; Willows & Ryan, 1986).

In conclusion, based on the literature reviewed in the present section there is little evidence that syntactic skills play a crucial role in text comprehension. As showed by the results of the previous studies, children with adequate syntactic skills might not be able to interpret the meaning of individual sentences with reference to the text as a whole. In fact adequate text comprehension requires that information express in different sentences is connected and integrated with previous world knowledge (Long & Chong, 2001). The ability to link up information from different sentences in a text does not rely on syntactic skills but is determined by other text- or discourse-level skills.

1.6 Text- or discourse-level components

Up to this point, text comprehension has been described as a bottom-up process, namely a process driven by the data (i.e. linguistic information presented in the text), from now on text

comprehension is described as a top-down process, namely as a process that is driven by the readers/listener's world knowledge. The text or discourse-level component skills analyzed in the present section are inferential skills, the ability to use linguistic context, the knowledge of story structure and comprehension monitoring.

1.6.1 Inferential skills

The core of text comprehension is the ability to mentally interconnect different events in the text and form a coherent representation of what the text is about (Trabasso, Secco & van den Broek, 1984). Indeed, many details and the connections between sentences and ideas in a text are not explicitly mentioned and therefore the reader/listener needs to go beyond what it is explicitly stated: he/she must infer details and links using both explicit information in the text and his/her general knowledge (Levorato, 1988; Kintsch, 1988).

Research in this area has classified inferences in various categories (Graesser, Singer, & Trabasso, 1994; Kintsch & Kintsch, 2005; Singer, 1994; van den Broek, 1994); basically, it is possible to identify inferences that are necessary for text comprehension and those that only contribute to embellish the mental representation of texts but are not strictly necessary for text understanding, referred to as elaborative inferences. Inferences necessary to construct coherent and integrated text representations, include inferences that establish textual coherence at a local or at a global level; the first type of inference (hereafter text-based inferences), is necessary to establish cohesion between sentences and can be derived from information presented in the text. Inferences necessary for local coherence include linguistic devices that maintain referential continuity within a text such as anaphors and pronouns. Inferences necessary for global coherence, (hereafter knowledge-based inferences), require the application of general world knowledge in order to make sense of the information that is only implicitly presented in the text. Causal inferences are included in this second group and have received considerable attention in previous research because are believed to play a central role in text comprehension (Mandler & Johnson, 1977; Stein & Glenn, 1979; Trabasso et al., 1984).

Developmental studies on inferential skills on school-age children have shown that they engage in very much the same inferential processes as do older children and adults, but are less likely to generate inferences spontaneously and are more dependent on contextual support to the inference; they may only generate the inference when prompted or questioned (Ackerman, 1986; 1988; Casteel & Simpson, 1991; Omanson, Warren, & Trabasso, 1978; Paris & Lindauer, 1976; Paris & Upton, 1976).

The research has been extended to younger children and support for the previous claims has

been provided (van den Broek et al., 2005; see also Kendeou, Bohn-Gettler, White, & van den Broek, 2008). Specifically, these studies have shown that children as young as 4 engage in inferential process that allow the identification of meaningful relations in a text and that are necessary to establish coherence much as do older children and adults (Trabasso & Nichels, 1992; van den Broek, Lorch, & Thurlow, 1996). In these studies 4- and 6- year-olds were able to make causal inferences and establish meaningful connections between events presented in aural and televised stories. However, systematic age differences in the ability to infer semantic relations were detected; these differences reflect the different knowledge and experiences of children of different age. Moreover, they might be due to the increasing efficiency of working memory and attention allocation. In sum, very young children are thought to be able to engage in inferential processes as do older children and adults but the inferences they generally make are less complex and need to be supported by contextual information or background knowledge (van den Broek et al., 2005). Van den Broek and colleagues (2005) described a developmental sequence of the semantic relations that preschool children can identify. The first type involve concrete and physical relations between events that are described close in the text. Only when children gain experience and develop their cognitive abilities are able to identify relations concerning abstract, distant or group of events, as in the case of the causal relations involving internal events (i.e., goals, emotions, desires of the characters), hierarchical and thematic relations between clusters of events and the theme or the overall point of the story.

Overall, the previous studies converge on the finding the inferential skills develop with age, however these studies did not specifically address the relation between text comprehension and inferential skills. This relation has been addressed in studies carried out on groups of good and poor comprehenders in the early years of elementary school; these studies mainly focused on the ability to generate inferences that are necessary for text comprehension (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Oakhill, 1982; 1984; Oakhill et al., 1998; Yuill, Oakhill, & Parkin, 1989) but in some cases also on the ability to generate inferences that contribute to embellish the mental representation of texts, namely elaborative inferences (Barnes, Dennis, & Haefele-Kalvaitis, 1996; Cain, Oakhill, Barnes, & Bryant, 2001). In this work inferential skills were compared to the ability to understand and remember information explicitly presented in the text. Overall, findings showed that good comprehenders made more inferences than less-skilled comprehenders when reading or listening to a text, on the other hand the two groups did not show significant differences in the ability to answer questions about information explicitly presented in texts. This difficulty in making inferences results in poorly integrated representations of the meaning of the text and therefore comprehension suffers

(Levorato & Nesi, 2001). Despite this difficulty and in line with their relative importance for a basic understanding of texts, in both groups inferences necessary to establish textual coherence were made more frequently than elaborative inferences.

The most important result emerged form the above mentioned studies is that poor comprehenders, although capable of generating inferences, do not make enough inferences to ensure adequate comprehension (Cain & Oakhill, 1998). Different explanations for poor comprehenders's failure in inference generation have been proposed and analyzed. Some studies have ruled out poor memory for the text as a possible cause of difficulties in generating inferences (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Cain et al., 2001; Oakhill, 1982; 1984). These studies found that less skilled comprehenders were able to recall explicit information from the text and inferential skills remained a strong predictor of text comprehension-level even when the ability to recall explicit information was controlled for. A more plausible explanation for difficulties in inference making experienced by poor comprehenders is a limited working memory capacity that might affect the ability to combine different sorts of information necessary for inference generation (Cain & Oakhill, 1998). Support for this explanation comes from studies in which children's ability to generate inferences was impaired to a greater extent when information to be connected in the text was not contained in adjacent sentences but was distant (Cain, Oakhill, & Lemmon, 2004; Yuill & Oakhill, 1991; Yuill et al., 1989). However, other work (see Cain & Oakhill, 1998) suggested that deficits in working memory provide only part of the explanation for difficulties in inference making experienced by poor comprehenders.

An other possible source of the difficulty is general knowledge: some types of inferences require the listener/reader to use previous knowledge to fill-in missing information in the text. The availability of the necessary knowledge has been shown not to be sufficient to ensure adequate inferential skills (Barnes et al., 1996; Cain & Oakhill, 1999; Cain et al., 2001). These studies tested the availability of general knowledge necessary to make an inference through direct questions and found that even when children were not able to answers inferential questions that required such a knowledge, they actually had this relevant general knowledge (Cain & Oakhill, 1999). In other works, a procedure was used that enable a strict control of individual differences in previous knowledge; children learned a new knowledge based and then were read a story and asked inferential questions that required the new knowledge to be used (Barnes et al., 1996; Cain et al., 2001). Even when the availability of the knowledge was controlled for in this strict way, less skilled comprehenders generated fewer inferences than skilled comprehenders. These results confirmed that poor comprehenders are not as aware as skilled comprehenders of the conditions in which it is appropriate to use previous world knowledge to

generate inferences. The ability to understand how to apply pre-existing knowledge to understand texts is one aspect of metacognitive ability, which therefore, can be considered as a concurrent cause of text comprehension failure in poor comprehenders (Cain & Oakhill, 1998).

Findings discussed in previous sections demonstrate that reading comprehension is associated with young children's inferential skills. More than simple associative links have been demonstrated by research in this area. Some support for the existence of a causal link between the two skills came from training or intervention studies in which groups of good and poor comprehenders were specifically trained in inferential skills or other more general abilities (Yuill & Joscelyne, 1988; Yuill & Oakhill, 1988) and from studies using the CAM design (Cain & Oakhill, 1999). The evidence has further been confirmed by more recent longitudinal studies (Oakhill & Cain, 2007b) that have also suggested the existence of a possible reciprocal relation between text comprehension and inferential skills.

1.6.2 The use of linguistic context

In order to construct a coherent mental representation of the text, the reader/listener has to interpret the information of single words and sentences in light of the surrounding context, and then the meaning of incoming information has to be constructed and integrated with the previously processed textual information (Kintsch, 1988). In other words, adequate text understanding requires a search for the global meaning of the whole linguistic context and integrative processes to go beyond the processing of single sentences

The ability to exploit contextual information in meaning construction has been analyzed in relation to the ability to read words (Nation & Snowling, 1998a) and the ability to understand the meaning of words (i.e., novel words, ambiguous words) and sentences (i.e., ambiguous expressions such as idioms) (e.g., Cain, Oakhill, & Elbro, 2003; Cain, Oakhill, & Lemmon, 2004; Cain, Oakhill, & Lemmon, 2005; Cain, Towse, & Knight, 2009; Levorato, Nesi & Cacciari, 2004; Levorato, Roch & Nesi, 2007; Oakhill, 1983; van der Schoot, Vasbinder, Horsley, Reijntjes, & Lieshout, 2009). The present paragraph is specifically focused on the ability to use context at a textual-level and its relation to text comprehension ability. It is also worth noting that the majority of these studies has considered the ability to learn new information from written texts.

Some studies analyzed the ability of groups of good and poor comprehenders to use story context to acquire new vocabulary items (Cain et al., 2003; Cain, Oakhill, & Lemmon, 2004). In this work children were presented with short texts that contained unknown words and were explicitly required to produce a meaning for the novel word (see Fukkink, 2005 for a description of the processes

involved in deriving word meaning from context in deliberate learning situations). The meaning of the novel word could be derived considering the context in which it was embedded; the proximity of the useful contextual information was manipulated, in fact the useful information could be placed immediately after the unknown word or after some additional sentences. The results, showed that less skilled comprehenders were poorer at this task than the skilled comprehenders, and were particularly impaired when the unknown word and the useful context were non adjacent, presumably because the processing request of the task was greater. These results fit well with the evidence reported in the previous section that children with text comprehension difficulties are poor at generating integrative links and that these difficulties are related, almost in part, to working memory limitations that characterize these children.

A second group of studies has analyzed the ability to use linguistic context in understanding multiword linguistic expressions such as idioms. Idioms are conventional ambiguous expressions that have both a literal and a figurative meaning which can in part overlap, as in the case of analyzable idioms, or significantly differ, as in the case of non-analyzable idioms. The comprehension of idioms is affected by different factors, but mainly by the ability to use the linguistic context in which they are embedded; in fact studies have consistently shown that idiomatic expressions are better understood when embedded in informative contexts than when they are presented in isolation (Levorato et al., 2007). Given the important role played by the ability to use context, various studies have analyzed the relation between the ability to understand idioms and text comprehension (Cain, Oakhill et al., 2005; Levorato et al., 2004). Levorato et al. (2004), considered elementary school children with different levels of text comprehension, and analyzed their ability to use context in the interpretation of familiar idiomatic expressions. Idioms were embedded in short stories and children had to chose among a literal interpretation, an idiomatic interpretation or an interpretation contextually appropriate but not related to either the literal or idiomatic interpretation. Results showed that poor comprehenders tended to chose the literal interpretation whereas the good comprehenders preferred the idiomatic interpretation. Overall the results show that poor comprehenders have a reduced capacity to take advantage of the contextual information and go beyond a simple word-by-word comprehension strategy. This difficulty is even more marked when poor comprehenders are required to understand non-analyzable idioms (Cain, Oakhill et al., 2005).

1.6.3 Knowledge of story structure

Previous paragraphs have shown that text understanding requires the reader/listener to actively use his/her background knowledge in order to make sense of the text. Knowledge that has to be accessed and retrieved from long term memory include knowledge of the structure of the different types of texts (e.g., narrative, expository, etc.) (Levorato & Nesi, 2001). There is evidence that knowledge about the structure of a story plays a relevant role in both the comprehension, production and memory of narrative texts from an early age (Stein & Glenn, 1979). Knowledge of story structure is an implicit knowledge about the underlying structure of the stories: this structure represents a sequence of casually related events which involve one or more characters (Grasser et al., 1994). Work in this area has shown that knowledge about the organization of the stories improves during childhood and that inadequate knowledge about text structure may be a possible cause of text comprehension failure (Cain, 2003; Skarakis-Doyle & Dempsey, 2008; van den Broek et al., 2005).

The relation between knowledge about story structure and text comprehension has been analyzed mainly using productive tasks, that is using an indirect measure of story knowledge (Cain, 1996). In these tasks children were required to retell stories or to narrate stories using different types of prompts. In this analysis the focus was mainly on the use of local referential and cohesive devices that contribute to the construction of the linguistic cohesion of the text, and the overall event story structure that contribute to the construction of the global coherence of a story. Overall, results showed that children with poor text comprehension have difficulties with elements of cohesion and the overall organization of the stories (Cain, 2003; Cain & Oakhill, 1996; Yuill & Oakhill, 1991). In particular, Yuill & Oakhill (1991) showed that, when poor comprehenders were required to retell stories, they produced fewer causal connectives and used referential ties ambiguously. More recent work showed that poor comprehenders' difficulties were not restricted to the use of local cohesive devices but extended to the overall structure of narratives (Cain, 2003; Cain & Oakhill, 1996). Cain (2003) required groups of good and poor comprehenders and a younger comprehension-age match group to produce stories using three different sorts of prompts. The results showed that poor comprehenders produced more poorly organized narratives than both good comprehenders and the comprehension-age match group.

In some cases, the relation between story knowledge and text comprehension has been analyzed through interviews that evaluated consciously accessible knowledge about the fictional nature of the story and the purpose of specific textual features (Cain, 1996). This work showed that poor

comprehenders were characterized by poor declarative knowledge about text features, such as titles, story beginnings and endings (Cain, 1996).

As far as causal relations are considered, the previously mentioned results obtained by Cain (2003), suggested that the ability to produce coherent stories does not simply arise from repeated experience with stories, rather, the finding that poor comprehenders obtained lower performance than the comprehension-age match group, suggests that a deficit in this skill may be a possible cause of text comprehension difficulties. Moreover Cain's (1996) study suggested that the ability to understand the purpose of specific textual features, namely a measure of consciously accessible story knowledge, may be casually related to text comprehension. Support for these results, at least in part, has been provided by the already cited longitudinal study by Oakhill & Cain (2007b). In this study knowledge of story structure was evaluated using both a story anagram task and the material used by Cain (1996) to evaluate declarative knowledge of several story features; results showed that the story anagram task predicted unique variance in text comprehension between 7-8 and 10-11 years, over and above the effect of intelligence, vocabulary and the effect of the autoregressor.

1.6.4 Metacomprehension or metacognitive skills

The term metacomprehension refers to the metacognitive skills that are involved in understanding a text, which are required to realize that the comprehension of the text is inadequate and to apply reparatory strategies to remedy comprehension problems. These skills are metalinguistic in nature and involve a deliberate and controlled reflection on text comprehension and the ability to regulate this process. In general, the ability to monitor text comprehension increases with age; in fact younger children are less likely to realize that they do not understand and do not know what to do if they do realize (Oakhill & Cain, 2004). However, there is evidence that even very young children show some competence in evaluating their comprehension (Revelle, Wellman, & Karabenick, 1985; Schmidt, Schmidt, & Tomalis, 1985; Skarakis-Doyle, 2002; Wimmer, 1979). For instance Skarakis-Doyle (2002), used an on-line paradigm to examine the ability to detect violations to familiar script-like stories in children aged 2;6 to 4 years. The aim of the study was to investigate the development of comprehension monitoring, in particular the link between the ability to detect a violation and the evaluation and resolution of the comprehension problem. Children's comprehension monitoring skills were evaluated considering both non verbal and verbal responses produced on-line while the experimenter read versions of familiar stories containing violations. Overall, the results showed that these young children were able to detect the inconsistencies in the story and confirmed that the ability

to detect violations and monitor the comprehension process increased with age.

The nature of the relation between comprehension monitoring and text comprehension has been extensively analyzed in older school-age children. Less-skilled comprehenders are poorer than skilled comprehenders in monitor their text comprehension, and in applying strategies to repair text comprehension such as re-reading part of the text, ask for assistance or use a dictionary (Cain, 1999; Cataldo & Oakhill, 2000; Ehrlich, Remond, & Tardieu, 1999; Oakhill, Hartt & Samols, 2005; Yuill & Oakhill, 1991). Usually the ability to monitor comprehension has been evaluated using inconsistency detection tasks; these tasks required the children to detect inconsistencies between different pieces of information in the text itself, namely internal inconsistencies, uncommon or non sense words that are not in the child's vocabulary, or statements that conflict with external information such as general knowledge (Cain & Oakhill, 2007). These tasks require the children to evaluate their understanding of the text, in fact children are able to detect inconsistencies if they are actively engaged in constructive processes. Studies that used these tasks found that less-skilled comprehenders were less accurate than skilled comprehenders in detecting non words, anomalous phrases in short narratives, and pairs of sentences that were contradictory (Oakhill et al., 2005). Moreover the less-skilled comprehenders difficulties were more pronounced when sentences were separated by filler text, due to their working memory limitations. Poor comprehenders' difficulties in text comprehension monitoring are also explained by their limited knowledge about the strategies to repair comprehension failure; in fact there is evidence that poor comprehenders spend less time reading sections of the text containing inconsistent information than good comprehenders and are less likely, or at least use less sophisticated strategies, to look back to previous part of the text in order to resolve inconsistencies or to locate specific information in text (Cataldo & Oakhill, 2000; Ehrlich et al., 1999). In sum the results of this work showed that, even though less skilled comprehenders are aware to some extent of their difficulties in text understanding and are able to apply some strategies to repair comprehension, they are less aware and less likely to use multiple standards in a flexible manner.

Difficulties in comprehension monitoring and in the application of reparatory strategies to remedy text comprehension problems have been though to be a possible causal factor of text comprehension difficulties, however it has also been suggested that a more reciprocal relation may exist (Yuill & Oakhill, 1991). The first claim has been supported by findings reported in studies that used a CAM and longitudinal design (Cain, 1999; Oakhill & Cain, 2007b). Longitudinal studies (Oakhill & Cain, 2007b) have not only provided evidence that comprehension monitoring plays a causal role in the development of text comprehension, but also that text comprehension may favour the

development of comprehension monitoring skills, therefore supporting the hypothesis of a bidirectional causal link. The existence of a bidirectional link between the two skills means that the ability to recognize that the comprehension of the text is inadequate and to apply reparatory strategies to remedy comprehension problems accounts for good comprehension which, in turn, accounts for the development of an adequate ability to reflect on and repair problems in text comprehension.

1.7 Cognitive skills

1.7.1 Non verbal and verbal intelligence

The study of the relation between text comprehension and general intelligence has produced mixed set of findings, which might be explained considering the measures used to evaluate general intelligence, specifically, whether these measures evaluated verbal or non verbal intellectual ability. General intellectual ability has been evaluated through the administration of a short-form of widely used standardized intelligence scales (Floyd, Bergeron, & Alfonso, 2006; Stothard & Hulme; 1996) and an in depth analysis of the relation between general intelligence and text comprehension development and difficulties has rarely been carried out (but see Nation, Clarke, & Snowling, 2002; Ferrer et al., 2007). Studies in which these pro-rated measures of general intellectual ability were used led to convergent evidence that a relation between general intelligence and text comprehension may be found when measures of verbal intelligence are used, whereas only weak relations may be found when measures of non verbal intelligence are considered (Cain & Oakhill, 2006; Oakhill et al., 2003; Oakhill & Cain, 2007b; Stothard & Hulme; 1996, but see Ferrer et al. 2007 for different results). These results basically show that the ability to manipulate and operate with verbal material is related and plays a causal role in text comprehension. However, there is also evidence that good text comprehension skills lead to better performance on measures of general intelligence; for instance Stanovich (1993) has shown that reading experience can facilitate growth in general verbal ability as well as increasing performance in non verbal intelligence measures (Raven's Matrices). Support for this hypothesis has also been provided by Ferrer et al. (2007) who applied latent growth models to longitudinal data in order to analyze the relation between intelligence (both verbal and non verbal), text comprehension and reading from first to twelfth grade. The results supported the hypothesis of the existence of a reciprocal relation between intelligence and text comprehension which seems to be stronger in the early elementary school years. Moreover, text comprehension was a leading indicator of positive changes in verbal intelligence, whereas the opposite relation was weak: the authors interpreted this result

suggesting that text comprehension is likely to improve content knowledge.

In sum, previously presented findings showed that a causal reciprocal relation between verbal intelligence and text comprehension is likely to exist.

1.7.2 Short-term and working memory

Many recent models of text comprehension emphasized the importance of various aspects of memory; it is possible to distinguish between aspects that are involved in the permanent storage of linguistic information and that are a source of background knowledge, usually indicated as long-term memory and aspects that are involved in the temporary storage and processing of the information presented in the text (Kintsch, 1988). The present paragraph is focus on the last aspects, usually referred to as short-term and working memory and described as a limited pool of cognitive resources (Baddeley, 1986).

Two important factors explain the relation between memory and text comprehension: the memory functions considered and the type of stimuli presented in memory tasks used for analyze these functions and their relation with text understanding (Carretti, Borella, Cornoldi, De Beni, 2009). The first factor refers to the above mentioned distinction between short-term and working memory. Short-term memory is the capacity to store information in memory, usually evaluated using simple span tasks in which the passive storage of words, letters, syllables, digits and numbers is required. Mixed results have been obtained by studies in which this memory function has been considered, in fact a correlation between the capacity to passively store information in memory and text comprehension has been reported in some but not in other studies (Adams, Bourke, & Willis, 1999; Daneman & Blennerhassett, 1984; De Beni et al., 1995; Dufva et al., 2001; Goff et al, 2005; Hulme, 1988; Shankweiler et al., 1999; Stothard & Hulme, 1992; Swanson & Berninger, 1995). The mixed results concerning the role of short-term memory have led some authors to hypothesize that the role played by memory in text comprehension is more complex than the simple ability to store or maintain information in memory, as analyzed using simple span tasks. Specifically some authors have hypothesized that in text understanding, were the crucial ability is to build an integrated mental representation of the text, the reader/listener is required not only to maintain pieces of information in memory, but also to merge specific information presented in the text with information contained in other parts of the text and with previous world knowledge (Daneman & Carpenter, 1980; 1983). In order to test for this hypothesis, other tasks that evaluate the capacity to both store and process information in memory, usually referred to as working memory, have been proposed. Different types of such complex working memory tasks

that evaluate the functional capacity rather than the passive storage capacity of memory, are currently available (see Savage, Lavers, & Pillay, 2007). However, all these types of tasks hark back to the complex span task proposed in both a listening and reading version by Daneman & Carpenter (1980): the "Reading Span Test" or "Listening Span Test". In this tasks individuals read or listen to a set of unrelated sentences and are required to judge whether these sentences are true or false. Then at the end of each set of sentences they attempt to recall the final word of each sentence. In this task therefore both processing and storage functions of memory are involved; the reader/listener has to process the linguistic information to establish whether the sentence is true or false, and concurrently to maintain some information to perform the recall task. A relation between working memory, evaluated using this type of task, and most of the process involved in text comprehension has been repeatedly demonstrated in both adults and children (e.g., Cain, 2006; Daneman & Merikle, 1996; Leather & Henry, 1994; Nation, Adams, Bowyer-Crane & Snowling, 1999; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000; Stothard & Hulme, 1992; Swanson & Berninger, 1995; see also the previous paragraphs on the role of text- or discourse- level component skills); these results show that individual differences in text comprehension are related to the efficiency with which working memory resources are used to manipulate and integrate information in a text.

A second factor is relevant in explaining the relation between working memory and text comprehension, that is the nature of the material used in complex memory tasks. In fact, the work cited above found a relation between text comprehension and working memory mainly when verbal complex span tasks were presented, on the contrary tasks that required the manipulation of shapes and patterns did not explain variance in text comprehension (Nation et al., 1999; Seigneuric et al., 2000). Based on this result, some authors have suggested that the relation between working memory and text comprehension might be mediated by verbal and semantic skills (Nation, et al., 1999), however other work has shown that the relation between working memory and text comprehension is not completely accounted for by verbal ability (Cain, Oakhill, & Bryant, 2004).

As far as evidence for causal relations between working memory and text comprehension is concerned, mixed results have been obtained. In fact, some studies found working memory to be a direct predictor of text comprehension development in the early years of elementary school (Seigneuric & Ehrlich, 2005), but evidence from other longitudinal studies and studies using the CAM design did not support the existence of a causal link between the two skills (Oakhill & Cain, 2007b; Oakhill et al., 1998; Stothard & Hulme, 1992).

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1.7.3 Inhibition of irrelevant information

The reader/listener selects and maintains the important information and eliminate the irrelevant information not necessary for text understanding: the ability to select relevant information involves inhibitory (or attentional) control and is strictly related to the ability to control the contents of working memory (Chiappe, Hasher, & Siegel, 2000; Gernsbacher, 1990). Working memory is the work space in which information is processed during text comprehension. An important feature of working memory is that it has a limited functional capacity (see the previous paragraph) and therefore, adequate comprehension requires that only contextually appropriate knowledge and relevant information form previously processed text is active and maintained in working memory during text processing.

Inhibition controls the contents of working memory through different ways; preventing any activate but goal-irrelevant information to enter working memory, suppressing the activation of no-longer relevant information in working memory, and preventing strong responses to allow the less probable, but appropriate, responses to be activated (Chiappe et al., 2000). Some studies on text comprehension took into account the ability to inhibit automatic and prepotent responses and to initiate alternative responses that are more relevant (Conners, 2009), however, the role played by inhibitory control on text understanding has been mainly investigated in relation to the ability to suppress the activation of irrelevant or no-longer relevant information in working memory (Cain, 2006; Carretti, Cornoldi, De Beni & Romanò, 2005; De Beni & Palladino, 2000; De Beni, Palladino, Pazzaglia & Cornoldi, 1998).

Cain (2006) analyzed the relation between text comprehension ability, working memory and inhibitory deficits in children aged 9 to 10 years. In the first two experiments presented in the study of Cain's (2006), groups of good and poor comprehenders were administered word- and number-based short-term and working memory tasks that required the children to recall the words or digits in the correct serial order (short-term memory tasks), and to complete sentences with a single word or count dots on a page and then recall the words or the total number of dots (working memory tasks). Both short-term and working memory tasks were constituted by different set of trials. In order to analyzed inhibitory deficits, the types of errors made in the word-based short-term and working memory tasks were considered. Inhibitory control was analyzed taking into account "intrusion errors" defined as the recall of a non-target word in a particular serial position either form the same or previous set of items. Overall, results form the two experiments showed that children with poor text comprehension skills differed in the number of intrusions errors made, in fact poor comprehenders made a greater number of intrusion errors then good comprehenders who therefore were better able to eliminate no-longer

relevant information from memory. A third experiment further supported these findings; in this experiment, an implicit procedure was used, namely a procedure that, contrary to the measure used in the previous two studies, was not based on conscious retrieval processes. Good and poor comprehenders' inhibitory processing was compared using a sentence completion and a memory task. In a first phase of the sentence completion task children were presented with sentences which final word was provided only after they had predicted what the final word might be. The final word generated by the children might be confirmed (high-probability endings, filler sentences) or disconfirmed by a low-probability ending (critical sentences); children were instructed to remember these final endings for later recall. In a second phase an implicit memory sentence completion task was proposed: the task was designed to test memory for the to be-remembered sentence endings (confirmed endings) and the to be-forgotten sentence endings (disconfirmed endings). The ability to inhibit the words that had been disconfirmed was measured by a priming and an inhibition score (see Cain, 2006 for further details). Good and poor comprehenders differed in both priming and inhibition scores; these results showed the existence of group differences in the ability to inhibit, in the second phase, the words that had been disconfirmed during the first phase. Specifically, these findings suggested that poor comprehenders found it harder to inhibit no-longer relevant information when explicitly directed to do so. In sum, the overall pattern of results reported by Cain's (2006) provided evidence for a relation between inhibitory process, memory performance and text comprehension ability.

1.8 Summary and conclusions

The present chapter aimed to review the most important studies on the linguistic and cognitive skills that must be acquired to become a successful comprehender and that are responsible for individual differences in text comprehension in childhood. It also described the different methodologies that have been used to explore the relation between component skills and text comprehension, distinguishing between methods aimed to test for associative links and methods aimed to test for causality. The work reviewed in this chapter shows that individual differences in children's text comprehension are related to a range of lower- and higher- level linguistic and cognitive components that allow linguistic information at the word-, sentence- and text- or discourse-level to be processed. However, the findings reported in the literature showed that a reduced number of skills play a crucial role or are causally related to text comprehension; these skills mainly include discourse-or text- level components that are involved in the construction of a global coherent and integrated mental representation of the text.

The review presented in this chapter constitutes the theoretical and methodological framework of the investigation presented in the next chapters which aimed to analyze the role of the components involved in listening text comprehension in preschool children. As previously noted, the literature on text comprehension, with some recent exceptions, has been mainly focused on written text and to date there is no systematic analysis of the skills related to text comprehension in preschool children, and specifically in preschool children speaking languages other than English. In the present investigation it is assumed that the components investigated with reference to reading comprehension might play a role in listening comprehension as well, and the concurrent and longitudinal relations between some of the relevant skills described in this chapter and text understanding in Italian preschool children are analyzed. As pointed out at the beginning of the chapter, assuming an involvement of the same skills in the comprehension of written and oral texts in older and younger children does not mean that these components play the same role, instead their relative importance might change during development.

In the next chapters five studies are presented; four cross-sectional studies and one longitudinal study. Firstly the four cross-sectional studies are described. Each study focused on the concurrent relation between a specific skill and text comprehension; this relation is analyzed considering the role of possible mediators and age. The first studies (Chapters 2, 3, 4-Study 3A) took into account more basic cognitive and lower-level linguistic component skills and afterwards, more complex text-level component skills were considered (Chapter 4, Study 3B and Chapter 5). Specific predictors identified in the first four cross-sectional investigations, were considered in the last longitudinal study (Chapter 6); in this study the cross-sectional predictors and listening text comprehension were evaluated at two time points at a 6- to 8- months of distance in order to identify longitudinal and causal predictors of text comprehension.

Chapter 2

Study 1. The Role of Non Verbal and Verbal Intelligence and Receptive Vocabulary

2.1 Introduction

The present investigation aimed to analyze the relations between listening text comprehension, on one hand, and non verbal and verbal intelligence and receptive vocabulary, on the other hand, in preschool children. The developmental path of the relationship between listening text comprehension, on one hand, and intelligence and receptive vocabulary, on the other hand, between 4 and 6 years of age, was also analyzed. The next paragraphs review the most relevant literature on the relations between text comprehension and the above mentioned component skills.

2.1.1 Text comprehension and non verbal and verbal intelligence

Few studies have analyzed the relation between text comprehension and general intelligence in childhood, moreover different results were obtained when different measures of intelligence were used. The above mentioned relation has mainly been considered in studies carried out on selected groups of good and poor comprehenders; the main aim of these studies was to analyze whether difficulties in text comprehension might substantially be accounted for by deficits in general intelligence. Usually, the performance of skilled and less skilled comprehenders has been compared based on pro-rated measures obtained trough the administration of standardized intelligence test (see also Chapter 1 of this work). Stothard and Hulme (1996) carried out a study in which the CAM design was used; they compared groups of good and poor comprehenders matched for chronological age (7-8 year-olds) and word reading skill, and a younger control group (comprehension-age match group or CAM group) which text comprehension ability was appropriate for age, on measures of both verbal and non verbal intelligence (Vocabulary and Similarities subtests and Block design[2] and Object assembly subtests form the Verbal and Performance scales respectively of the Wechsler Intelligence Scale for Children Revised-WISC-R). Stothard and Hulme (1996) found that the poor comprehenders' performance was lower than that obtained by both the control group matched for chronological age (i.e., good comprehenders) and the younger CAM group in the verbal subtests. Instead the poor comprehenders and both control groups obtained comparable performance in the non verbal subtests. Finally, unlike the two control groups, the

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[2] These type of measures evaluate the quality and the complexity of the representations of words in the semantic system and can also be referred to as measures of vocabulary depth (see also Chapter 5 of this work)

poor comprehenders showed a remarkable discrepancy between performance at the non verbal and verbal subtests. Based on these results, the authors concluded that poor comprehenders exhibited a specific deficit in general verbal ability that might substantially account for individual differences in text comprehension ability.

More recently, Nation et al., (2002) carried out a systematic analysis of general intellectual ability of good and poor comprehenders. Good and poor comprehenders had almost the same chronological age (8-9 year-olds) of the participants in the study of Stothard and Hulme (1996). The two groups were matched for word reading skill and chronological age. Intellectual ability was evaluated using the Verbal ability, Non-Verbal Reasoning Ability and Spatial Ability subscales of the British Ability Scales 2nd edition (BAS-II). Good and poor comprehenders' performance on these subscales was then compared and related to reading comprehension, reading accuracy and number skills. Overall, poor comprehenders showed lower intellectual ability than the control children to whom they were matched to. However, the majority of poor comprehenders were of average intelligence and, more relevant, differences in terms of general intellectual ability between the two groups were largely accounted for by differences in verbal ability. These data are in line with findings reported by Stothard and Hulme (1996) in supporting that poor comprehenders' difficulties were limited to aspects of verbal processing and therefore were fairly specific.

Findings reported by Cain & Oakhill (2006) further supported the results of previous studies in which a relation between text comprehension and non verbal intellectual ability was excluded. Cain & Oakhill (2006) compared general intellectual abilities of good and poor comprehenders with age-appropriate word reading skill, when they were 8 and 11 year-olds. Non verbal and verbal intellectual ability were evaluated using the same subtests adopted by Stothard & Hulme (1996). No difference emerged between the two groups for non verbal abilities at the age of 8 years, however there was a marginally significant difference for verbal intelligence. Contrary to the evidence reported by Stothard & Hulme (1996), there was no evidence of a discrepancy between verbal and non verbal intelligence in the group of poor comprehenders. Finally, a sizeable difference between good and poor comprehenders was found considering verbal reasoning skills, which were evaluated by the schools when children were 11 year-olds. Similar findings were also reported by Cornoldi, De Beni & Pazzaglia (1996) in slightly older poor comprehenders (11-14 year-olds); this group obtained lower performance on a measure of verbal reasoning when contrasted with good comprehenders matched for age, decoding skills and general intelligence.

In sum, the review of the literature reported above, supported: (a) the existence of a relation between text comprehension and general verbal ability or verbal reasoning, (b) the absence of a relation between text comprehension level and non verbal intelligence (see also Nation, 1998).

2.1.2 Text comprehension and receptive vocabulary

Vocabulary knowledge has been shown to be strongly correlated with text comprehension; different hypothesis have been put forward in order to explain this link, however a common conclusion on the nature of such a relationship has not been reached (see Chapter 1 of this work). For the purpose of the present study, work that has analyzed the concurrent relations between vocabulary knowledge, in most cases evaluated using measures of receptive vocabulary[3](Pearson, Hiebert, Kamil, 2007) and text comprehension has been taken into account.

Studies on selected-groups of good and poor comprehenders suggested that poor vocabulary knowledge might led to difficulties in text comprehension (e.g., Cain, Oakhill & Lemmon, 2004; Catts et al.; 2006). For instance poor comprehenders examined by Catts and colleagues (2006), showed mild-to-moderate deficits in receptive vocabulary; in fact they obtained lower performance on such a measure of vocabulary than both a group of poor decoders with adequate comprehension and a group of typical readers. In line with the previous result, Cain, Oakhill and Lemmon (2004) reported evidence that some poor comprehenders showed impoverished receptive and expressive vocabulary knowledge.

Studies on unselected groups of school-age children (first to fourth graders), supported the existence of a relation between receptive vocabulary and text comprehension (Seigneuric & Ehrlich, 2005; Seigneuric et al., 2000). In these studies vocabulary emerged as a specific contributor of reading comprehension compared with other important predictors of text understanding such as decoding skills and working memory.

Previous work suggests the existence of a direct relation between vocabulary and text comprehension, however this is still a debatable issue. Specifically, some authors (e.g., Anderson & Freebody, 1981 but see also Chapter 1 of this work) have hypothesized that the relation between vocabulary and text comprehension might be mediated by a third factor, that is verbal intelligence. However evidence form work carried out by Oakhill and colleagues (e.g. Oakhill et al., 2003) suggested that the effect of vocabulary is not entirely explained by verbal intelligence. Specifically, Oakhill et al. (2003) found that vocabulary knowledge accounted for unique variance in text

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[3] Receptive vocabulary evaluates the size of the lexicon and can also be referred to as a measures of vocabulary breadth (see also Chapter 5 of this work)

comprehension over and above the contribution of verbal intelligence, that was strongly related to text comprehension ability in elementary school children aged 7-8 and 8-9 years.

To conclude, previous work supported the existence of a relation between receptive vocabulary and text comprehension. However, the nature of this relation, namely whether it is direct or mediated by verbal intelligence, it is not clear.

2.1.3 Research questions and hypotheses

The present study aimed to examine the specific role played by general intelligence and receptive vocabulary knowledge in preschoolers listening text comprehension. Based on the literature presented in previous sections, the following research questions and hypothesis were formulated:

a) verbal intelligence was expected to be a specific contributor of listening text comprehension (Nation et al., 2002; Stothard & Hulme, 1996);

b) non verbal intelligence was not expected to be specifically related to listening text comprehension (Cain & Oakhill, 2006; Nation et al., 2002; Stothard & Hulme, 1996);

c) receptive vocabulary was expected to be related to listening text comprehension (Catts et al., 2006; Seigneuric & Ehrlich, 2005). The nature of this relation (i.e., direct or indirect namely mediated by verbal intelligence) was also explored in the present study, however the mixed findings reported in the literature about the nature of this link did not allow specific predictions to be formulated (e.g., Anderson & Freebody, 1981; Oakhill et al., 2003);

Finally, the developmental path of the relationship between intelligence and receptive vocabulary, on one hand, and listening text comprehension, on the other hand, between 4 and 6 years was also examined.

2.2 Method

2.2.1 Participants

Eighty-four children aged 4 to 5;11 years (mean age = 4 years and 9 months, *SD* = 6 months) participated to the present study[4]. Males were 52% and females were 47%.

Children attended kindergartens located mainly in the North of Italy and came from families living in mid-low socio-economic catchment areas. All the children spoke Italian as their first language.

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[4] Data presented in this study were collected during 2007

According to their teachers, none of these children had cognitive impairments or language difficulties. Parental consent was obtained for each child.

2.2.2 Materials and Procedure

As part of a more wide cross-section project (see Chapter 1 of this work), this study was concerned with three abilities: listening comprehension of short stories (dependent variable), non verbal and verbal intelligence, and receptive vocabulary (predictors) which were evaluated in three sessions of about 20 minutes each. Tasks used to evaluate the above mentioned skills are described below. All the tasks were individually administered in a quiet area of the school in order to guarantee the children remained attentive.

Listening text comprehension. Test TOR 3-8 (Levorato & Roch, 2007) (hereafter TOR 3-8), designed for children between 3 and 8 years of age, was used to evaluate listening text comprehension. The test consists of two short stories of equal difficulty and length, which are read individually to each participant. Comprehension was evaluated using 10 questions per story, half of which were based on explicit information (textual questions) while the others required inferences to be generated (inferential questions). The questions were followed by a multiple-choice task: After having listened to the questions, the children were asked to respond by choosing the correct answer out of four possibilities. The answers were read by the experimenter who also pointed to the corresponding picture: A set of four pictures was presented for each question. In order to avoid overburdening memory resources and in order to guarantee the children remained attentive, the tester interrupted the reading at two pre-established points in order to ask questions either explicitly or implicitly related to the preceding part of the story. One point was credited for each correct answer (range 0 to 20). One score was considered: the total number of correct answers. The reliability for TOR 3-8, evaluated by calculating Cronbach's Alpha over items and reported in the manual of the test, ranges from .52 to .72; these values are not low considering that two types of questions (textual and inferential) were used to assess comprehension.

Non verbal and verbal intelligence. Non verbal and verbal intelligence were estimated using three sub-tests from the Wechsler Intelligence Scale for Preschool and Primary School-WPPSI (Wechsler, 1967 - Italian adaptation by Bogani & Corchia, 1973[5]).

    a) One subtest from the Performance scale: Picture Completion (hereafter PIQ) which has been used in the literature to estimate non verbal intelligence (e.g., Catts et al., 2006). In

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[5] In the present and next studies, the performance obtained at the WPPSI's subtests were interpreted with reference to a more recent standardization carried out by Orsini & Picone (1996).

this subtest children were presented with series of incomplete monochrome pictures of common objects (e.g., a comb, a rose, a watch etc.) and required to identify the important missing element, pointing to the element and/or using a verbal label for it. Testing ceased when the child gave 5 consecutive incorrect answers. One point was credited for each correct answer (total number of items = 23). The reliability for the Picture Completion subtest, evaluated using the split-half procedure and reported in the manual, is .77;

b) two subtests from the Verbal scale: Vocabulary and Similarities (e.g., Stothard & Hulme, 1996). In the Vocabulary subtest the children were required to use semantic knowledge to define words of increasing semantic complexity and decreasing frequency; testing ceased when the child gave 5 consecutive incorrect answers (i.e., incorrect or vague definitions also obtained after additional requests of clarification). Zero, one or two points were credited for each answer (total number of items = 22). In the Similarities subtest children were asked to detect and describe commonalities between two words representing objects and concepts. Testing ceased when the child was not able to give at least 1correct answer in the first 5 items (total number of items = 16). Zero, one or two points were credited for each answer (maximum score = 22). A composite score (hereafter VIQ) was estimated by computing mean scaled scores *(M =* 10, *SD* = 3) for Vocabulary and Similarities subtests (cf. Cain & Oakhill, 2006).The reliability for the Vocabulary and Similarities subtests, evaluated using the split-half procedure and reported in the manual, is .87 and .80 respectively.

Receptive vocabulary. The Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981, standardised for Italian speakers by Stella, Pizzoli, & Tressoldi, 2000) (hereafter PPVT-R) was used. The test was standardised on children between the ages of 3 and 12 inclusive. Children were required to choose which picture out of four represented words of increasing complexity and decreasing frequency spoken by the experimenter. The test stopped when children gave six incorrect answers on eight consecutive items. Each answers was credited one point and the sum of correct answers was the total raw score. The reliability for the PPVT-R, evaluated using the split-half procedure and reported in the manual, is .88.

Study 1. Non verbal and verbal intelligence and receptive vocabulary

2.3 Results

2.3.1 Descriptive statistics

All the children completed the tasks. Table 1 shows the descriptive statistics.

Table 1. **Mean performance with standard deviations and range**

	M	*SD*	Range
Listening text comprehension (TOR 3-8) [a]	10.7	1.8	7-14
Non verbal intelligence (PIQ) [b]	10.0	3.0	3-17
Verbal intelligence (VIQ) [b]	9.3	2.4	3-15
Receptive vocabulary (PPVT-R) [c]	80.1	12.1	65-113

Note. [a] Scaled scores: $M = 10$, $SD = 2$. [b] Scaled scores: $M = 10$; $SD = 3$. [c] Standard scores: $M = 100$, SD = 15.

Listening text comprehension (TOR 3-8). Performance was appropriate for age and ranged from 1.5 SD below the mean to 2 SD over the mean.

Non verbal and verbal intelligence (PIQ and VIQ, respectively). In both tasks, children performed at a level appropriate for their age. Performance ranged from about 2 SD below the mean to about 2 SD over the mean.

Receptive vocabulary (PPVT-R). Performance ranged from the standard score of 65 (about 2 *SD* below the mean) to the standard score of 113 (about 1 *SD* above the mean). Children in both groups performed at a lower level than that of the normative population for their age[6]. The standard deviation was comparable to that of the national standardization sample. This result suggests that the range of performance was normal and unrestricted; Storch and Whitehurst (2002) reported that in their longitudinal study a group of children from low-income families from US performed similarly to the participants of the current study on the PPVT-R. The PPVT-R is very sensible to socio-economic and cultural level (e.g., Campbell, Dollaghan, Needleman, & Janosky, 1997; see also Le Normand, Parisse, & Cohen, 2008 who analyzed the effect of sociocultural factors on lexical development in 4 year-olds); although we do not have access to detailed information about the socio-economic and cultural indicators of our participants, we may hypothesize that our data are affected by the socio-economic status of the participants.

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[6] Based on the normative data, eight children obtained scores more than 2.5 standard deviations below the mean. A parallel set of analyses was carried out excluding these eight children; no substantial differences emerged, therefore the following analyses were based on all 84 children of the original group.

Study 1. Non verbal and verbal intelligence and receptive vocabulary

2.3.2 The role of age and gender

A set of correlational analyses was carried out in order to analyze the relation between gender and age, on one hand, and listening text comprehension (TOR 3-8), non verbal and verbal intelligence (PIQ and VIQ) and receptive vocabulary (PPVT-R), on the other hand. None of the component skills considered in the present study was related to gender ($p > .05$). On the other hand, statistically significant correlations were found between age and all the other variables ($p < .05$). Therefore, the effect of the age on the performance at the test of listening text comprehension (TOR 3-8), non verbal and verbal intelligence (QIP and QIV) and receptive vocabulary (PPVT-R), was controlled for in the next analyses.

2.3.3 Correlations between listening text comprehension, non verbal and verbal intelligence and receptive vocabulary

Table 2 shows the correlations between listening text comprehension, non verbal and verbal intelligence and receptive vocabulary, controlling for the effect of age[7].

Table 2. Correlations between listening text comprehension, non verbal and verbal intelligence, and receptive vocabulary (controlling for the effect of age)

	1	2	3	4
1. Listening text comprehension (TOR 3-8)	-	.34*	.41*	.53*
2. Non Verbal intelligence (PIQ)		-	.34*	.51*
3. Verbal intelligence (VIQ)			-	.48*
4. Receptive vocabulary (PPVT-R)				-

*$p = .008$ (Bonferroni correction: $.05/6 = .008$).

Moderate correlations[8] were found between listening text comprehension, on one hand, and non verbal and verbal intelligence and receptive vocabulary, on the other hand. As expected, preschoolers' text comprehension was related to verbal ability evaluated with measures of verbal intelligence and receptive vocabulary which, in turn, were related to each other. A significant correlation between listening text comprehension and non verbal intelligence also emerged. It was hypothesized the relation

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[7] In the present study and in the next ones, the *p* value was corrected using the Bonferroni Method in order to control for type one error.
[8] In the studies presented in this work, effect sizes were interpreted with reference to conventional definitions proposed by Cohen (1988)

might be due in part to the specific subtest we used for the evaluation of non verbal intelligence which might partially involve verbal ability in such young children (Orsini & Picone, 1996). The next analysis was aimed to analyze the specific contribution of the components considered in the present study, specifically; a) whether non verbal intelligence contribute to listening text comprehension, when the contribution of both verbal intelligence and receptive vocabulary was taken into account and b) whether the contribution of receptive vocabulary might be mediated by verbal intelligence.

2.3.4 Listening text comprehension: The contribution of non verbal and verbal intelligence and receptive vocabulary

In order to analyze the specific role played by non verbal and verbal intelligence and receptive vocabulary in preschoolers' text understanding, a fixed-order hierarchical multiple regression analysis with the number of correct answers at the TOR 3-8 as the dependent variable, was carried out. We established *a priori* the order with which the different components were entered in the model in order to test for our hypotheses; age in the first step, non verbal and verbal intelligence in the second step and receptive vocabulary in the last step. In the forth step we tested for interactions between age, on one hand, and non verbal and verbal intelligence and receptive vocabulary, on the other hand.

Age was first entered to test for its effect on text comprehension and to test for its interaction with the predictors in the last step: interaction terms allow to test for a possible moderation effect of age on the relation between measures of verbal intelligence and vocabulary, on one hand, and text comprehension, on the other hand. In order to control problems arising from multicollinearity and to facilitate interpretation of the results, the variables non verbal and verbal intelligence, receptive vocabulary and age were standardized ($M = 0$, $SD = 1$) and z scores were used to calculate the interaction terms (Aiken & West, 1991). Verbal intelligence entered the model before receptive vocabulary, in order to test whether the latter accounted for a specific amount of variance in listening text comprehension or whether its role was mediated by verbal intelligence.

The interactions between age, on one hand, and non verbal and verbal intelligence, and receptive vocabulary, on the other hand, were not significant ($p > .13$); age did not operate as a moderator in the relation between the above mentioned predictors and listening text comprehension, which was stable between 4 and 6 years. Consequently, we tested a more parsimonious model in which these interactions were excluded. The final model is presented in Table 3.

Study 1. Non verbal and verbal intelligence and receptive vocabulary

Table 3. Fixed-order hierarchical multiple regression analysis with listening text comprehension as the dependent variable, non verbal and verbal intelligence, and receptive vocabulary as predictors, controlling for age

	R^2	ΔR^2	B	SE B	β
Step 1	.19	.19**			
Age			0.29	0.07	.43**
Step 2	.35	.16**			
Age			0.22	0.06	.32**
Non verbal intelligence (PIQ)			0.23	0.14	.17
Verbal intelligence (VIQ)			0.55	0.17	.32**
Step 3	.42	.07**			
Age			0.22	0.06	.33**
Non verbal intelligence (PIQ)			0.10	0.14	.07
Verbal intelligence (VIQ)			0.34	0.18	.20*
Receptive vocabulary (PPVT-R)			0.11	0.04	.32**

$* \ p < .05; ** \ p < .01$

The model accounted for 42% of variance in listening text comprehension; age explained 19% of variability; non verbal and verbal intelligence added 16% of variance and finally, receptive vocabulary accounted for a further 7% of variance. The amount of variance account for in each step was significant.

The final model (see Step 3) showed that performance at Tor 3-8 increased between 4 and 6 years. Verbal intelligence and receptive vocabulary were significant predictors of listening text comprehension, and, more importantly, the contribution of receptive vocabulary was not completely accounted for by verbal intelligence[9]. Non verbal intelligence, on the other hand, was not a significant predictor of listening text comprehension when the contribution of both verbal intelligence and receptive vocabulary was taken into account.

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[9] Further support for this result was obtained in a post-hoc regression analysis in which verbal intelligence and receptive vocabulary were entered in the model in the reverse order; verbal intelligence accounted for a significant but smaller (4%), at least at a descriptive level of analysis, amount of unique variance over and above receptive vocabulary.

2.4 Discussion

The present investigation analyzed the role played by general intelligence and a lower-level linguistic component, namely receptive vocabulary in listening text comprehension in preschoolers. The main hypotheses tested in the present study were supported; verbal intelligence, but not non verbal intelligence, was a specific predictor of listening text comprehension which was also predicted by receptive vocabulary. Moreover, the role played by the above mentioned skills on text comprehension was stable in the age range considered. These findings are discussed in turn below.

The results on the relation between text comprehension and general intelligence are in line and extend to preschool children findings emerged in previous studies on elementary school children. A better ability to manipulate verbal material is related to text comprehension ability in the unselected groups of children considered in this study; this result is in line with work showing that deficits in verbal intelligence might be responsible for difficulties in text comprehension (e.g., Nation et al., 2002; Stothard & Hulme, 1996). Non verbal intelligence did not specifically account for text comprehension in preschoolers, even though a significant correlation between non verbal intelligence and listening text comprehension emerged. The results of this study suggest that young children's performance on the non verbal intelligence task is partly mediated by verbal ability (Orsini & Picone, 1996). The magnitude of the correlations between non verbal intelligence, on one hand, and verbal intelligence and receptive vocabulary, on the other hand, supports this interpretation. In sum, when verbal ability, namely verbal intelligence and receptive vocabulary, is taken into account, non verbal intelligence does not account for listening text comprehension. The latter result is supported by previous literature in which there was little evidence in support of a relation between text comprehension and non verbal intelligence (Cain & Oakhill, 2006; Nation & Snowling, 1998b; Stothard & Hulme, 1996). Findings of the present study therefore are in line with the evidence that the majority of poor comprehenders showed difficulties that are limited to the verbal domain. However, the analysis carried out in this investigation can not ruled out the possibility supported by other works (e.g., Nation et al., 2002), that a minority of children with comprehension difficulties might show also more general cognitive deficits.

Receptive vocabulary was the ability most strongly related to listening text comprehension, a result that has repeatedly emerged in most of the previous literature. More importantly, the present investigation contributed to clarify the nature of the relation between vocabulary and text comprehension, showing the existence of a direct relation between the two skills. Our data do not support the hypothesis for which the contribution of vocabulary to text comprehension may be completely explained by verbal intelligence. In fact, even though receptive vocabulary was related to

verbal intelligence, it accounted for a significant 7% of variance over an above verbal intelligence. The important role played by receptive vocabulary is further supported by the results of a post-hoc regression analysis in which verbal intelligence and receptive vocabulary were entered in the model in the reverse order. This additional analysis showed that verbal intelligence accounted for a significant but smaller, at least at a descriptive level of analysis, amount of unique variance over and above receptive vocabulary (4%). Children's performance on the receptive vocabulary task needs some comments, because as previously observed, it was poor; this result is unexpected given the age-appropriate performance obtained by children in both subtests selected for the evaluation of verbal intelligence, which tap even more complex verbal skills.

Finally, non verbal and verbal intelligence and receptive vocabulary have been shown to have the same effect on listening text comprehension between 4 and 6 years of age. On the contrary, the ability to understand oral texts develops in this age range. In fact, age turned out to be a crucial variable affecting children's performance on the test of listening text comprehension, suggesting that a significant development occurs in this ability which is still in an early phase of its acquisition.

In sum, findings emerged in the present investigation emphasize the prominent role played by verbal ability, namely verbal intelligence and receptive vocabulary, in listening text comprehension. The results of this study also contribute to clarify the relation between verbal intelligence and receptive vocabulary which may be considered basic or lower-level components of text comprehension. The next study has taken into account the role of other basic cognitive skills that previous literature has shown to play a role in text comprehension, namely verbal short-term and working memory.

Chapter 3

Study 2. The Role of Verbal Short-Term and Working Memory in Listening Text Comprehension; Is it Mediated by Verbal Ability?

3.1 Introduction

The present study aimed to analyze the relationship between listening text comprehension and verbal memory in preschoolers. Two memory functions were considered, namely short-term and working memory, and the specific contribution of each function between 4 and 6 years was examined. In order to analyze the role played by verbal short-term and working memory in listening text comprehension, verbal ability (i.e., verbal intelligence and receptive vocabulary) was taken into account as a control variable. In the next paragraphs the specific literature on the relations between text comprehension, on one hand, and short-term and working memory, on the other hand, is reviewed.

3.1.1 Memory and Text Comprehension

Many previous studies analyzing individual differences in reading comprehension ability in childhood have taken into account the role played by memory (e.g., Cain, 2006; Carretti et al., 2009; Leather & Henry, 1994; Nation et al., 1999; Seigneuric et al., 2000; Stothard & Hulme, 1992; Swanson & Berninger, 1995). In these studies, two memory functions were considered: a) the capacity to store material over short periods of time in situations that do not impose other competing cognitive demands (i.e., short-term memory); b) the capacity to store information while engaging in other cognitively demanding activities (i.e., working memory).

Short-term memory, was measured by tasks that required information storage, such as word or digit span tasks. Studies that investigated the relations between reading comprehension and short-term memory in school-age children obtained mixed results. Some studies reported that a relation between short-term memory and reading comprehension existed; these studies considered unselected groups of children (Goff et al., 2005; Hulme, 1988) and compared children with poor text comprehension skills to children characterized by poor word reading and adequate comprehension (Shankweiler et al., 1999). Other studies, instead, that compared good and poor comprehenders found no difference between the two groups with regards to their short-term memory skills (Stothard & Hulme, 1992; Swanson & Berninger, 1995).

Daneman and Carpenter (1980) have proposed a model which is particularly adequate to describe the processes of text comprehension and has been supported by empirical evidence (Daneman

& Merikle, 1996). In this model, working memory is considered as a unitary system which carries out both storage and processing functions of linguistic information. It has limited resources and there is a performance trade-off between processing and storage functions[10]: An increase in the amount of processing required results in a decrease in the number of items stored. This limitation may result in coarse text comprehension and is among the causes of individual differences.

Working memory capacity is evaluated through complex span tasks, such as the listening span test (Daneman & Carpenter, 1980). This test requires linguistic information to be both stored and processed: The participants have to process the meaning of a series of non-connected sentences and to answer true/false questions while maintaining the final word of each sentence for later recall. Studies on groups of good and poor comprehenders and on unselected groups of children have found a strong relationship between working memory and reading comprehension (Cain, 2006; Engle, Carullo, & Collins, 1991; Seigneuric et al., 2000; Swanson & Berninger, 1995) as well as between working memory and many of the skills involved in text comprehension, such as inference making, anaphoric processing and use of context (Cain, Oakhill, & Lemmon, 2004; Ehrlich & Rémond, 1997; Oakhill et al., 1998; Yuill & Oakhill, 1988; Yuill et al., 1989). These studies suggest that reading comprehension depends in part on the capacity of working memory to maintain and manipulate information.

Few studies have examined the relation between listening comprehension and memory in preschoolers. Daneman and Blennerhassett (1984) analyzed short-term memory, working memory and their relationship with listening text comprehension in children between 3 and 5 years of age. Short-term memory was evaluated through a word span task, and working memory through a modified version of the listening span test. They found that working memory predicted listening text comprehension in preschoolers better than short-term memory, which, however, also correlated with listening text comprehension. It was not possible to prevent the children taking the listening span test from repeating the entire sentences rather than recalling only the sentence-final words. Therefore, this study actually demonstrated that the ability to repeat sentences was related to listening comprehension. However, the relationship between memory and text comprehension remained unclear.

More recently, Adams et al. (1999) examined the relationship between spoken language comprehension, on one hand, and short-term and working memory, on the other hand, in children aged

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[10] It is worth noting that as far as working memory is considered, two major theoretical approaches can be identified: the multiple-resources models (Baddeley, 1986; Shah & Miyake, 1996) and the resource-sharing models (Daneman & Carpenter, 1980; Just & Carpenter, 1992). The former assumes that performance in complex span tasks is supported by a number of subsystems dedicated to specific processes or domains, whereas the latter assumes that processing and storage operations compete for a limited pool of working memory resources (for further details about this debate see Bayliss, Jarrold, Gunn & Baddeley, 2003).

between 4;6 and 5;6 years. Spoken language comprehension was evaluated considering a range of linguistic components and the ability to draw inferences. Different measures of short-term memory and a listening span task were used to evaluate memory skills. In the latter task, in order to avoid the difficulties found by Daneman and Blennerhassett (1984), children were required to supply the missing final word of sets of unrelated sentences and then to recall all the final words in each set. The authors found a relation between spoken language comprehension on one hand, and short-term and working memory measures, on the other hand. In this study, as well, the children found the listening span task difficult and produced a very limited range of scores. In sum, the results obtained with preschool children suggested that complex span tasks, such as the listening span test, are unsuitable for this population.

Based on these considerations, we decided to analyze the specific role played by working memory in listening text comprehension by using a backward word span task, which seemed to be more suitable with respect to the resources of preschool children. In order to evaluate short-term memory, we used a forward word span task. Alloway, Gathercole, and Pickering (2006) used these tasks in a numerical format (forward and backward digit recall) to evaluate short-term memory and working memory in preschoolers (see also Alloway, Gathercole, Willis, & Adams, 2004). The two tasks differ in terms of their processing load: forward digit recall places a minimal processing load on the child whereas backward digit recall imposes a substantial one. In the current work, these two memory measures were analyzed in order to disentangle the contributions made by short-term and working memory to listening text comprehension in preschoolers.

3.1.2 Is the effect of verbal memory direct or mediated?

Evidence of a relationship between memory (in particular working memory), evaluated through verbal tasks, and reading comprehension in school-aged children has given rise to a debate concerning what the nature of that relationship might be. The debate is based on the consideration that tasks evaluating working memory may tap into verbal and semantic skills that may underpin the relationship between working memory and reading comprehension.

It has been extensively demonstrated that verbal ability is strongly related to individual differences in text comprehension ability in school-age children. As reported in the introduction of Study 1 (see Chapter 2 of this work), some authors argued that variation in comprehension skill can largely be accounted for by variation in verbal intelligence and vocabulary knowledge is one of the best predictors of reading comprehension ability (e.g., Ouellette, 2006; Stothard & Hulme, 1996). Results

reported in the first study of the present investigation lend support for an involvement of verbal ability in preschoolers' text comprehension as well. Furthermore, additional evidence for the influence of verbal ability on text comprehension, has been provided by longitudinal studies (de Jong & van der Leij, 2002; Muter et al., 2004; Roth, Speece, & Cooper, 2002).

Given the importance of verbal ability in reading comprehension Stothard and Hulme (1992), suggested that working memory differences among groups of good and poor comprehenders would disappear if differences in verbal intelligence were controlled for. Nation et al.(1999) also compared groups of good and poor comprehenders and proposed that working memory's role is mediated by verbal ability. The authors argued that poor comprehenders have a semantic weakness that restricts their ability to store verbal information in short-term memory and impairs performance on verbal complex span tasks. Their impaired performance on working memory tasks could be due to language difficulties, which have a direct impact on reading and listening comprehension. This conclusion was supported by the finding that no differences were found between good and poor comprehenders in spatial complex span tasks (see also the recent meta-analysis carried out by Carretti et al., 2009).

On the other hand, work that investigated the relations between working memory and reading comprehension in unselected groups of school-age children, has found that working memory emerged as a direct predictor of reading comprehension after controlling for variables related to language comprehension (e.g., Leather & Henry, 1994; Seigneuric et al., 2000). A recent study by Cain, Oakhill, and Bryant (2004) has found a direct relationship between verbal working memory tasks and reading comprehension after controlling for verbal ability. Cain, Oakhill and Bryant (2004) followed a group of 100 children from 7 to 10 years of age and evaluated concurrently their working memory skills using a sentence span and a numerical working memory task. Verbal ability was assessed using two tests of vocabulary knowledge and two subtests (Vocabulary and Similarities) from the Wechsler Intelligence Scale for Children. Relations were found between the two working memory tasks and reading comprehension, with stronger correlations for the sentence span task than for the numerical task. To analyze whether working memory explained significant variance in reading comprehension over and above verbal abilities, the authors carried out a hierarchical regression analysis in which a measure of verbal working memory was entered after controlling for the contribution of verbal ability to reading comprehension. In each of the three age groups, working memory explained unique variance over and above the contributions made by verbal ability. Based on this result, the authors concluded that verbal ability can not entirely account for the relationship between reading comprehension and working memory, which is a specific contributor to reading comprehension

Study 2. Verbal short-term and working memory

3.1.3 Research questions and hypotheses

The current study adopted a methodology similar to that of Cain, Oakhill, and Bryant (2004) to investigate the relationship between text comprehension and verbal memory, controlling for the role of verbal ability; we considered an unselected group of children and performed hierarchical multiple regression analyses to identify specific contributors. Specifically, the present study aimed to:

a) analyze the relation between working memory and listening text comprehension and specifically to verify the hypothesis that working memory is a specific contributor to listening text comprehension in preschool children even after controlling for verbal ability;

b) analyze the relation between short-term memory and listening text comprehension. Studies on the role played by short-term memory have obtained mixed results, however we might expect short-term memory to play a role in text comprehension as found in studies with unselected groups of school-age children and specifically, preschool children (Adams et al., 1999; Daneman & Blennerhassett, 1984; Goff et al., 2005). We also expected that working memory explains additional variance over and above the contribution of short-term memory (Leather & Henry, 1994);

c) analyze the developmental path of the relationship between short-term and working memory, on one hand, and listening text comprehension, on the other hand, from 4 to 6 years of age.

Given these main expectations, an other hypothesis had to be tested firstly: there are differences between backward word span, measuring working memory, and in forward word span, measuring short-term memory, since the backward memory task is more complex than the forward memory task (Alloway et al., 2006).

Study 2. Verbal short-term and working memory

3.2 Method

3.2.1 Participants

The same eighty-four children aged 4 to 5;11 years who took part to Study 1 (Chapter 2 of this work) participated in the present study[11]. For additional information about participants see Study 1.

3.2.2 Materials and procedure

As part of a more wide cross-section project (see Chapter 1 of this work), this study was concerned with three abilities: listening comprehension of short stories (dependent variable), verbal ability (control variable) and short-term and working memory (predictors).

Data for listening text comprehension and verbal ability, namely verbal intelligence and receptive vocabulary, were available from Study 1; in this study the following tests were individually administered (for a detailed description of these tasks see Study 1, Chapter 2 of this work).

Listening text comprehension. Test for Listening Comprehension - TOR 3-8 (Levorato & Roch, 2007) (hereafter TOR 3-8);

Verbal ability (verbal intelligence and receptive vocabulary).

a) Vocabulary and Similarities subtests from the Verbal scale of the WPPSI (Wechsler, 1967 – Italian adaptation by Bogani & Corchia, 1973) which evaluate verbal intelligence;

b) Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981, standardised for Italian speakers by Stella et al., 2000) (hereafter PPVT-R), which evaluates receptive vocabulary.

Two additional tasks were used to evaluate short-term and working memory. These tasks were individually administered in two sessions of 5-10 minutes each, during the same period in which data of the first study were collected.

Short-term and working memory. A forward word span task to evaluate short-term memory skills, and a backward word span task to evaluate working memory were used. Each task consisted of 20 series of list of words (from 2 to 6 words). Four series of words were presented for each list length. The words were bi-syllabic concrete nouns taken from different semantic domains and having the same frequency of use in a child's vocabulary (Marconi, Ott, Pesenti, Ratti, Tarella, 1994) (see Appendix A). They were the same for the two tasks, which were administered at a one-to-two-week distance from each other to control for memory effects. In the forward word span, children were required to repeat the

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[11] Data presented in this study were collected during 2007

list of words in the same order as they were presented by the experimenter (storage of information was required), whereas in the backward word span children had to repeat the word lists in the reverse order (simultaneous storage and processing of information was required). Testing ceased when the child was unable to repeat three out of four series of the same length. One point was credited for each series correctly repeated. Two measures were computed for each participant: a) the number of the series correctly repeated (possible range 0-20); b) the memory span, i.e., the maximum length at which the child was able to correctly repeat three series of words out of four (possible range from 1 - when children were not able to repeated three series at word length two - to 6). Practice trials preceded the experimental trials to ensure comprehension of the tasks (see Appendix A).

The reliability of the forward and backward word span tasks was assessed by calculating Cronbach's Alpha over items. The reliability coefficient was acceptable for forward word span (.58) and good for backward word span (.70).

3.3 Results

3.3.1 Descriptive statistics

All the children completed the memory tasks. Descriptive statistics are reported in Table 1. Data about performance on listening text comprehension and verbal ability are also reported.

Table 1. Mean performance with standard deviations and range

	M	*SD*	Range
Listening text comprehension (TOR 3-8)[a]	10.7	1.8	7-14
Verbal intelligence (VIQ)[b]	9.3	2.4	3-15
Receptive vocabulary (PPVT-R)[c]	80.1	12.1	65-113
Short-term memory (forward span)[d]	7.6	1.4	4-13
Working memory (backward span)[d]	4.5	1.7	0-8

Note.[a] Scaled scores: $M = 10$, $SD = 2$. [b] Scaled scores: $M = 10$; $SD = 3$. [c] Standard scores: $M = 100$, $SD = 15$. [d] Number of series correctly repeated (possible range 0-20).

Performance obtained on the Tor 3-8 and the verbal intelligence subtests was appropriate for age. As far as performance on the PPVT-R was concerned, children performed at a lower level than the

normative population of their age[12] (for a more detailed discussion of these data see Study 1, Chapter 2 of this work).

Forward and backward word span. The average forward memory span was 3 and the average backward word span was 2.2. In Table 1 the number of series correctly repeated is reported. This measure was used in the following analyses since it is a more sensitive measure of the performance level reached by each child than memory span. Neither task suffered from floor effects, but for the backward task the scores were low overall and there was a restricted variability, presumably because the task was very demanding for the young children in this study and the scoring procedure used was very strict. Nonetheless, in both tasks the performance of the two groups seems to be in line with the findings reported by other authors (i.e., Adams et al., 1999; Alloway et al., 2004; Alloway et al., 2006; Gathercole & Adams, 1994).

3.3.2 Comparison between verbal short-term and working memory performance

Based on the findings of Alloway et al. (2006), performance in forward and backward word span tests were compared to analyze differences in the processing load between the two memory tasks. Paired *t*-tests on the number of series correctly repeated in forward and backward word span were computed. Children performed better in the short-term memory task than in the working memory task (t (83) = 13.5, $p < .001$, $d = 1.9$ which corresponds to a large effect). This result confirmed that the backward word span requires more processing resources and measures a more complex ability than forward word span (Alloway et al., 2006).

3.3.3 The role of age and gender

A set of correlational analyses was carried out in order to analyze the relation between gender and age, on one hand, and short-term and working memory (forward and backward word span), on the other hand. No statistically significant correlations were found between the gender of participants and short-term and working memory ($p > .05$), whereas statistically significant correlations were found between age and the two variables ($p < .05$)[13]. Therefore the effect of age was controlled for in the next analyses.

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[12] A parallel set of analyses was carried out excluding eight children who obtained very low performance on the PPVT-R (see Study 1, Chapter 2 of this work); no substantial differences emerged and the analyses were based on all 84 children of the original group.

[13] As it has been shown in Study 1 (Chapter 2 of this work) age but not gender was significantly correlated with listening text comprehension, receptive vocabulary and verbal intelligence.

3.3.4 Interrelations between listening text comprehension, verbal ability, verbal short-term and working memory

Table 2 shows the correlations between listening text comprehension, on one hand, and verbal abilities and verbal memory, on the other hand, controlling for the effect of age.

Table 2. Correlations between listening text comprehension, verbal ability, verbal short-term and working memory (controlling for age)

	1	2	3	4	5
1. Listening text comprehension (TOR 3-8)	-	.41*	.53*	.35*	.30*
2. Verbal intelligence (VIQ)		-	.48*	.11	.14
3. Receptive vocabulary (PPVT-R)			-	.27	.17
4. Short-term memory (forward span)				-	.08
5. Working memory (backward span)					-

* $p = .005$ (Bonferroni correction: $.05/10 = .005$).

Significant correlations were found between listening text comprehension, on one hand, and verbal ability, on the other hand.

Moderate correlations were found between listening text comprehension and both short-term and working memory. No significant correlations were found between short-term and working memory, on one hand, and verbal ability, on the other hand. A correlation between short-term and working memory did not emerge as well.

In sum, based on these results, listening text comprehension is related to verbal short-term and working memory. It is also worth noting that the relations between text comprehension and verbal ability seem to be higher in magnitude than those between text comprehension and verbal memory, therefore an analysis in which the role of verbal ability is taken into account, is crucial to understand the role of verbal memory in listening text comprehension.

The next analysis is aimed at evaluating the specific contribution of these skills to listening text comprehension in 4- to 6-year-olds.

3.3.5 The role of verbal memory in listening text comprehension

To analyze the role of verbal memory in preschoolers' listening text comprehension, a fixed-order hierarchical multiple regression analysis with TOR 3-8 as the dependent variable was carried out. The

order of predictors was selected *a priori* to test our hypothesis. Predictors entered were age in the first step, verbal ability (VIQ and PPVT-R) in the second step, short-term memory (forward word span) in the third step, working memory (backward word span) in the fourth step and the interactions between short-term and working memory, on one hand, and age, on the other hand, in the last step.

Age was entered to test for its effect on listening text comprehension and to test for its interactions with short-term and working memory in the last step. In testing for moderation effects, the variables short-term and working memory and age were standardized to control for problems arising from multicollinearity and to facilitate interpretation of the results (see Study 1, Chapter 2 of this work). In the second step, we entered verbal intelligence and receptive vocabulary to test for their effects on and control for their relation with listening text comprehension. These variables were treated as control variables in order to verify whether verbal memory predicts listening text comprehension after controlling for verbal abilities. Short-term and working memory were added next to the model in order to evaluate whether or not they explained additional variance over and above verbal ability. Short-term and working memory were entered in separate steps in order to evaluate their specific contribution and whether the additional processing requirement of working memory explained additional variance over and above storage, which is involved in both tasks.

Interactions between short-term and working memory, on one hand, and age on the other hand were not significant ($p = .552$; $p = .779$ for short-term and working memory respectively). This result shows that the nature of the relation between memory and listening text comprehension is not moderated by the effect of age, and it is stable between 4 and 6 years.

Consequently, we tested a more parsimonious model in which these interactions were excluded. This model is presented in Table 3.

Study 2. Verbal short-term and working memory

Table 3. Fixed-order hierarchical multiple regression analysis with listening text comprehension as the dependent variable and verbal short-term and working memory as predictors, controlling for age, verbal intelligence and receptive vocabulary

	R^2	ΔR^2	*B*	*SE B*	ß
Step 1					
	.19	.19**			
Age			0.29	0.07	.43**
Step 2					
	.42	.23**			
Age			0.22	0.06	.34**
Verbal intelligence(VIQ)			0.36	0.17	.21*
Receptive Vocabulary (PPVT-R)			0.12	0.03	.34**
Step 3					
	.46	.04*			
Age			0.21	0.05	.32**
Verbal intelligence(VIQ)			0.36	0.17	.21*
Receptive Vocabulary (PPVT-R)			0.10	0.03	.30**
Short-term memory (forward Span)			0.69	0.26	.23**
Step 4					
	.52	.06**			
Age			0.17	0.06	.26**
Verbal intelligence(VIQ)			0.32	0.16	.19*
Receptive Vocabulary (PPVT-R)			0.10	0.03	.29**
Short-term memory (forward Span)			0.65	0.25	.21*
Working memory (backward Span)			0.55	0.20	.23*

* $p < .05$; ** $p < .01$

The model accounted for a substantial amount of variance (52%) in listening text comprehension. Age explained 19% of variability, verbal intelligence and receptive vocabulary accounted for an additional 23% of variance, short-term memory contributed to a significant 4% of variance and working memory, entered in the last step, added an additional 6% of variance.

Results showed that performance on listening text comprehension increases between 4 and 6 years and verbal ability plays a relevant role in preschoolers' text comprehension. As far as the memory variables are concerned, both verbal short-term and working memory were significant predictors of

listening text comprehension over and above verbal ability. Working memory explained additional variance after controlling for short-term memory, showing that the ability to process information in memory accounts for listening text comprehension over the contribution of storage-only capabilities.

In sum, verbal memory gives a specific contribution to text comprehension in preschool children, over and above verbal ability which contribute to listening text comprehension to a large extent.

3.4 Discussion

In this study we adopted an approach similar to that of Cain, Oakhill, and Bryant (2004), who demonstrated that the contribution of verbal working memory to text comprehension is specific and not wholly mediated by verbal ability. We also analysed the role played by verbal short-term memory in listening text comprehension and extended the investigation to preschool children aged between 4 and 6 years. A link between verbal memory and text comprehension was expected on the basis of studies on reading comprehension in school-age children that had found relations between text comprehension and working memory (Cain, 2006; Seigneuric et al., 2000) and studies on both school-age and preschool children (Adams et al., 1999; Daneman & Blennerhassett, 1984; Goff et al., 2005) which found a link with short-term memory (Goff et al., 2005; Leather & Henry, 1994).

We found that short-term and working memory, evaluated using verbal tasks, gave a unique and independent contribution to listening text comprehension after controlling for verbal ability, explaining the 10% of variability in listening text comprehension. The role of verbal memory is stable over the time period we considered. On the whole, these findings suggest that the model proposed by Cain, Oakhill, and Bryant (2004), which has proven valid for school-age children, is valid for preschoolers as well. The method we used is similar to the one adopted by these authors; in particular, we considered a group of unselected children and used hierarchical multiple regression analysis to investigate if verbal memory contributes to listening comprehension over and above verbal ability. Our results differ from those obtained by Nation et al. (1999), who adopted a different method; they compared groups of good and poor comprehenders in verbal and spatial complex span tasks and concluded that memory difficulties associated with poor reading comprehension were specific to verbal domain and were mediated by verbal ability.

The differences between our study and Cain, Oakhill and Bryant's (2004), on one hand and Nation et al.'s (1999), on the other hand deserve further discussion. If we consider the relationship between verbal memory and verbal ability, no significant correlations were found in the current study.

Study 2. Verbal short-term and working memory

An explanation of this result might be found in the type of memory tasks we used, which had a low semantic load, involving only concrete words which were supposed to be familiar for the majority of the children. Therefore, the absence of a significant correlation between verbal ability and memory could be due to the fact that the role of verbal knowledge was reduced in the memory tasks. This hypothesis is in line with the findings of Cain (2006), who did not report any strong relation between short-term memory and verbal ability when vocabulary differences between groups of good and poor comprehenders were controlled for.

Our results seem to support the conclusion that a direct relation exists between memory and listening text comprehension. Future investigations should clarify the conditions under which the ability to store and manipulate verbal material is related to text comprehension in preschoolers and in particular whether (a) only verbal memory is related to listening text comprehension, as shown by Nation et al. (1999), who excluded a role of visuo-spatial memory, and (b) the role of verbal memory depends on the type of verbal material used in memory tasks. It could be argued that partially different results might be obtained according to whether abstract words, as in Nation et al.'s (1999) study, or low-frequency words were used.

Additional information on the relationship between verbal memory and listening text comprehension might be obtained by taking into consideration the type of errors made by preschool children in performing memory tasks. A qualitative observation of our protocols showed that children tended to substitute some words with semantically related words: this suggests that verbal knowledge might intervene in performing memory tasks and that we should exercise some caution when we exclude the possibility that the contribution of memory to listening text comprehension could be affected by verbal knowledge. Indeed, studies that analyzed the short-term recall of sentences in preschoolers found an influence of semantic memory showing that children were more likely to substitute target words in the sentence to be recalled with synonyms rather than unrelated words (Alloway & Gathercole, 2005; Potter & Lombardi,1990).

Another contribution of the current study concerns the analysis of the specific role played by short-term and working memory respectively. Short-term memory played a role in explaining individual differences in listening text comprehension, and working memory specifically contributed to text comprehension over and above short-term memory. Overall, the two functions of memory contribute to listening comprehension to a similar extent, with working memory accounting for slightly more variance. It also worth noting that the two functions had the same effect on listening comprehension between 4 and 6 years of age.

Study 2. Verbal short-term and working memory

Short-term memory explained 4% of variance in listening comprehension after controlling for verbal ability, showing that the function of storage plays a role in the process of listening comprehension; this result might be expected since in preschoolers the simple function of storage and maintenance of information also has to have developed to allow comprehension of complex linguistic information such as texts. This is particularly true considering the nature of a listening comprehension task where the information is available for a short time and therefore might involve greater storage demands than reading comprehension, where the text is at disposal of the reader for all the time needed to carry out processing.

Working memory accounts for a 6% of variance in listening text comprehension over and above short-term memory: This means that not only the maintenance but also the processing of information in memory provides a unique and independent contribution to text comprehension. This result was expected given that a major component of text comprehension is the ability to actively manipulate text information in memory; indeed, the construction of a coherent and meaningful text representation is based on the ability to integrate newly encountered information with that which has been previously acquired and with world knowledge (Kintsch, 1988). This finding confirms evidence from elementary school children showing that complex span tasks, which require the simultaneous storage and processing of information in memory, explained additional variance with respect to simple span tasks (Leather & Henry, 1994).

As far as the relations between short-term and working memory are concerned, we found that forward and backward word span did not share a large amount of variance. Previous studies involving school-age (e.g., Leather & Henry, 1994) and preschool children (e.g., Adams et al., 1999) also found weak correlations between complex and simple span tasks, although not so weak as those found in the current study. This result was explained considering the different abilities involved in the two tasks as found in recent studies that analyzed the structure of memory in preschool-age with reference to Baddeley's (1986) model (Alloway et al., 2006). Alloway et al. used, among other tasks, simple span measures which are purported to tap into verbal short-term memory (storage component), and complex span measures, which tap into more executive resources (processing component) in children between 4 and 6 years of age. These authors found evidence that verbal short-term memory span tasks tap into a single factor that corresponds to a storage-only component for verbal material, whereas complex span tasks also involved a second factor that corresponds to a processing component or central executive. This result suggests that the abilities underlying the two memory tasks are partially independent.

Study 2. Verbal short-term and working memory

In conclusion, results obtained in this study with children aged 4-6 years are similar in various aspects to findings previously obtained with school-age children:

a) working memory contribute to individual differences in text comprehension (Cain, 2006; Leather & Henry, 1994; Seigneuric et al., 2000);

b) working memory explains additional variance in text comprehension over and above verbal ability (Cain, Oakhill, & Bryant, 2004);

c) working memory accounts for additional variance in text comprehension over and above short-term memory (Leather & Henry, 1994);

d) the amount of variance explained by verbal ability and verbal memory (33%) is comparable to that explained in other studies analysing the role of the same variables (e.g., Cain, Oakhill and Bryant, 2004; Oakhill et al., 2003, see the regression analysis for 7 - 8 year - old children at Time 1) and of vocabulary knowledge and working memory (Seigneuric & Ehrlich, 2005; Seigneuric et al., 2000).

Overall, these findings suggest that similar phenomena underlie text comprehension in preschoolers and in school-age children, and listening text comprehension is based on the same components that have been shown to underpin reading comprehension. In order to further explore the role of other theoretically relevant components in preschoolers' listening text comprehension, in the study presented in the next chapter other lower-level linguistic component skills namely the ability to understand sentences (i.e. syntactic knowledge), and text-level components namely the ability to use the linguistic context, have been considered.

Chapter 4

Study 3. The Relationship Between Text and Sentence Comprehension in Preschoolers: Is it Specific or Mediated by Lower- and Higher-Level Components?

4.1 Introduction

The two studies presented in this chapter aimed to analyze the relation between sentence comprehension (i.e., syntactic knowledge) and listening text comprehension in 4- to 6- years-olds. In the first study (Study 3A) the role of sentence comprehension was analyzed taking into account the role played by possible lower-level mediators, namely verbal ability (i.e., verbal intelligence and receptive vocabulary) and verbal working memory. Given that sentences forming a text are not processed in isolation but in context, the second study (Study 3B) explored the role of the ability to use linguistic context, a higher-level component, in sentence and text understanding. In the next paragraphs the literature on the relations between text and sentence comprehension is reviewed.

4.1.1 The relation between sentence and text comprehension

The ability to work out the syntactic structure of a sentence in order to construct its meaning, is based on the use of syntactic knowledge, a kind of knowledge which is hypothesized to be implicit. To date few studies have investigated the relation between sentence and text comprehension (much more work has been done on the role of syntactic awareness, which is regarded as explicit metalinguistic knowledge, see Chapter 1 of this work). The understanding of linguistic information at sentence- level is necessary, although not sufficient, for text understanding, therefore, the existence of a relationship between the level of sentence and text comprehension should be expected. However, studies which have considered this relation have reported mixed and contradictory results As a consequence the role played by sentence comprehension in text comprehension is not clear (Cain & Oakhill, 2007). In the following paragraphs, the factors that might explain these contradictory results obtained in studies on both selected and unselected groups of children were considered.

Stothard and Hulme (1996) considered groups of good and poor comprehenders and found sentence comprehension to be associated with reading comprehension. In this study the CAM design was used (see also Study 1, Chapter 2 of this work); the performance of poor comprehenders was compared to that of two control groups, one of age-match controls and a younger group matched for comprehension age, on one of the most widely used tests of sentence comprehension, the Test for the Reception of Grammar (TROG) (Bishop, 1983). The TROG measures a range of grammatical concepts

(e.g., gender, personal pronouns, comparatives and so on) and requires the child to indicate which picture out of four corresponds to a sentence read by the experimenter. In this study, poor comprehenders performed significantly worse on the TROG than age-matched controls and at a similar level to younger children matched for comprehension level. The authors concluded that the difficulties poor comprehenders had in sentence comprehension might mirror their lower verbal ability; in fact, the poor comprehenders had lower verbal IQs than the age-match controls. The implication of this interpretation is that verbal ability is an important predictor of reading comprehension, and in order to evaluate the role played by the ability to understand sentences in reading comprehension, the role of verbal ability also has to be taken into account.

Results obtained by Nation et al. (2004) and Cain. Patson, et al. (2005) seem to support the interpretation proposed by Stothard and Hulme (1996). Nation et al. (2004) compared the performance of 8-year-old poor comprehenders with fluent and accurate reading skills and normal nonverbal ability to that of a control group matched for age and decoding ability, on different measures of morphosyntax that involved expressive skills (recalling sentences and a past tense elicitation task). Results showed that poor comprehenders performed less well than good comprehenders on tests of morphosyntax as well as in tasks assessing verbal ability (Word Definition and Similarities from the British Ability Scales - BAS). Therefore, as in Stothard and Hulme (1996), it may be concluded that difficulties with morphosyntax are mediated by difficulties with verbal ability. Cain, Patson et al. (2005) considered performances of good and poor comprehenders, aged 8 and 9 years, on a reduced version of the TROG, finding comparable performance for the two groups. This result supports the absence of a direct relation between text and sentence comprehension. In this study, the two groups were matched for receptive vocabulary (British Picture Vocabulary Scale - BPVS) and word reading ability, suggesting that when differences in verbal ability are controlled for, no differences in comprehension at the sentence-level emerge (see also Yuill & Oakhill, 1991).

Roth et al. (2002), analyzed the relation between oral language development and early reading development in unselected groups of children followed from kindergarten to second grade. The main aim of the study was to identify parsimonious models of reading comprehension using a broad range of oral language and reading ability measures. Both first and second graders' text comprehension was related to a measure of receptive morphology and syntax which assesses the comprehension of word classes, grammatical morphology and sentence structures. In the study, however, the relation between sentence and text comprehension was evaluated without taking into account a possible mediating role of verbal ability.

Study 3. Sentence comprehension and the ability to use linguistic context

In another longitudinal study, Oakhill et al. (2003) analyzed the contribution of several theoretically relevant components, among which sentence comprehension, in accounting for reading comprehension in primary school children at the age of 7-8 and 8-9 years (Time 1 and Time 2, respectively). Sentence comprehension was evaluated using the TROG and results showed that it accounted for reading comprehension after controlling for age, non verbal and verbal intelligence (pro-rated using the Wechsler Intelligence Scale for Children - WISC) and receptive vocabulary (BPVS), when children were 8-9 but not when they were 7-8 year-olds. Explanations brought forward for this discrepancy in the results were, on one hand, the existence of possible developmental differences in the influence of syntactic knowledge on text comprehension and, on the other hand, the absence of appropriate controls for individual differences in verbal working memory. In fact, Oakhill and colleagues (2003) hypothesized that the items which discriminated between good and poor comprehenders had a high processing component, and therefore, verbal working memory, which in turn is linked to text comprehension (see Study 2, Chapter 3 of this work), might explain individual differences in the older age group. Indeed, a much higher correlation between the TROG and verbal working memory was evident at Time 2 than at Time 1. This interpretation supported the importance of taking into account the role of verbal working memory when examining the role of sentence comprehension in text comprehension.

Goff et al., (2005), analyzed the relation between reading comprehension and sentence comprehension, controlling for the influence of various measures of visuo-spatial and verbal working memory in a unselected group of third to fifth graders (age range from 7-8 to 10-11 years). The authors found differences with respect to the results reported by Oakhill et al. (2003) for children aged 7-8 years; sentence comprehension, evaluated using the TROG, predicted reading comprehension after controlling for the role of memory and other control variables (age, non verbal intelligence, receptive vocabulary).

4.1.2 The relation between sentence and text comprehension: What can we conclude?

The literature presented above reports a somewhat mixed set of results concerning the relation between text and sentence comprehension. The lack of consistency between studies on the role of sentence comprehension is difficult to explain, considering that most of them used the same standardized assessment of grammar, the TROG. However, the inconsistency might be accounted for by (a) the different group selection criteria (Cain & Oakhill, 2007), (b) the existence of developmental differences in the influence of syntactic knowledge on text comprehension, given that the above

mentioned studies considered children of different ages (Oakhill et al., 2003), and (c) the control variables taken into account in the evaluation of the relation between sentence and text comprehension. As stated in the previous section, the relation between sentence and text comprehension might be mediated by verbal ability and verbal working memory. However, none of the previous studies took into account all of these control variables concurrently.

4.2 Study 3A.

The present study aimed to analyze the role played by sentence comprehension in text comprehension in preschoolers, taking into account the role of verbal ability and working memory as possible mediators.

In order to analyze the relation between sentence and text comprehension, we adopted a standardized Italian test similar to the TROG which is used by researchers and speech and language therapists (see below). As far as memory is considered, we adopted a measure of verbal working memory (i.e., a measure of both storage and processing function of memory) rather than one of short-term memory (e., a measure of storage function of memory) because working memory has been shown to be related to preschoolers' listening text comprehension and to account for additional variance in listening text comprehension over and above short-term memory (see Study 2, Chapter 3 of this work). In addition, short-term memory has been shown to be involved in sentence repetition, whereas it plays a minor role in sentence comprehension in children aged 4 and 5 years (Willis & Gathercole, 2001).

4.2.1 Method

4.2.1.1 Participants

One-hundred and sixty-two children aged 4 to 5;11 years (mean age = 4 years and 9 months, *SD* = 6 months) participated to the study[14]. Fifty-six percent of the participants were male and 44% were female. The children attended kindergartens located mainly in the North of Italy and came from families living in middle and lower socio-economic catchment areas. All the children spoke Italian as their first language. According to their teachers, none of these children had cognitive impairments or language difficulties. Parental consent was obtained for each child.

4.2.1.2 Materials and procedure

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[14] Data presented in this study were collected during 2007 and 2008

Study 3. Sentence comprehension and the ability to use linguistic context

As part of a more wide cross-section project (see Chapter 1 of this work), the present study focused on listening text comprehension of short stories (dependent variable), verbal ability and verbal working memory (control variables) and sentence comprehension (predictor) which were evaluated in three sessions of about 15 minutes each. The tasks used to evaluate the above mentioned skills are described below. All the tasks were individually administered in a quiet area of the school in order to guarantee the children remained attentive.

Listening text comprehension. Test for Listening Comprehension - TOR 3-8 (Levorato & Roch, 2007) (hereafter TOR 3-8) (for a detailed description of this test see Study 1, Chapter 2 of this work).

Verbal ability (verbal intelligence and receptive vocabulary). Children's verbal ability was evaluated through:

a) Vocabulary and Similarities subtests from the Verbal scale of the WPPSI (Wechsler, 1967 - Italian adaptation by Bogani & Corchia, 1973) which evaluate verbal intelligence;

b) Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981, standardised for Italian speakers by Stella et al., 2000) (hereafter PPVT-R), which evaluates receptive vocabulary (for a detailed description of these tests see Study 1, Chapter 2 of this work).

Working memory. A backward word span task was used to evaluate working memory (for a detailed description of this test see Study 2, Chapter 3 of this work). The reliability for the backward word span task, which was assessed by calculating Cronbach's Alpha over items, was good (.66).

Sentence comprehension. The Prova di Valutazione della Comprensione Linguistica [Test for the Evaluation of Linguistic Comprehension] (Rustioni & Associazione "La Nostra Famiglia", 1994) (hereafter PVCL) was used to evaluate sentence comprehension. The test was standardized on children between the ages of 3;6 and 8 inclusive and is similar in structure and procedure of administration to the Test of Reception of Grammar-TROG (Bishop, 1983). Sentences contain salient morphosyntactic cues such as gender and number agreement, conjunction, negation, different types of phrasal structures, i.e. relative, passive, temporal, and so on. The children, who were presented with the form of the test appropriate for their age, were required to choose among a set of four pictures, the one that correctly represented the sentence spoken by the experimenter. One point was credited for each correct answer and the percentage of correct answers was the total raw score. Raw scores can be converted into weighted scores ranging from 0 to 100; these scores evaluate children's overall performance taking into account not only the number of correct answers but also the level of difficulty of each item. Children's performance may be classified into 7 levels (from a non-sufficient level to a very good level) based on this weighted score.

4.2.2 Results

4.2.2.1 Descriptive statistics

All the children completed the tasks. Table 1 shows the descriptive statistics.

Table 1. Mean Performance With Standard Deviations and Range

	M	*SD*	Range
Listening text comprehension (TOR 3-8) [a]	10.7	1.8	7-15
Verbal intelligence (VIQ) [b]	10.1	2.3	3-16
Receptive vocabulary (PPVT-R) [c]	84.6	14.3	65-123
Working memory (backward span) [d]	4.4	1.5	0-8
Sentence comprehension (PVCL) [e]	55.7	17.9	0-91

Note. [a] Scaled scores: $M = 10$, $SD = 2$. [b] Scaled scores: $M = 10$; $SD = 3$. [c] Standard scores: $M = 100$, $SD = 15$. [d] Number of series correctly repeated (possible range 0-20). [e] Standards scores ranging from 0 to 100.

Listening text comprehension. Performance on the test of listening text comprehension (TOR 3-8) was appropriate for age and ranged from 1.5 *SD* below the mean to 2.5 *SD* over the mean.

Verbal intelligence. Children's average verbal intelligence was appropriate for their age and performance ranged from about 2 *SD* below the mean to about 2 *SD* over the mean.

Receptive vocabulary. On the receptive vocabulary task (PPVT-R), performance ranged from the standard score of 65 (about 2 *SD* below the mean) to the standard score of 123 (about 2 *SD* above the mean). The average performance laid at the lower boundary of the range appropriate for age, the standard deviation was comparable to that of the national standardization sample. This result suggested that the range of performance was normal and unrestricted and probably reflected the socio-economic status of the participants (for a more detailed discussion of this point see Study 1, Chapter 2 of this work).

Working memory. The average backward word span was 2.2. Table 1 reports the number of series correctly repeated. These results are similar to those reported in Study 2 (Chapter 3 of this work). This measure was used in the following analyses since it is a more sensitive measure of the level reached by each child than memory span.

Sentence comprehension. Children obtained an average score of about 56 out of a maximum score of 100; this score correspond to medium-level performance. Considering individual performance,

the 70% of participants performed at a medium level (i.e., performance at the medium-low, medium and medium-high levels) while the remaining 30% performed at lower or higher levels (i.e., performance at the insufficient, scarce or good and very good levels).

4.2.2.2 The role of age and gender

A set of correlational analyses was carried out in order to analyze the relation between gender and age, on one hand, and listening text comprehension (TOR 3-8), receptive vocabulary (PPVT-R), verbal intelligence (VIQ), working memory (backward word span) and sentence comprehension (PVCL), on the other hand. No statistically significant correlations were found between gender of participants and the component skills considered in the present study ($p > .05$). Statistically significant correlations were found between age and all the other variables ($p < .05$) with the exception of the sentence comprehension task (PVCL). In the latter task, different forms were used for different age-groups, therefore a non significant correlation with age was expected. The role of age was controlled for in the next analyses.

4.2.2.3 Correlations between listening text comprehension, verbal ability, verbal working memory and sentence comprehension

Table 2 shows the correlations between listening text comprehension, verbal ability and verbal working memory (control variables) and sentence comprehension, controlling for the effect of age.

Table 2. Correlations between listening text comprehension, verbal intelligence and receptive vocabulary, verbal working memory and sentence comprehension (controlling for age)

	1	2	3	4	5
1. Listening text comprehension (TOR 3-8)	-	.43*	.49*	.27*	.26*
2. Verbal intelligence (VIQ)		-	.56*	.15	.27*
3. Receptive vocabulary (PPVT-R)			-	.18	.38*
4. Working memory (backward span)				-	.09
5. Sentence comprehension (PVCL)					-

* $p = .005$ (Bonferroni correction: $.05/10 = .005$).

A significant correlation was found between listening text comprehension and sentence comprehension. Considering the control variables, the ability to understand a text was related to both verbal ability and verbal working memory. Sentence comprehension was not significantly correlated with verbal working memory, instead it was related to both variables that assessed verbal ability. In sum, performance on the tasks that evaluated linguistic comprehension at word-, sentence-, and text-level correlated with each other, whereas working memory was related only to listening text comprehension.

The above described correlational pattern suggests the existence of a relation between sentence comprehension and listening text comprehension in preschoolers. However, the present analysis did not clarify whether the relation between text and sentence comprehension is mediated by control variables, as suggested by previous work. This possibility is also suggested by our results, which showed a correlation between sentence comprehension and verbal ability. The next analysis explored the relation between preschoolers sentence and text comprehension, taking into account the contribution of the control variables, namely verbal ability and verbal working memory.

4.2.2.4 Listening text comprehension: the contribution of sentence comprehension

In order to analyze the specific role played by sentence comprehension in text understanding, a fixed-order hierarchical multiple regression analysis with the number of correct answers on the TOR 3-8 as the dependent variable, was carried out. We established *a priori* the order with which the different components were entered in the model; age in the first step, verbal intelligence and receptive

vocabulary in the second step, working memory in the third step and sentence comprehension in the fourth step. In the fifth step we tested for interactions between age and sentence comprehension.

Age was entered first to test for its effect on text comprehension and to test for its interaction with sentence comprehension in the last step: The use of the interaction term allowed us to test for a possible moderation effect of age on the relation between sentence and text comprehension. In testing for this moderation effect, the variables sentence comprehension and age were standardized to control for problems arising from multicollinearity and to facilitate interpretation of the results (for further details about this procedure see Study 1, Chapter 2 of this work). In order to test for the specific and unique contribution of sentence comprehension to listening text comprehension, verbal intelligence and receptive vocabulary were entered at the second step and verbal working memory at the third step.

The interaction between age and sentence comprehension did not explain a significant amount of variance ($p = .10$): age did not operate as a moderator in the relation between sentence and listening text comprehension which was stable between 4 and 6 years. Consequently, we tested a more parsimonious model in which this interaction was excluded. The final model is presented in Table 3.

Study 3. Sentence comprehension and the ability to use linguistic context

Table 3. Fixed-order hierarchical multiple regression analysis with listening text comprehension as the dependent variable, sentence comprehension as predictor, and age, verbal intelligence, receptive vocabulary, and verbal working memory as control variables

	R^2	ΔR^2	B	SE B	β
Step 1	.19	.19**			
Age			0.29	0.05	.44**
Step 2	.39	.20**			
Age			0.25	0.04	.38**
Verbal intelligence (VIQ)			0.40	0.13	.23**
Receptive vocabulary (PPVT-R)			0.08	0.02	.28**
Step 3	.43	.04**			
Age			0.21	0.04	.33**
Verbal intelligence (VIQ)			0.36	0.13	.20**
Receptive vocabulary (PPVT-R)			0.08	0.02	.27**
Working memory (backward span)			0.54	0.18	.20**
Step 4	.44	.01			
Age			0.21	0.04	.32**
Verbal intelligence (VIQ)			0.35	0.13	.20**
Receptive vocabulary (PPVT-R)			0.07	0.02	.25**
Working memory (backward span)			0.53	0.18	.20**
Sentence comprehension (PVCL)			1.65	1.54	.07

**p<.01*

The model accounted for 44% of variance in listening text comprehension, 19% of which was explained by age, 20% by verbal intelligence and receptive vocabulary, and 4% by working memory; all the contributions were significant. Sentence comprehension did not explain a significant additional amount of variance.

The final model (see Step 4) showed that performance on TOR 3-8 improved between 4 and 6 years. Verbal IQ, receptive vocabulary and verbal working memory were significant predictors of listening text comprehension. Instead, the ability to understand sentences was not a specific contributor of text comprehension in the age range considered.

4.2.2.5 Discussion

The present study aimed at investigating the relation between sentence and text comprehension in preschool children. In the current study the role of possible mediators, namely verbal ability (verbal intelligence and receptive vocabulary) and verbal working memory, has been considered. Although a moderate correlation was found between sentence and text comprehension, the ability to understand sentences did not account for additional variance in preschoolers' listening text comprehension over and above verbal ability and working memory, in line with findings of Oakhill et al. (2003) and Stothard and Hulme (1996). In other words, even though a text is constituted by sentences, the ability to identify syntactic relations between the constituents of sentences did not explain individual differences in text comprehension, instead, the role played by sentence comprehension is mediated by more basic linguistic and cognitive components. The mediators explained individual differences in listening text comprehension in line with the results emerged in Study 1 and 2 (see Chapter 2 and 3 of this work). In sum, these findings showed that the syntactic knowledge necessary for understanding isolated sentences does not play a crucial role in establishing the meaning of the text, at least when verbal ability and working memory are taken into account. It might be observed that the sentence comprehension task we adopted in the present work, evaluates complex syntactic constructions, the knowledge of which might not be required to understand the rather simple sentences found in the TOR 3-8. On the other hand, multicomponent approaches of text comprehension emphasize that the construction of a coherent mental representation of the text is based not only on lower-level components but also on higher-level integrative processes. The comprehension of words and sentences in a text might be affected by these higher-level components. In fact, a text is not constituted by a set of isolated words and sentences, but by words and sentences which are related and embedded in a meaningful linguistic context; moreover, the ability to use linguistic context is related to text comprehension via its influence on word and sentence comprehension in a text (Cain & Oakhill, 2004). Therefore, it is possible to hypothesize that partially different component skills might be used in the understanding of isolated sentences and sentences integrated within a text; these component skills include the ability to use linguistic context, which corresponds to the ability to use semantic information provided by the context in order to understand complex linguistic information, such as sentences. Strictly speaking, the meaning of a sentence embedded in a meaningful context is not constructed per se, but is related to the meaning of sentences preceding in the text, which in turn is the result of the integration of explicit information in the text and previously acquired world knowledge.

Study 3. Sentence comprehension and the ability to use linguistic context

The ability to use linguistic context has been analyzed mainly with reference to word reading ability (e.g., Nation & Snowling, 1998a), new vocabulary acquisition (e.g., Cain, Oakhill, & Lemmon, 2004), and the comprehension of multiword linguistic expressions such as idioms (for additional information see Chapter 1 of this work). Studies on children from 5 to 9 years of age have shown that the comprehension of transparent or decomposable idioms benefited from the presence of context that also supported their semantic analysis (i.e., the ability to analyze the internal semantics of a sentence), suggesting an early sensitivity to the ability to use context in sentence comprehension (e.g., Cain et al., 2009; Levorato & Cacciari, 1999). Moreover, studies on groups of good and poor comprehenders have reported a clear relation between the ability to use the context of a story in idiom understanding and text comprehension (e.g., Cain, Oakhill et al., 2005; Levorato & Cacciari, 1992; Levorato et al., 2004; Levorato et al., 2007; Nesi, Levorato, Roch & Cacciari, 2006).

In order to further clarify the nature of the relation between sentence and text comprehension and to establish whether the ability to use linguistic context to construct the meaning of sentences contributes to text comprehension, a second study was carried out in which the same sentences presented in isolation in the first study were accompanied by a brief linguistic context.

4.3 Study 3B

Based on the hypotheses that preschool children use partially different skills in understanding sentences in context and out of context and that the use of a linguistic context contributes to constructing text meaning, we carried out a second study with the same children who participated in the first one. In the second study, the sentence comprehension test used in the first study (PVCL), was modified by embedding each target sentence in a brief linguistic context consisting of about three simple sentences placed before the target sentence. The children's performance on this task was analyzed with reference to (a) performance on the test of sentence comprehension out of context (PVCL), in order to analyze the role of context in sentence comprehension, and (b) performance on the TOR 3-8, in order to analyze its relation with listening text comprehension.

Based on the literature presented in the Discussion of the previous study (e.g., Cain et al., 2009; Levorato et al., 2007), we hypothesized that (a) preschoolers showed an early sensitivity to the use of context in sentence comprehension, and (b) preschoolers' ability to use context in sentence comprehension contribute to their listening text comprehension.

Study 3. Sentence comprehension and the ability to use linguistic context

4.3.1 Method

4.3.1.1 Participants

The one-hundred and sixty-two children aged 4 to 5;11 years who participated in Study 3A, took part to this study. For additional information on the characteristics of the participants see Study 3A.

4.3.1.2 Materials and procedure

Sentence comprehension in context. In order to evaluate the ability to understand sentences in context, the same items of the Prova di Valutazione della Comprensione Linguistica (PVCL) used in the previous study were embedded in a meaningful and wider linguistic context of two or three sentences, in which the sentence to be understood was the final one (hereafter we will refer to this test as PVCL in context; for an example of the material presented in this task see Appendix B). As in the original version of the PVCL, children were required to identify which picture out of four correctly represented the target sentence. One point was credited for each correct answer and the percentage of correct answers was the total raw score. The test was administered to the children approximately two weeks after the first study in one session of about 15 minutes. We believe that a two-week lapse between sessions was suitable for a comparison with performance on the PVCL and the other tests administered in Study 3A, and sufficient to exclude memory effects.

A group of 25 undergraduate students who did not know the final aim of the research, participated in a preliminary investigation aimed at evaluating the probability of choosing the correct answer after reading the context that preceded each target sentence. The students were not presented with the PVCL sentences themselves, but only with a brief text (i.e., the linguistic context, see the example reported in Appendix B) and the set of four pictures related to each target sentence. They were then asked to choose the picture that fit the text. It emerged that the choice of each of the four pictures was equiprobable and the choices that were appropriate to the target sentence were as probable as any other ($p > .05$). We are therefore confident that the linguistic context used did not in itself provide any indications that would lead the participants to identify the figure corresponding to the target sentence.

4.3.2 Results

4.3.2.1 The effect of linguistic context

All the participants completed the PVCL in context. A paired t-test on the performance (proportion of correct answers) on the test of sentence comprehension out of context (PVCL; $M = 0.6$; $SD = 0.2$;

range 0-.9) and on the test of sentence comprehension in context (PVCL in context; $M = 0.7$; $SD = 0.2$; range 0.2-1) was computed to compare performance on the two tasks. Preschoolers performed better on the test of comprehension of sentences in context than on the test of comprehension of sentences out of context (t (161) = 7.9, $p < .001$, $d = 0.6$, which corresponds to a medium effect-size). This result indicated the children's early sensitiveness to the use of linguistic context in sentence understanding: Better performance on the test of sentence comprehension in context was due to the additional semantic information provided by the context, which made the sentence more plausible and meaningful.

4.3.2.2 Correlations between listening text comprehension and comprehension of sentences in and out of context

The correlations between listening text comprehension (TOR 3-8), comprehension of sentences in and out of context (PVCL in context and PVCL) were computed controlling for the effect of age[15]. We only reported and discussed the new data emerged in Study 3B; significant correlations were found between listening text comprehension and the ability to understand sentences in context, and between the latter variable and the ability to understand sentences out of context ($r = .39$ and $r = .46$, $p < .017$ – Bonferroni correction .05/3 = .017). These results showed that, as expected, the comprehension of sentences in context was related to both text comprehension and the ability to understand the same sentences out of context.

The next analysis explored whether the ability to use the linguistic context specifically contributes to preschoolers' listening text comprehension.

4.3.2.3 Listening text comprehension: Is the ability to use linguistic context a specific contributor?

In order to analyze whether the ability to use linguistic context to understand sentences contributed to listening text comprehension, we carried out a fixed-order hierarchical multiple regression analysis where the dependent variable was the number of correct answers on the TOR 3-8. This analysis was similar to the one carried out in Study 3A; the only difference was that the ability to understand sentences in context (PVCL in context) entered the model at the fifth step, after all the predictors considered in the previous study (age, verbal intelligence and receptive vocabulary, working memory and the ability to understand sentences out of context - PVCL). A significant effect of the

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[15] A preliminary analysis showed a significant correlation between sentence comprehension in context and age ($r = .32$; $p <.01$) and no significant correlation with gender.

ability to understand sentences in context over and above the other predictors would mean that the ability to use context to understand sentences has an impact on listening comprehension between 4 and 6 years of age. Finally, in the sixth step we entered the interaction between age and the ability to use context in sentence comprehension to test for a possible moderation effect of age on the relation between the ability to use linguistic context and text comprehension. In the interaction term (a) the measure of the ability to use context was constituted by the standardized residuals computed in a separate regression analysis, in which the ability to understand sentences in and out of context (PVCL in context and PVCL) were the dependent and independent variable respectively; and (b) the variable age, as in the previous studies, was standardized.

The interaction between age and the ability to use linguistic context was not significant ($p = .22$), showing that the role played by this ability in listening text comprehension is stable between 4 and 6 years. Consequently, we tested a more parsimonious model in which this interaction was excluded. This model is presented in Table 4.

Table 4. Fixed-order hierarchical multiple regression analysis with listening text comprehension as the dependent variable, the ability to understand sentences in context as predictor and age, verbal intelligence, receptive vocabulary, verbal working memory and sentence comprehension out of context as control variables

	R^2	ΔR^2	B	SE B	β
Step 1	0.19	.19**			
Step 2	0.39	.20**			
Step 3	0.43	.04**			
Step 4	0.44	.01			
Step 5	0.46	.02*			
Age			0.19	0.04	.29**
Verbal intelligence (VIQ)			0.34	0.13	.19**
Receptive vocabulary (PPVT-R)			0.06	0.02	.21**
Working memory (Backward span)			0.45	0.18	.17*
Sentence comprehension (PVCL)			0.35	1.63	.02
Sentence comprehension in context (PVCL in context)			4.02	1.78	.17*

** $p < .01$; * $p < .05$

The model accounted for 46% of the variance in listening text comprehension. As already showed in the first study, predictors entered in the first four steps explained 44% of variability. The ability to understand sentences in context explained an additional 2% of variance, which was significant.

In sum, a relevant new finding emerged from the present analysis; the ability to use the linguistic context to understand sentences, differently from the ability to understand isolated sentences, contributed to explain individual differences in preschoolers' listening text comprehension.

4.3.2.4 Discussion

The second study of the present paper aimed to test the hypotheses that partially different skills are used by preschoolers when they are required to process sentences in or out of context and that the

ability to use the linguistic context accounts for individual differences in listening text comprehension. In order to test for these hypotheses, children who took part in Study 3A were presented with the same sentences used in that study and embedded in a meaningful context.

Children's ability to understand sentences improved when the target sentence was embedded in a brief linguistic context; this result is in line with work that analyzes the role of context in the comprehension of ambiguous expressions (e.g., Cain et al., 2009; Levorato & Cacciari, 1999). The crucial result of the second study emerged from the regression analysis: the ability to exploit contextual information contributes to text understanding and is related to text comprehension via its influence on sentence comprehension (Cain & Oakhill, 2004). Young children, at an even earlier age than verified in previous work, are able to use semantic information provided by the context, applying integrative processes that require the use of information presented in the text, to understand sentences.

4.4 General discussion of the studies 3A and 3B

The relation between text and sentence comprehension has been scantly analyzed in school-age children, and, to date, a common conclusion on the role played by sentence comprehension in text comprehension has not been reached. It was argued that the mixed results obtained in previous studies arise from the numerous factors that might affect the relation, specifically basic cognitive and lower-level linguistic components that may mediate the relation between sentence and text understanding. The two studies reported in the present paper focused on the above mentioned relationship in preschoolers; the first study took into account the relevant lower-level linguistic and basic cognitive components (i.e., verbal ability and verbal working memory) that may affect the relation, and the second study tested an additional, still unexplored, hypothesis which considered the role of a higher-level component, namely the ability to use linguistic context. The present investigation, therefore, not only extended the analysis of the components involved in text comprehension to younger children, but elaborated on the data presented in the literature on the relation between sentence and text comprehension, exploring innovative explanations.

The overall pattern of results, showed that listening text comprehension ability is related to lexical, semantic, cognitive and pragmatic skills, whereas syntactic knowledge does not play a specific role. In fact, Study 3A showed that the role played by the ability to understand isolated sentences was mediated by lower-level lexical, semantic and cognitive components, and Study 3B showed that the comprehension of sentences embedded in a text was mediated by a higher or text-level component, that

is the ability to use linguistic context. The use of context can be considered a higher- or text-level component of text comprehension in that it requires to process information at a global level. In fact the processing of the semantic information provided by the context implies that the meaning of a sentence is integrated with previously processed sentences which meaning, in turn, has already been integrated with both world knowledge and the preceding parts of the text (Kintsch, 1998). Therefore, the use of context is based on the ability to integrate new information (i.e., the meaning of the target sentence in the test of sentence comprehension in context), with previously information in the text (i.e., the two or three sentences placed before the target sentence in the test of sentence comprehension in context), in order to up-date the comprehension process. Thanks to this process, the sentence is integrated into a global semantic representation of the linguistic information, which makes the sentence more plausible and meaningful.

The importance of integrative process for sentence comprehension and in turn for text comprehension, is also supported by findings that groups of good and poor comprehenders showed difficulties in specific areas of syntactic knowledge, such as the understanding of anaphoric devices and inter-sentence conjunctions (Cain, Patson et al., 2005; Yuill & Oakhill, 1991). These morphosyntactic elements are devices of cohesion and coherence that promote the identification of the connections between different parts in a text and the construction of its overall meaning. This consideration might explain why intra-sentence syntactic elements, which are not crucial for text cohesion and coherence, did not explain individual differences in text understanding.

The findings of this study have relevant applications in education. These results emphasize the importance of educational practices and interventions aimed to improve the ability to use semantic information provided by the context to inform meaning at word-, sentence-, and text- or discourse-level. These practices and interventions should focus on the context as a source of relevant information and on the ability to integrate linguistic information. To date, support for teaching methods aimed at improving the ability to acquire information, such as vocabulary knowledge, through the use of context come form studies on school-age children. For instance, Nash and Snowling (2006) reported that a method based on the use of context was more effective than a method based on the use of word-definitions, in improving vocabulary knowledge and reading comprehension in 7-8 year-old children with poor vocabulary knowledge. One potential explanation for the greater efficiency of the context method, was that presenting a word in context provided more semantic, syntactic and pragmatic information that create well specified semantic representations of the word's meaning. The results of the present paper extend previous literature on the use of context in vocabulary acquisition and

comprehension of ambiguous expressions in school-age children (e.g., Cain, Oakhill, & Lemmon, 2004; Cain et al., 2009; Levorato & Cacciari, 1999) showing that 4 to 6 year-olds are able to use semantic information provided by the context, and suggest that this kind of practices and interventions might also be suitable for younger children.

To conclude, the results of the present paper are in line with claims that text comprehension involves not only lower-level but also higher-level components, such as the ability to use the linguistic context. The ability to use context requires the processing of linguistic information at a global-level and it involves the ability to integrate information in the text. The role of higher- level integrative processes in preschoolers' listening text comprehension has been considered in the study presented in the next chapter in which the role of inferential skills is analyzed with reference to the ability to understand explicit and implicit information in a text.

Chapter 5

Study 4. Comprehension of Explicit and Implicit Information in a Text: The Role of Verbal Ability and Inferential Skills

5.1 Introduction

The present study aimed to: (a) investigate preschool children's ability to understand explicit information (i.e., information presented in the text) and implicit information (i.e., information inferable from the text or from previous knowledge) in oral texts; (b) identify the role of verbal and inferential skills with regard to the processing of explicit and implicit information between 4 and 6 years.

The process of meaning construction involved in text comprehension requires the reader/listener to apply linguistic and world knowledge to understand both information explicitly presented in the text and implicit information that can be inferred from the text (Kintsch, 1998; Kintsch & Kintsch, 2005). Therefore the understanding of explicit and implicit information in a text represents two fundamental abilities which are involved in text processing. Studies on school-age children have shown that they are better at understanding and remembering explicit information and that poor comprehenders differ from good comprehenders in their ability to perform a deep analysis of the text to infer implicit information (e.g., Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Catts et al., 2006; Hansen & Pearson 1983). The first aim of the present study was to investigate preschool children's ability to understand explicit and implicit information in a text.

The second aim of the present study was to analyze whether some of the relevant components involved in text comprehension contributed differently to the understanding of what a text explicitly says and what it implies. Specifically, the components considered in the present study were (a) verbal ability, evaluated through measures of receptive vocabulary or vocabulary breadth and verbal intelligence or vocabulary depth (see Study 1, Chapter 2 of this work), and (b) inferential skills. The specific role played by the latter higher-level component was the main focus of the present study. The role of verbal ability has been already considered in Study 1 (see Chapter 2 of this work), but it was further explored in relation to the ability to understand implicit and explicit information in a text (see below) and controlled for in order to analyze the relation between inferential skills and listening text comprehension (i.e., text comprehension of explicit and implicit information in a text). Moreover, in the analysis of the relation between verbal ability and inferential skills, on one hand, and the ability to understand explicit and implicit information, on the other hand, also the role of verbal working memory

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was taken into account as a control variable; in fact in the literature on text comprehension there is evidence of a relation between children's working memory, on one hand, and text comprehension, verbal ability and inferential skills, on the other hand (see Study 2 and Study 3, Chapter 3 and Chapter 4 of this work).

In the next paragraphs, the role played by inferential skills in text comprehension was analyzed after briefly consider the role of verbal ability in relation to the specific aims of this study.

5.2 Verbal ability

Many studies have analyzed the relation between verbal ability and reading comprehension (e.g., Cain & Oakhill, 2006; Cain & Oakhill, 2007; Muter et al., 2004; Nation & Snowling, 2004; Ouellette, 2006; Ricketts, Nation, & Bishop, 2007; Roth et al., 2002; Seigneuric & Ehrlich, 2005). As already noted (see Study 1, Chapter 2 of this work), verbal ability has been evaluated using measures of vocabulary breadth, namely receptive vocabulary or picture naming, and measures of vocabulary depth, namely word definitions and identification of the semantic relations between words. The few studies in which different measures of verbal ability have been used (i.e., measures of vocabulary breadth and depth) revealed mixed findings (see Study 1, Chapter 2 of this work); some studies supported the existence of an indirect relation (i.e., mediated by verbal intelligence or vocabulary depth; e.g., Ouellette, 2006), while other studies showed that both vocabulary breadth and depth accounted for individual differences in text comprehension (e.g., Oakhill et al., 2003). Inconsistencies among the results of previous studies might be due, among other reasons, to the different materials used to evaluate text comprehension. For instance, Ouellette (2006) evaluated text comprehension using the Woodcock Reading Mastery Test-Revised, which is constituted by short-texts and is a cloze task; instead Oakhill and colleagues (Oakhill et al., 2003) used the Neale Analysis of Reading Ability, which was formed by longer texts followed by open-ended questions. Given these differences, it may be hypothesized that the two tests tap into different comprehension components and rely on the ability to understand explicit and implicit information to a different degree (see Bowyer-Crane & Snowling, 2005). In the present study, in an attempt to control for one source responsible for the mixed set of results presented in the literature, we further analyzed the role played by receptive vocabulary and verbal intelligence in the understanding of implicit and explicit information in a text separately.

5.3 Inferential skills

The process of meaning construction extends beyond the understanding of the information presented in the text to require the reader/listener to integrate explicit content with previously acquired knowledge. This process, which is carried out in working memory, has traditionally been considered inferential in nature (Kintsch & Kintsch, 2005).

The inferential skills of school-age children classified as having good or poor comprehension were evaluated by using tasks that required them to answer inferential questions about written and orally presented short stories. Performance on these tasks was then related to reading comprehension of more complex texts. Comparisons between groups of good and poor comprehenders showed that the latter group was characterized by specific difficulties in making different types of inferences, therefore supporting the conclusion that there is a relation between inference making skills and reading comprehension (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Cain et al., 2001; Oakhill, 1982; 1984; Oakhill et al., 1998; Yuill et al., 1989).

Work on unselected groups of school-age children has further extended previous findings, showing that inferential skills play a specific role in text comprehension (Cain, Oakhill, & Bryant, 2004; Oakhill et al., 2003). Cain, Oakhill and Bryant (2004) followed a group of 100 children from 7 to 10 years of age and evaluated concurrently at three time points, inferential skills (and other discourse-level components such as comprehension monitoring), verbal ability and verbal working memory. Given that inferential skills tap on both verbal ability and working memory, the authors were interested to verify whether individual differences in inferential skills reflected individual differences in the above mentioned components or whether they accounted for unique variance in text comprehension over and above these lower-level linguistic and basic cognitive components. Cain and colleagues (Cain, Oakhill, & Bryant, 2004) found a consistent pattern of results at each time point; inferential skills accounted for specific variance in reading comprehension over and above verbal ability and working memory. Based on this result, the authors concluded that verbal ability and verbal working memory can not entirely account for the relationship between reading comprehension and inferential skills, which is a specific contributor to reading comprehension.

Younger children are less likely to make inferences than older ones, since inference making skills develop with age (see Chapter 1 of this work). Nevertheless, work on children aged 4-6 years, showed that inferential skills predicted narrative comprehension and the recall of aural and televised stories, even after controlling for receptive vocabulary (Kendeou et al., 2008). Therefore, in preschoolers a

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relation between inferential skills and text comprehension, particularly comprehension of implicit information, was expected.

5.4 Research questions and hypotheses

The present study aimed to analyze: (a) differences in young children's ability to understand explicit and implicit information in a text; (b) the specific role played by verbal ability and inferential skills in the comprehension of the two types of information. Neither of the two objectives of the current study has been considered in previous investigations.

As far as the first aim is concerned, we hypothesized: (a) a significant improvement in the ability to understand both explicit and implicit information in a text from 4 to 6 years of age; (b) that explicit information is understood and remembered better than implicit information, as was shown in school-age children (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Catts et al., 2006; Hansen & Pearson 1983).

As far as the second aim is concerned, in order to analyze the specific and unique contributions of inferential skills and verbal ability to the comprehension of explicit and implicit information in a text, we established *a priori* the order with which the different components were examined. The role of the more active components was analyzed after controlling for the role of less active ones; receptive vocabulary, the less active and complex component, was entered before verbal intelligence, a measure of more active verbal skills[16]. The role of inferential skills, the most active and complex component, was examined over and above all the other predictors. Working memory was controlled for before analyzing the role played by all the other predictors. Based on the literature reviewed in the previous sections, we hypothesized that: (a) verbal ability play a different role in the understanding of explicit and implicit information; receptive vocabulary may affect the understanding of explicit information to a greater extent than implicit information, whereas verbal intelligence may play a relevant role in the understanding of both types of information; (b) inferential skills predicted text comprehension over and above verbal ability and working memory, and contributed to the understanding of implicit information to a greater extent than explicit information.

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[16] In the present study receptive vocabulary was entered before verbal intelligence because the interest was to firstly analyze the role of less active and than the role of more active measures of verbal ability in the understanding of the two types of information. However, the same results were obtained when the two predictors were entered in the reverse order.

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5.5 Method

5.5.1 Participants

Two hundred and twenty-one children aged 4 to 5;11 years (mean age = 4;10 years; *SD* = 6 months) participated in this study[17]. Fifty-two percent of the participants were males and 48% were females. The children attended kindergartens located mainly in the North of Italy and came from families living in middle class and lower class socio-economic catchment areas. All the children spoke Italian as their first language. According to their teachers, none of these children had cognitive impairments or language difficulties. Parental consent was obtained for each child.

5.5.2 Materials and procedure

As part of a more wide cross-section project (see Chapter 1 of this work), the present study focused on listening text comprehension of short stories (dependent variable), verbal working memory (control variable), verbal ability and inferential skills (predictors) which were evaluated over three sessions lasting approximately 30 minutes each. The tasks used to evaluate the above mentioned skills are described below. All the tasks were individually administered in a quiet area of the school in order to guarantee the children remained attentive.

Listening comprehension. The Test for Listening Comprehension - TOR 3-8 (Levorato & Roch, 2007) was used. A detailed description of this test has been provided in Study 1 (Chapter 2 of this work). In this study two scores rather than a unitary comprehension score were considered: the number of correct answers for the explicit and implicit comprehension questions (hereafter TOR 3-8 Explicit and Implicit respectively) (range 0-10).

Working memory. A backward word span task was used to evaluate working memory (for a detailed description of this test see Study 2, Chapter 3 of this work). The reliability for the backward word span task, which was assessed by calculating Cronbach's Alpha over items, was good (.66).

Verbal ability receptive vocabulary and verbal intelligence). Children's verbal ability was evaluated through:

a) Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981, standardised for Italian speakers by Stella et al., 2000) (hereafter PPVT-R), which evaluates receptive vocabulary;

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[17] Data presented in this study were collected during 2008

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b) Vocabulary and Similarities subtests from the Verbal scale of the WPPSI (Wechsler, 1967 - Italian adaptation by Bogani & Corchia, 1973) which evaluate verbal intelligence (for a detailed description of these tests see Study 1, Chapter 2 of this work).

Inferential skills. An inferential task was constructed to evaluate the children's ability to carry out inferential processes based on short simple sentences. Several taxonomies of inferences have been proposed in the field of psycholinguistics and discourse processing (see Chapter 1 of this work). In the inferential task used in the present study two types of inferences which are necessary for text understanding were included: knowledge-based inferences, which require information from previously acquired world knowledge to be incorporated within the text, and text-based inferences, which connect various pieces of information provided in the text to each other and identify their implicit relations (Graesser & Bower, 1990; Kintsch & Kintsch, 2005; Singer & Ferreira, 1983; Trabasso & Suh, 1993). Some evidence supporting a distinction between the two types of inferences came from studies in which good and poor comprehenders performed differently on comprehension questions aimed at evaluating knowledge-based and text-based inferences (e.g., Bowyer-Crane & Snowling, 2005), however it should be borne in mind that this distinction it is not really a dichotomy but rather a continuum dimension. Therefore, in the present study, given the small number of items, the two types of inferences were not considered separately.

The suitability of the task for children in the age range considered was tested in a pilot study on a small number of children aged 4-6 years who did not take part in the present study. The pilot work led to minor modifications. The final version of the task consisted of five simple trials. Inferential skills were evaluated through two open-ended questions for each trial. In each trial children were presented with one or two sentences and asked an inferential question. Then additional information was given and the children were asked a second inferential question (for an example of the material presented in this task see Appendix C).

Each child's answers were evaluated by two independent raters on a 0-2 points scale. Incorrect answers were scored 0, partially correct answers or answers obtained after an additional clarification request were scored 1, and fully correct answers obtained without additional requests were scored 2.

The reliability of the task, evaluated by calculating Cronbach's Alpha over the 10 items of the task, was .52. This rather low Alpha level is not surprising; the task consisted of different types of questions which aimed at evaluating the ability to generate different types of inferences. Moreover, there were too few items of each type to obtain reliable assessments of homogeneity within each type (cf. Oakhill et al., 2003).

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5.6 Results

5.6.1 Descriptive statistics

All the children completed the tasks. Table 1 shows the descriptive statistics.

Table 1. Mean performance with standard deviations and range

	M	*SD*	Range
Comprehension of explicit information (TOR 3-8 Explicit)[a]	10.9	1.9	6-14
Comprehension of implicit information (TOR 3-8 Implicit)[a]	10.4	1.9	6-15
Working memory (Backward span)[b]	4.7	1.5	0-8
Receptive Vocabulary (PPVT-R)[c]	85.9	14.1	65-127
Verbal Intelligence (VIQ)[d]	10.1	2.2	3-16
Inferential skills[e]	12.1	3.7	2-19

Note. [a] Scaled scores: $M = 10$, $SD = 2$. [b] Number of series correctly repeated (possible range 0-20). [c] Standard scores: $M = 100$, $SD = 15$. [d] Scaled scores: $M = 10$; $SD = 3$. [e] Correct answers (maximum score = 20).

Listening comprehension of explicit and implicit information. Performance of the children was appropriate for their age; scores ranged from 2 *SD* below the mean to about 2 *SD* over the mean for both types of questions.

Working memory. The average backward word span was 2.3. Table 1 reports the number of series correctly repeated. These results are similar to those reported in Study 2 e 3 (Chapter 3 e 4 of this work). This measure was used in the following analyses since it is a more sensitive measure of the level reached by each child than memory span.

Receptive vocabulary. On the receptive vocabulary task (PPVT-R), performance ranged from the standard score of 65 (about 2 *SD* below the mean) to the standard score of 127 (about 2 *SD* above the mean). The average performance laid at the lower boundary of the range appropriate for age, the standard deviation was comparable to that of the national standardization sample. This result suggested that the range of performance was normal and unrestricted and probably reflected the socio-economic status of the participants (for a further discussion of this point see Study 1, Chapter 2 of this work).

Verbal intelligence. Children's average verbal intelligence was appropriate for their age and performance ranged from about 2 *SD* below the mean to about 2 *SD* over the mean.

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Inferential skills. Performance at this measure covered almost the total possible range of scores, showing a good variability. The task did not suffer from either floor or ceiling effects.

5.6.2 The role of age and gender

A set of correlational analyses was carried out in order to analyze the relation between gender and age, on one hand, and the ability to answer explicit and implicit questions on the test for listening comprehension TOR 3-8, working memory (backward word span), receptive vocabulary (PPVT-R), verbal intelligence (VIQ), and inferential skills, on the other hand. No statistically significant correlations were found between gender of participants and the component skills considered in the present study ($p > .05$). Statistically significant correlations were found between age and all the other variables ($p < .05$). The effect of age and its interaction with the component skills on the ability to understand explicit and implicit information were analyzed in more detail in the regression analysis presented below.

5.6.3 Correlations between comprehension of explicit and implicit information, verbal working memory, verbal ability and inferential skills

Table 2 shows the correlations between the ability to answer explicit and implicit questions on the test for listening comprehension, working memory (backward word span), receptive vocabulary (PPVT-R), verbal intelligence (VIQ) and inferential skills, controlling for the effect of age.

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Table 2. Correlations between listening comprehension of explicit and implicit information, working memory, receptive vocabulary, verbal intelligence, inferential skills (controlling for age)

	1	2	3	4	5	6
1. Comprehension of explicit information (TOR 3-8 Explicit)	-	.60*	.32*	.50*	.58*	.40*
2. Comprehension of implicit information (TOR 3-8 Implicit)		-	.26*	.36*	.41*	.37*
3. Working memory (backward word span)			-	.28*	.27*	.28*
4. Receptive Vocabulary (PPVT-R)				-	.57*	.49*
5. Verbal Intelligence (VIQ)					-	.45*
6. Inferential skills						-

* $p = .003$ (Bonferroni correction: .05/15 = .003)

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The ability to understand explicit information in a text was related to the ability to understand implicit information: The two variables shared 36% of the variance (r = .60). This result showed that the two abilities differ but at the same time they are related; presumably the comprehension of the two types of information taps into partially similar abilities that contribute to a global process, namely the construction of an integrated semantic representation of the text. The ability to understand both explicit and implicit information in a text was correlated with working memory. Significant correlations were found between the performance on TOR 3-8, both explicit and implicit answers, on one hand, and receptive vocabulary and verbal intelligence, on the other hand. Thus, both the ability to understand information explicitly presented in a text and implicit information are related to the verbal ability. Performance on explicit and implicit answers on TOR 3-8 correlated with performance at the inferential task to a similar extent, suggesting that, from an early age, inference skills are used in text processing and are related to the ability to understand implicit information as well as explicit information.

All the components correlated to each other. Particularly, medium to high correlation were found between receptive vocabulary and verbal intelligence. Verbal ability was related to inferential skills and both were correlated with working memory. Overall, these results showed that the components of text comprehension considered in the present study contribute to the construction of the semantic representation of the text, presumably in interaction with each other. The next analysis aimed to disentangle the specific contribution of each component to the understanding of explicit and implicit information in a text.

5.6.4 Listening comprehension of explicit and implicit information: The role of verbal ability and inferential skills

A fixed-order hierarchical multiple regression analysis was carried out in order to analyze (a) the contribution of receptive vocabulary, verbal intelligence and inferential skills to listening comprehension of explicit and implicit information, and (b) whether the role played by these components changed with age and for the two types of information (i.e., explicit and implicit information). The number of correct answers on the listening comprehension test TOR 3-8 was the dependent variable. The predictors entered were age and verbal working memory (first step), type of information, that is explicit vs. implicit information (second step), receptive vocabulary (PPVT-R) (third step), verbal intelligence (VIQ) (fourth step), inferential skills (fifth step), and interactions between: (a) verbal ability and inferential skills, on one hand, and age and type of information, on the other hand; (b) type of information and age (sixth step). Working memory, age and type of information were entered to test for their effect on listening comprehension and, as far as age and

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type of information are concerned, to test for interactions entered in the sixth step. In the interaction terms, the variables age, receptive vocabulary, verbal intelligence and inferential skills were standardized (for further details see Study 1, Chapter 2 of this work).

Interactions between age and the other predictors did not explain a significant amount of variance ($p>.29$): Age did not operate as a moderator of the relation between the components and listening text comprehension, which was stable between 4 and 6 years, and of the effect of type of information. Interactions between type of information, on one hand, and verbal intelligence and inferential skills, on the other hand, were not significant either ($p>.55$), showing that the role played by these components was similar in the understanding of both explicit and implicit information. Consequently, we tested a more parsimonious model in which these interactions were excluded. This model is presented in Table 3.

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Table 3. **Fixed-order hierarchical multiple regression analysis with listening comprehension as the dependent variable, type of information, receptive vocabulary, verbal intelligence and inferential skills as predictors, age and verbal working memory as control variables** [18]

	R^2	ΔR^2	B	SE B	β
Step 1	.15	.15**			
Age			0.09	0.02	.21**
Working memory (Backward span)			0.44	0.07	.27**
Step 2	.25	.10**			
Type of information			-1.48	0.20	-.31**
Step 3	.38	.13**			
Receptive vocabulary (PPVT-R)			0.06	0.01	.37**
Step 4	.41	.03**			
Verbal intelligence (VIQ)			0.23	0.05	.21**
Step 4	.43	.02**			
Inferential skills			0.10	0.03	.15**
Step 5	.44	.01*			
Receptive vocabulary*type of information			-0.03	0.01	-.49*

* $p < .05$; ** $p < .01$

The model accounted for 44% of variance in listening text comprehension. Age and working memory explained 15%, type of information 10%, receptive vocabulary 13%, verbal intelligence 3% and inferential skills explained an additional 2% of variance in text comprehension. Finally, in the last step, a significant interaction between type of information and receptive vocabulary explained 1% of variability. In sum, all the variables entered in each step accounted for a significant amount of variance in listening text comprehension over and above the contribution of the predictors considered in the previous steps These results showed that:

a) listening text comprehension ability increased between 4 and 6 years;
b) children performed better on explicit than on implicit questions at TOR 3-8[19];
c) the effect of receptive vocabulary was qualified by a significant, albeit small interaction with type of information: individual differences in receptive vocabulary explained individual differences in the ability to understand explicit but not implicit information;

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[18] Given the high number of variables considered in this regression analysis, only the contribution of predictors added in each consecutive step is reported. These results were comparable to those obtained in the last step (Step 5) in which all predictors and significant interactions were considered together

[19] In Table 1 standard scores for the explicit and implicit questions of the TOR 3-8 were reported; the raw scores which allow the performance on the two types of questions to be compared were: $M = 6.5$ ($DS = 2.4$) for the explicit questions; $M = 5.1$ ($DS = 2.2$) for the implicit questions

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d) verbal intelligence, namely more active verbal skills accounted for the ability to understand both explicit and implicit information over and above receptive vocabulary;

e) inferential skills made a specific contribution, over and above working memory and verbal ability, in the understanding of both explicit and implicit information.

5.7 Discussion

To date, studies on text comprehension considered school-age children's ability to understand explicit and implicit information in a text and analyzed the role played by different component skills of text comprehension without distinguishing between the two types of information. The present study expand on the existing literature in several ways; it focused on listening text comprehension in children aged 4-6 years, examining (a) the ability to understand explicit and implicit information in a text; (b) the role played by receptive vocabulary and verbal intelligence (i.e., lower-level verbal components), and inferential skills, namely a text-level component, in the comprehension of explicit and implicit information. Verbal working memory was taken into account as a control variable. Furthermore, the developmental path of the relationship between listening text comprehension of implicit and explicit information and the above mentioned components between 4 and 6 years was also considered. The next paragraphs summarize and discuss the main findings of the present study.

Results showed a significant improvement in the ability to understand explicit and implicit information in a text from 4 to 6 years. This finding means that in preschool age a significant development occurs in these abilities, which are still in an early phase of acquisition. Moreover, explicit information was understood and remembered better than implicit information and this difference was stable in the age range considered. This result is in line with findings reported in previous studies on school-age children (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Catts et al., 2006; Hansen & Pearson 1983). The studies that have compared children's ability to process implicit and explicit information in a text covered a wide age range (from 4 to 13 years of age), therefore findings of this work seem to suggest that differences in the processing of the two types of information are not developmental in nature and tend to disappear, but are an intrinsic characteristic of the process of meaning construction involved in text comprehension.

Our results also confirmed that working memory, considered as a control variable, accounted for individual differences in text comprehension ability in line with results reported in previous studies (see Study 2 and 3 of this work).

As far as verbal ability is concerned, evidence from previous studies in which measures of vocabulary breadth and depth were considered and related to the ability to understand a text, led to mixed results (e.g., Oakhill et al., 2003; Ouellette, 2006); we hypothesized that the different

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findings obtained might be explained considering, among other factors, the materials used for the evaluation of text comprehension. In fact, various tests might rely on the ability to understand explicit and implicit information to a different extent. In the present study both measures of vocabulary breadth and depth, namely receptive vocabulary and verbal intelligence were taken into account and their role in the comprehension of explicit and implicit information in a text was analyzed separately. We found some evidence that individual differences in receptive vocabulary, which measures the amount of words a child knows or the size of the lexicon, accounted for the comprehension of the two types of information to a different extent, explaining significant variance in the ability to understand explicit but not implicit information in a text. However, this conclusion needs further investigation considering that the interaction between receptive vocabulary and type of information is significant but small. On the other hand, verbal intelligence accounted for a specific amount of variance in the comprehension of both types of information; this result shows that the comprehension of both explicit and implicit information in a text depends on complex measures of vocabulary depth which evaluate how well children know the meaning of words, and are based on the semantic representations of the words and their organization in the semantic system.

The most important contribution of present study is that it analyzed the role played by inferential skills, namely a text-level component, in preschoolers' text comprehension. We showed that inferential skills are related to the understanding of both explicit and implicit information in a text. This finding is not trivial since it might be expected that inferential skills would account for greater variability in the understanding of implicit than explicit information. Our results instead show that a deep analysis of linguistic information based on inferential processes is linked to the understanding of explicit information as well, suggesting that top-down processes facilitate the processing of every type of verbal information when it is presented within a meaningful linguistic context. The ability to make inferences contributes to the construction of a semantic representation in which text information is integrated and organized, allowing the children to retrieve implicit as well as explicit information more easily. These results on the role played by inferential skills in preschoolers' listening comprehension extend findings obtained in previous investigations on reading comprehension in school-age children (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 1999; Cain et al., 2001; Cain, Oakhill, & Bryant, 2004; Oakhill, 1982, 1984; Oakhill et al., 2003; Oakhill et al., 1998; Yuill et al., 1989). They also integrate with the results of van den Broek and collaborators (Kendeou et al., 2008), showing that inferential skills account for specific additional variance in preschoolers' text comprehension, not only over and above receptive vocabulary but also over and above verbal intelligence and verbal working memory. It is worth noting that while

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the amount of variance explained by inferential skills is not large, it is nonetheless significant. This result is valuable because it is stable in the age range considered and shows that text-level inferential processes play a specific role in preschoolers' text comprehension over and above lower-level and more basic components.

The results of the present study confirm models of text comprehension showing that the understanding of both explicit and implicit information is necessary in order to form a coherent semantic representation of the text (e.g., Kintsch & Kintsch, 2005) and, more importantly, show that children as young as 4 engage in a deep and active analysis of the text and develop a semantic representation that is not limited to the information explicitly given (Kendeou et al., 2008). Indeed, the most interesting and rather surprising result emerged for the understanding of explicit information, for which it is not sufficient to adhere strictly and remember in detail the information presented in the text, since it requires an involvement of integrative process. We argue that the overall pattern of results concerning the role of the different components in the understanding of the two types of information is due to a process of integration, implied in the construction of a coherent mental representation of the text. Strictly speaking, children do not use different skills in order to process explicit information and supplement it with implicit information. Rather, from the earliest phases of the development of the ability to understand a text, linguistic and cognitive component skills cooperate in order to process explicit content and, in parallel, to recover the necessary information from previous knowledge and parts of the text to construct a coherent semantic representation which has the quality of a Situation Model.

In conclusion, the results of the present study are in line with those reported in the previous chapter in supporting a specific involvement of higher-level component skills in preschoolers' listening text comprehension. Based on these findings text comprehension might be described not only as a bottom-up but also as a top-down process.

The next chapter reports the final study of the present investigation in which the role of the components that have been shown to be concurrently related to listening text comprehension has analyzed adopting a longitudinal design.

Chapter 6

Study 5. A Longitudinal Analysis of Cognitive and Linguistic Components of Listening Text Comprehension

6.1 Introduction

In the previous chapters a number of skills specifically related to listening text comprehension in preschoolers have been identified. These studies have adopted a cross-sectional design as most of the research on text comprehension. Longitudinal work on text comprehension is scarce, and, more importantly, to our knowledge, there are no longitudinal investigations on listening text comprehension in preschoolers. The present study is the first that analyzed the longitudinal relations between some lower- and higher-level components and text comprehension in preschoolers; the skills that have shown to specifically contribute to text comprehension in previously presented studies were taken into account and were related to listening text comprehension evaluated at 6- to 8- months of distance.

The aim of longitudinal studies is twofold; they allow to analyze longitudinal relations and are appropriate for the identification of causal predictors of text comprehension (see Chapter 1 of this work). In this kind of investigations sets of skills are measured at different time points in order to; a) assess whether some of these variables are better predictors of later text comprehension than others. In this way longitudinal studies allow for longitudinal relations between component skills and later text comprehension to be tested; b) assess whether a certain variable measured at an earlier time point predicts later text comprehension over and above text comprehension measured at an earlier time point which is referred to as the autoregressor (de Jong & van der Leij, 2002). In this way longitudinal studies allow to test for causal relations, namely for the existence of a direct effect of the components of interest on later text comprehension after the inclusion of the autoregressor. Stated clearly, the inclusion of the autoregressor allows among the components that are related to later text comprehension to be identified those which are not completely accounted for by the relationship with text comprehension evaluated at an earlier time point.

The next paragraphs considered the literature that has analyzed the longitudinal and causal relations between the components that studies in this work have found to specifically contribute to listening text comprehension (i.e. verbal intelligence, receptive vocabulary, short-term and working memory, the ability to use linguistic context and inferential skills). There are different methods to test for causality (see Chapter 1 of this work); in the present study, evidence for causal relations was reviewed mainly with reference to longitudinal studies in which the effect of the autoregressor was

considered and analyzed through the use of regression analysis or structural equation models, however also studies that used other methods, namely studies using the CAM design and training studies were taken into account.

6.1.1 Verbal intelligence

Longitudinal studies have shown that verbal intelligence, we also referred to as vocabulary depth (see Study 4, Chapter 5 of this work), exerted an effect on later reading comprehension. For instance, Näslund (1990) analyzed the relation between verbal intelligence evaluated in both German preschool- and school-age children at the beginning of formal instruction (first year), and reading comprehension evaluated in the second year of schooling. Using longitudinal regression analysis in which the role of other variables (e.g., word reading accuracy and speed, verbal short-term memory) was taken into account, Naslund (1990) found that verbal intelligence evaluated in kindergarten and in elementary school predicted in a similar manner later reading comprehension. More recently Cain & Oakhill (2006), analyzed whether poor verbal intelligence affect the progress in reading comprehension made by older poor comprehenders aged between 8 and 11 years. Results showed that the initial level of verbal intelligence was related to growth in reading comprehension in the age range considered; this results indicates that verbal intelligence acts as a facilitator of text comprehension development, probably because verbal intelligence reflects the general ability to process complex information in the verbal domain. In sum, these studies suggest the existence of longitudinal relations between text comprehension and verbal intelligence evaluated before formal literacy instruction begins and in the early elementary school years, however do not allow conclusions on the existence of causal relations to be made.

The existence of a causal link between verbal intelligence and text comprehension, has been suggested by studies which adopted the CAM design (e.g. Stothard & Hulme, 1996). In the study of Stothard and Hulme (1996) (see Study 1, Chapter 2 of this work) poor comprehenders' performance on verbal intelligence measures was lower than that obtained by a younger comprehension-age match group; this result rules out the possibility that verbal intelligence is a product of text comprehension and suggests that it is a cause of text comprehension. A recent four-year longitudinal study carried out by Oakhill and collaborators (Oakhill & Cain, 2007b, but for a description of this work see also Perfetti, Landi, & Oakhill, 2005) on school-age children, provided more clear evidence in support of a causal link between verbal intelligence and text comprehension. This study followed a group of children from 7-8 to 10-11 years and evaluated a wide range of skills related to text comprehension, among which verbal intelligence was also considered; results showed that verbal intelligence assessed at 7-8 years directly accounted for reading comprehension

at 8-9 years. Evidence for the existence of a causal relation between verbal intelligence and text comprehension also comes from studies that analyzed children's ability to provide oral definitions, a measure which is often used as an indicator of verbal intelligence (e.g., Roth et al., 2002; Torgesen, Wagner, Rashotte, Burgess, Hecht, 1997; see also Study 4, Chapter 5 of this work). Roth at al. (2002) found that the ability to provide oral definitions evaluated in kindergarten was causally related to reading comprehension evaluated in the first years of elementary school. Torgesen et al. (1997) found that the ability to define words accounted for reading comprehension over and above the effect of the autoregressor in two overlapping period of times, namely from second to fourth grade and from third to fifth grade. Overall, these results support the existence of a causal link between verbal intelligence and text comprehension.

6.1.2 Receptive vocabulary

Longitudinal work has repeatedly demonstrated an influence of receptive vocabulary on later text comprehension. Several studies considered the relation between receptive vocabulary, evaluated in kindergarten, and text comprehension evaluated in the early grades of elementary school (Muter et al., 2004; Snow, Tabors, Nicholson & Kurland, 1995). These studies found associations of similar magnitude (r ranging from .40 to .50) between receptive vocabulary and later reading comprehension. Evidence of longitudinal contributions was also reported by Catts et al. (2006) in a study in which vocabulary knowledge of eighth graders with good or poor comprehension ability was analyzed retrospectively when the children were in kindergarten, second and fourth grade. Some other studies found more specific associations, for instance Sénéchal, Ouellette, and Rodney (2006) showed that receptive vocabulary evaluated in kindergarten accounted for the 4% of specific variance in grade three reading comprehension.

There has been limited assessment of the causal relations between vocabulary and text comprehension because, as previously noted (Chapter 1 of this work), there is evidence that limited vocabulary knowledge does not always constrain text comprehension. Training studies aimed to improve vocabulary have obtain mixed results, however there is some evidence that vocabulary instruction fosters text comprehension (e.g., Beck & McKeown, 1991; Stahl & Fairbanks, 1986). Evidence for the existence of a direct causal relation between receptive vocabulary and text comprehension come form more recent studies in which the effect of the autoregressor was considered and analyzed through the use of regression analysis and structural equation models. Verhoeven and Leeuwe (2008) analyzed the longitudinal relations between receptive vocabulary and text comprehension during the elementary school using a combined structural model and found support for an effect of receptive vocabulary on later text comprehension in the early, middle and

final elementary school years. De Jong and van der Leij (2002) evaluated linguistic comprehension in first graders (7-8 years) using measures of receptive and expressive vocabulary and found that this composite vocabulary score predicted text comprehension at the end of the third grade (9-10 years) over and above the effect of the autoregressor and word reading skills. First to third graders were also considered by Seigneuric and Ehrlich (2005), who found that receptive vocabulary assessed in year one predicted text comprehension in the third year over and above the effect of age, autoregressor, non word reading and verbal working memory. The results reported by Cain & Oakhill (2007) are in line with those of previous investigations in showing that receptive vocabulary in children aged 7-8 years directly predicted text comprehension evaluated at 8-9 years.

In sum, work reported in this paragraph support the existence of longitudinal and causal relations between receptive vocabulary and text comprehension.

6.1.3 Verbal short-term and working memory

To our knowledge there is little research on longitudinal relations between verbal memory and text comprehension (see for instance the recent review of Savage et al., 2007). As far as short-term memory is concerned, the lack of longitudinal investigations might be explained considering that research on reading comprehension has found mixed evidence in support of a relation between verbal short-term memory and reading comprehension (see Study 2, Chapter 3 of this work). Overall, even though some studies found evidence of longitudinal links between short-term memory and reading comprehension (e.g., Näslund, 1990; Näslund & Schneider, 1991), there is little support for the existence of causal relations between the two skills, as shown by studies using the CAM design (Stothard & Hulme, 1992) and more recent longitudinal studies (Dufva et al., 2001). Studies in which the CAM design was used suggested the absence of a causal relation between working memory and text comprehension as well. The absence of a direct causal relation between these two skills has been further supported by more recent longitudinal studies that considered the effect of the autoregressor. Oakhill and colleagues (Cain & Oakhill, 2007b) found that working memory evaluated at 7-8 years using a listening span tasks did not directly account for text comprehension evaluated at 8-9 and 10-11 years, even though significant longitudinal correlations between the two skills were found. Seigneuric and Ehrlich (2005) found that working memory evaluated in children aged 8-9 years using a listening span task, had a direct effect on reading comprehension at 9-10 years, over an above the effect of the autoregressor, receptive vocabulary and non word reading. Moreover, in the Seigneuric and Ehrlich's (2005) study working memory emerged as a causal predictor of text comprehension at a later time point compared to other variables such as vocabulary. As far as the causal role of working memory is considered, in comparing the different

results obtained by Oakhill and Cain (2007b) and Seigneuric and Ehrlich (2005) for children in the same age range, it is worth noting that the former study took into account not only the role played by lower-level but also higher-level components of text comprehension; these components tap on working memory and might have taken up variance which would otherwise have loaded on working memory.

Overall, the findings presented in the previous paragraph support the existence of longitudinal relations between working memory and text comprehension, whereas evidence in support of a causal link is mixed.

6.1.4 Text-level components: The ability to use linguistic context and inferential skills

In the present investigation two discourse-level components were taken into account; the use of linguistic context and inferential skills. The former refers to children's ability to exploit linguistic information provided by the context in order to enhance the understanding of sentences; the ability to generate inferences, instead, requires the children both to search for relevant knowledge in long-term memory to fill in the text missing information and to integrate information between different sentences. These two discourse-level components share some skills, mainly the ability to generate/identify integrative links, but they differ as well; in fact, in order to use the context the child has to identify what is the relevant information in the text that has to be connected, whereas in order to generate inferences the child has to figure up which is the relevant knowledge or memory that has to be retrieved in order to give sense to the incoming information.

To our knowledge, there are no studies on the longitudinal/causal relations between the ability to use the linguistic context and text comprehension, however a great deal of evidence from different types of investigations support the existence of casual relations between inferential/integrative skills and text comprehension. Studies using the CAM design, ruled out the possibility that inferential skills are a by product of text comprehension (Cain & Oakhill, 1999); in fact poor comprehenders considered by Cain and Oakhill (1999) were poorer at making inferences to integrate information between different parts of the text compared to younger children with adequate text comprehension level. Further evidences supporting a causal relation between inferential/integrative skills and text comprehension come from training studies in which poor comprehenders benefited form the training on inferential skills more than good comprehenders did (Yuill & Joscelyne, 1988; Yuill & Oakhill, 1988; see also McGee & Johnson, 2003). Yuill and Joscelyne (1988) taught 7-to 8- year-old poor comprehenders to make lexical inferences using clue words presented in deliberately obscure tests and found that the trained group of poor comprehenders showed better text understanding than a control group of poor comprehendres, and

that the training did not produce significant improvement in good comprehenders[20]. Yuill and Oakhill (1988) compared the effects of different types of trainings in children aged 7-8 years. Trainings consisted in teaching children to: (a) generate questions to monitor comprehension and generate specific lexical inferences, as in the study of Yuill and Joscelyne (1988), (b) perform standard comprehension exercises and (c) read key words in a text quickly and accurately. Poor comprehenders in condition (a) improved their text comprehension to a greater extent than groups in the other conditions and increased their comprehension age to within 6 months of that of good comprehenders.

To our knowledge, only the repeatedly mentioned longitudinal study of Oakhill and colleagues (Oakhill & Cain, 2007b) has explored the causal relations between text comprehension, on one hand, and inferential skills, on the other hand. Results showed that inferential skills evaluated at 8-9 years predicted text comprehension at 10-11 years over and above the contributions of the autoregressor, word reading ability, verbal intelligence and receptive vocabulary. In addition, inferential skills had a specific influence on later reading comprehension when other higher-level component skills, namely comprehension monitoring and knowledge of story structure were taken into account.

In sum, work reported in this paragraph support the existence of longitudinal and causal relations between inferential/integrative skills and text comprehension.

6.1.5 Research questions and hypotheses

The present study aimed to analyze a) longitudinal and b) causal relations between the skills that previous studies presented in this work have shown to specifically account for preschoolers' text understanding, on one hand, and later listening text comprehension, on the other hand. The predictors we considered were verbal intelligence, receptive vocabulary, verbal short-term and working memory, the ability to use linguistic context and inferential skills. The specific predictors and listening text comprehension were evaluated at two points in time at 6- to 8- months of distance; the hypothesis that an improvement in younger children's text comprehension ability takes place in this lack of time is legitimate by recent evidence (Levorato & Roch, 2007).

This is the first study that tried to identify some of the longitudinal and causal contributors of listening text comprehension, however, based on the literature presented in the previous sections, some general expectations may be put forward:

a) as far as longitudinal relations are considered, verbal intelligence, receptive vocabulary, short-term and working memory, the ability to use context and inferential skills were

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[20] As recognized by the same authors, training children to be aware of relevant clues in the text to generate inferences involves also an element of comprehension monitoring

expected to be related to later listening text comprehension (e.g., Cain & Oakhill, 2006; Cain & Oakhill, 2007b; Näslund, 1990; Seigneuric & Ehrlich, 2005; Sénéchal et al., 2006);

b) as far as causal relations are considered,

- verbal intelligence and receptive vocabulary were expected to be causally related to later listening text comprehension (e.g., Roth et al., 2002; Seigneuric & Ehrlich, 2005);

- short-term memory was not expected to be causally related to later listening text comprehension (e.g., Dufva et al., 2001; Stothard & Hulme, 1992). As far as working memory is considered, no specific predictions could be made given the mixed findings emerged in the literature (e.g., Oakhill & Cain, 2007b; Seigneuric & Ehrlich, 2005);

- the ability to use context and inferential skills, namely text-level components, were expected to shown causal relationships with later listening text comprehension (e.g., Cain & Oakhill, 1999; Oakhill & Cain, 2007b; Yuill & Oakhill, 1988).

6.2 Method

6.2.1 Participants

Participants were part of the wide group of children tested in the cross-sectional project described in the previous studies; this group of children was tested at two time points (Time 1 and Time 2) at a six-to-eight-months distance from each other. One-hundred and fifty-six children (mean age = 4;10 years; SD = 7 months, range 4 to 5;11 years; 85 males and 71 females) were tested at Time 1 and 152 children (mean age = 5;4 years; SD = 7 months, range: 4,6 to 6;7 years; 84 males and 68 females) at Time 2[21]. The children attended kindergartens located mainly in the North of Italy and came from families living in middle and lower socio-economic catchment areas. All the children spoke Italian as their first language. According to their teachers, none of these children had cognitive impairments or language difficulties.

6.2.2 Materials and procedure

Children's listening text comprehension and all the components which have been shown to specifically predict listening text comprehension in cross-sectional work, were evaluated using the standardized and experimental measures presented in previous studies. At each time point, the tasks were individually administered over four sessions lasting approximately 30 minutes each. The tasks presented in each session were set in advance but the order of presentation was randomized. Tasks administered are briefly described below.

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[21] Data presented in this study were collected during 2008-2009

Listening text comprehension. Test for Listening Comprehension - TOR 3-8 (Levorato & Roch, 2007) (hereafter TOR 3-8) (for a detailed description of this test see Study 1, Chapter 2 of this work).

Verbal intelligence. Vocabulary and Similarities subtests from the Verbal scale of the WPPSI (Wechsler, 1967 - Italian adaptation by Bogani & Corchia, 1973) (for a detailed description of this test see Study 1, Chapter 2 of this work).

Receptive vocabulary. Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981, standardised for Italian speakers by Stella et al., 2000) (hereafter PPVT-R), which evaluates receptive vocabulary (for a detailed description of this test see Study 1, Chapter 2 of this work).

Short-term and working memory. A forward and a backward word span tasks were used to evaluate short-term and working memory respectively (for a detailed description of this test see Study 2, Chapter 3 of this work).

Sentence Comprehension out and in context. The test of Sentence Comprehension (Prova di Valutazione della Comprensione Linguistica-PVCL, Rustioni & Associazione "La Nostra Famiglia", 1994) which evaluates the ability to understand sentences in isolation and the test of Sentence Comprehension in context which evaluates the ability to understand sentence comprehension in context (for a detailed description of these tasks see Study 3, Chapter 4 of this work), were used to obtain a measure of the ability to use context.

Inferential skills. The inferential task constructed to evaluate children's ability to carry out inferential processes based on simple and short sentences, was used (for a detailed description of this test see Study 4, Chapter 5 of this work).

6.3 Results

Firstly the descriptive statistics, the correlations between variables at Time 1 and 2 and between variables at Time 1 and listening text comprehension at Time 2 were presented in order to provide a description of the performance at both time points and of the concurrent and longitudinal associations between measures. Secondly, the path analysis aimed at evaluating the longitudinal and causal relations between the concurrent predictors at Time 1 and listening text comprehension at Time 2 was reported.

6.3.1 Descriptive statistics at Time 1 and Time 2

Data for the four children who were not tested at Time 2 (one boy and three girls) were excluded in order to have full data for all participants (N = 152) at both time points.

Descriptive statistics are reported in Table 1.

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Table 1. Means, Standard Deviation, Range, Skewness and Kurtosis for tasks administered at Time 1 and Time 2

	Time 1 (N = 152)					Time 2 (N = 152)					
	M	*SD*	Range	Skewness	Kurtosis	*M*	*SD*	Range	Skewness	Kurtosis	Paired *t*-test$_{T12}$
Listening text comprehension (TOR 3-8) [a]	10.7	1.8	7-15	0.1	-0.2	11.0	1.8	7-15	-0.1	-0.4	*t* (151) = 3.9*[h] *d* = 0.3
Verbal intelligence (VIQ) [b]	10.9	2.5	3-18	-0.1	0.3	11.1	2.3	6-17	-0.1	-0.2	*t* (151) = 8.3*[h] *d* = 0.4
Receptive Vocabulary (PPVT-R) [c]	87.0	14.0	65-128	0.4	-0.2	87.8	15.0	65-125	0.3	-0.8	*t* (151) = 9.1*[h] *d* = 0.4
Sentence comprehension (PVCL) [d]	0.6	0.2	0-1	-0.3	-0.1	0.6	0.2	0.15-1	-0.1	-0.3	n.s.
Sentence comprehension in context (PVCL in context) [d]	0.7	0.2	0.17-1	-0.6	0.1	0.7	0.2	0-1	-1.2	-1.8	n.s.
Short-term memory [e]	7.9	1.7	4-15	0.8	2.2	8.4	2.0	4-16	0.7	1.7	*t* (151) = 3.8* *d* = 0.2
Working memory [e]	4.5	1.5	0-8	-0.3	0.7	5.4	1.6	1-12	0.4	1.2	*t* (151) = 7.1* *d* = 0.6
Inferential skills [g]	12.1	3.8	2-20	-0.2	-0.6	13.7	3.5	2-19	-0.7	0.2	*t* (151) = 6.1* *d* = 0.5

Note. [a] Scaled scores: *M* = 10, *SD* = 2. [b] Scaled scores: *M* = 10; *SD* = 3. [c] Standard scores: *M* = 100, SD = 15. [d] Proportion of correct answers. [e] Number of series correctly repeated (possible range 0-20). [g] Number of correct answers (possible range 0-20). [h] Paired *t*-test was calculated on raw scores

* *p* < .006 (Bonferroni correction: .05/8 = .006)

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As far as listening text comprehension is considered, performance on test TOR 3-8 was appropriate for age at both Time 1 and Time 2 (performance ranged from 1.5 *SD* below the mean to 2.5 *SD* over the mean). Concerning the component skills, performance on subtests of verbal intelligence was appropriate for age at both time points (performance ranged from about 2 *SD* below the mean to about 3 *SD* over the mean). As noted in the previous cross-sectional studies, performance on the PPVT-R laid at the lower boundary of the range appropriate for age (performance ranged from about 2 *SD* below the mean to about 2 *SD* over the mean) and the standard deviation was comparable to that of the national standardization sample at both Time 1 and 2, suggesting that the range of performance was normal and unrestricted. As far as the tests of sentence comprehension in and out of context are considered, it is worth noting that at both time points the majority of participants performed at a medium or higher-level (about the 80% of children at each time point) in the test of sentence comprehension out of context [22] and a facilitating effect of linguistic context on sentence comprehension was evident (*t* (151) = 6.76, *d* = .59 (medium to high effect) and *t* (151) = 7,44, *d* = .47 (medium effect), *p* <. 001 at Time 1 and 2, respectively). The average forward word span was 3.1 and 3.2 and the average backward word span was 2.3 and 2.5 at Time 1 and 2, respectively. Table 1 reports the number of series correctly repeated which was used in the following analyses. Neither short-term task nor working memory task suffered from floor effects, even though performance on the backward word span task showed restricted variability at Time 1 (see also Study 2, Chapter 3). Performance at the forward word span task was higher than at the backward word span task (*t* (151) = 20.85, *d* = 2.12 (large effect)[23] and *t* (151) = 18.13, *d* = 1.65 (large effect), *p* < .001 at Time 1 and 2, respectively); this result confirmed that the backward word span reliably measures a more complex ability than the forward word span. Finally, at both time points performance at the inferential task covered almost the total possible range of scores and the task did not suffer from either floor or ceiling effects.

Paired *t*-tests carried out on the raw scores on all the considered tasks at Time 1 and 2, showed that a significant development occurred in most of the component skills and listening text comprehension in a short-period of time (for most of the variables the effects sizes were small to medium). Performance on both the test of sentence comprehension out of context and in context at Time 1 and 2 did not significantly differ because different forms were used.

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[22] The level of performance was identify using weighted scores ranging from 0 to 100 (see Study 3, Chapter 4 of this work).
[23] A parametric technique was used to compare performance on the short-term and working memory tasks, even though the forward span tasks had a value of kurtosis higher than 2, because a graphic inspection indicated that the shape of the distribution for this variable did not deviate from normality by a considerable amount.

6.3.2 Pattern of relations at Time 1 and Time 2

Correlations between variables at Time 1 and Time 2 are reported in Table 2[24].

Table 2. Matrix of correlations between variables at Time 1 (lower triangle) and at Time 2 (upper triangle)

	Time 2						
Time 1	1	2	3	4	5	6	7
1. Listening text comprehension (TOR 3-8)	-	.60*	.52*	.39*	.37*	.31*	.45*
2. Verbal intelligence (VIQ)	.55*	-	.53*	.50*	.36*	.20	.50*
3. Receptive Vocabulary (PPVT-R)	.50*	.55*	-	.45*	.32*	.12	.53*
4. Short-Term Memory	.27*	.27*	.38*	-	.38*	.20	.37*
5. Working Memory	.34*	.28*	.17	.22	-	.29*	.41*
6. Use of Context	.34*	.28*	.26*	.18	.27*	-	.26*
7. Inferential skills	.48*	.42*	.36*	.29*	.34*	.31*	-

* $p = .002$ (Bonferroni correction: .05/21 = .002)

As it can be seen from Table 2 the pattern of interrelations between variables at both time points is similar. The predictors considered in the present investigation were correlated with listening text comprehension at Time 1 and Time 2.

The correlations between variables evaluated at Time 1 and listening text comprehension at Time 2 and the autocorrelation between listening text comprehension at Time 1 and Time 2 are reported in Table 3.

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[24] A measure of the ability to use context was obtained trough a regression analysis in which raw scores for sentence comprehension in and out of context at Time 1 and Time 2 were the dependent and independent variables respectively (for a more detailed description of this procedure see Study 3, Chapter 4 of this work)

Table 3. Matrix of correlations between variables at Time 1 and listening text comprehension at Time 2

	Time 2 : Listening text comprehension (TOR 3-8)
Time 1	
1. Listening text comprehension (TOR 3-8)	.59*
2. Verbal intelligence (VIQ)	.52*
3. Receptive Vocabulary (PPVT-R)	.49*
4. Short-Term Memory	.29*
5. Working Memory	.28*
6. Use of Context	.36*
7. Inferential skills	.37*

$*p = .007$ (Bonferroni correction: $.05/7 = .007$)

As it can be seen from Table 3, the autocorrelation between listening text comprehension at Time 1 and 2 was high. Correlations between listening text comprehension at Time 2 and variables evaluated at Time 1 were; a) high as far as verbal ability, namely verbal intelligence and receptive vocabulary, are considered, b) small to moderate for verbal short-term and working memory and c) moderate for text-level components, namely the ability to use context and inferential skills. These results showed that all the component skills evaluated at Time 1 were associated with later listening text comprehension.

6.3.3 Identification of longitudinal predictors of listening text comprehension: Is there any evidence for causal relations?

Longitudinal contributions were analyzed using path analysis models (structural equation models with observed variables) and the final aim was to identify the most parsimonious model that describes the relevant longitudinal and causal relations between predictors of text comprehension evaluated at Time 1 and listening text comprehension at Time 2. Stated clearly, the main aim of the study was to identify the predictors that uniquely contribute to listening text comprehension at Time 2, over and above the effect of the autoregressor, in order to identify causal predictors, and longitudinal or indirect relations, namely relations between predictors at Time 1 and text comprehension at Time 2 that were accounted for by the relationship with listening text comprehension evaluated at an earlier time point.

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Path analysis models were computed using the LISREL 8.7 statistical package (Jöreskog & Sörbom, 1996). Because path analysis is based on the assumption of multivariate normality of the observed data, the issue of normality was considered. For this purpose, Mardia's measure of relative multivariate kurtosis (MK) was obtained via the PRELIS program (Jöreskog & Sörbom, 1993). For the present sample the MK was 1, a value that implies non significant departure from normality (-1.96< z < 1.96; Mardia 1970).

In the present study the independent variables were verbal intelligence, receptive vocabulary, short-term and working memory, inferential skills and the ability to use context. The autoregressor was listening text comprehension at Time 1 and the dependent variable was listening text comprehension at Time 2. Standard scores for the test TOR 3-8 were used in the path analysis in order to control for the effect of age on listening text comprehension at Time 1 and Time 2. We did not control for the effect of age on the relation between our components and text comprehension; this choice was based on the results emerged from the cross-sectional studies which showed that age did not act as a moderator on the relations between our components and text comprehension in a two-years period. Based on this finding an effect of age on the relation between our components and text comprehension was not expected, at least when longitudinal relations are analyzed after a relatively short-period of time as in this work.

The fit of the model was evaluated taking into account multiple criteria and various measures simultaneously (Schermelleh- Engel, Moosbrugger, & Muller, 2003); the traditional chi-square text (χ^2) and the Root Mean Square Error of Approximation (*RMSEA*), the Nonnormed Fit Index (*NNFI*), the Comparative Fit Index (*CFI*), and the Akaike Information Criteria (*AIC*). These measures include both measures of the overall model fit and measures based on model comparisons. A model might be interpreted as having a good fit if the χ^2 is non significant, the *RMSEA* value is less than .08, the *NNFI* and *CFI* values are greater than .97[25]. The *AIC* used to compare alternative models, is an index of parsimony and it can be interpreted only with reference to the AIC of the other competing models; the most parsimonious model is that with the lowest AIC[26]. We started from the full model, namely Path Model 1 (see Table 4), which included all the considered independent and dependent variables. Independent variables at Time 1 were allowed to co-vary, direct and indirect paths between independent variables at Time 1 and text comprehension at Time 2 and the autoregressive path between

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[25] *NNFI* and *CFI* values in general range between 0 and 1, but for *NNFI*, which is a non normed index, values can be outside the 0-1 range.
[26] The *AIC* index was used to compare nested models, namely to compare two models in one of which a path has been deleted.

listening text comprehension at Time 1 and Time 2 were included. Afterwards variables were deleted mainly considering their weight and their significance, in order to find the more parsimonious model which provided a good fit to the data.

Table 4. Direct and indirect effects predicting listening text comprehension at Time 2 and total standardized regression weight (R^2) in Path Models 1, 2, 3, 4, 5, 6.

Dependent variable	Independent variable	Direct effects β	Direct effects z	Indirect effects β	Indirect effects z	Total R^2
Path Model 1						
Listening text comprehension Time 2						.45
	Verbal intelligence	.18	2.03	.09	3.05	
	Receptive Vocabulary	.16	2.09	.08	2.33	
	Short-term memory	.05	0.82	0	0.05	
	Working memory	.04	0.78	.04	1.62	
	Inferential skills	.01	0.08	.07	2.46	
	Use of context	.13	1.82	.04	1.56	
	Listening text comprehension Time 1	.34	4.30			
Path Model 2						
Listening text comprehension Time 2						.45
	Verbal intelligence	.18	2.04	.09	3.10	
	Receptive Vocabulary	.16	2.10	.08	2.33	
	Short-term memory	.05	0.71	0	0.05	
	Working memory	.04	0.84	.04	1.64	
	Inferential skills			.07	2.51	
	Use of context	.13	1.83	.04	1.56	
	Listening text comprehension Time 1	.34	4.30			
Path Model 3						
Listening text comprehension Time 2						.44
	Verbal intelligence	.19	2.13	.09	3.12	
	Receptive Vocabulary	.16	2.05	.08	2.37	
	Short-term memory	.06	0.93	0	0.05	
	Working memory			.04	1.61	
	Inferential skills			.07	2.54	
	Use of context	.13	1.96	.04	1.58	
	Listening text comprehension Time 1	.35	4.36			
Path Model 4						
Listening text comprehension Time 2						.44
	Verbal intelligence	.19	2.16	.10	3.14	
	Receptive Vocabulary	.18	2.36	.08	2.41	
	Short-term memory			0	0.05	
	Working memory			.04	1.61	
	Inferential skills			.07	2.54	
	Use of context	.14	2.01	.04	1.58	
	Listening text comprehension Time 1	.35	4.38			
Path Model 5						
Listening text comprehension Time 2						.44
	Verbal intelligence	.19	2.16	.10	3.15	
	Receptive Vocabulary	.18	2.36	.08	2.49	
	Working memory			.04	1.60	
	Inferential skills			.07	2.51	
	Use of context	.14	2.02	.04	1.58	
	Listening text comprehension Time 1	.35	4.39			
Path Model 6						
Listening text comprehension Time 2						.44
	Verbal intelligence	.19	2.17	.10	3.18	
	Receptive Vocabulary	.18	2.37	.08	2.46	
	Inferential skills			.09	2.67	
	Use of context	.14	2.02	.05	1.85*	
	Listening text comprehension Time 1	.35	4.39			

* corresponding to a *p* value of about .06

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We first looked at the direct relations between predictors at Time 1 and listening text comprehension at Time 2 and afterwards indirect relations were considered.

In Path Model 2, the direct relation between inferential skills at Time 1 (β = .01) and text comprehension at Time 2 was deleted because was low and not significant (see the weight of predictors in Table 4); therefore, contrary to expectations formulated based on the previous literature (e.g., Oakhill & Cain, 2007b), inferential skills did not uniquely predict text comprehension across time. The model showed a good fit ($\chi^2(1, n = 152) = 0.10, p = 0.93, RMSEA = 0; NNFI = 1.05; CFI = 1; AIC = 70.01$); the direct relations between verbal intelligence and receptive vocabulary, on one hand, and listening text comprehension at Time 2, on the other hand, were significant, whereas the direct relation between the ability to use linguistic context and text comprehension at Time 2 was not.

In Path Model 3, the direct relation between working memory at Time 1 (β = .04) and text comprehension at Time 2 was deleted. The model had a good fit and is more parsimonious than the previous one (see the *AIC* value that is lower than that in the previous model) ($\chi^2(2, n = 152) = 0.50, p = 0.77, RMSEA = 0; NNFI = 1.04; CFI = 1; AIC = 68.50$). In this model the relation between the ability to use the linguistic context and text comprehension at Time 2 was significant. In Path Model 4, also the direct relation between short-term memory at Time 1 (β = .05) and listening text comprehension at Time 2 was deleted. This model still provided a good fit ($\chi^2(3, n = 152) = 1.35, p = 0.72, RMSEA = 0; NNFI = 1.03; CFI = 1; AIC = 67.35$). These results are in line with some of the literature on reading comprehension in showing that verbal working memory is not causally related to text comprehension (Oakhill & Cain, 2007b). Listening text comprehension was directly predicted by verbal intelligence, receptive vocabulary and the ability to use linguistic context. In sum, these results supported the existence of a causal relation between verbal intelligence, receptive vocabulary the ability to use the linguistic context, on one hand, and listening text comprehension, on the other hand.
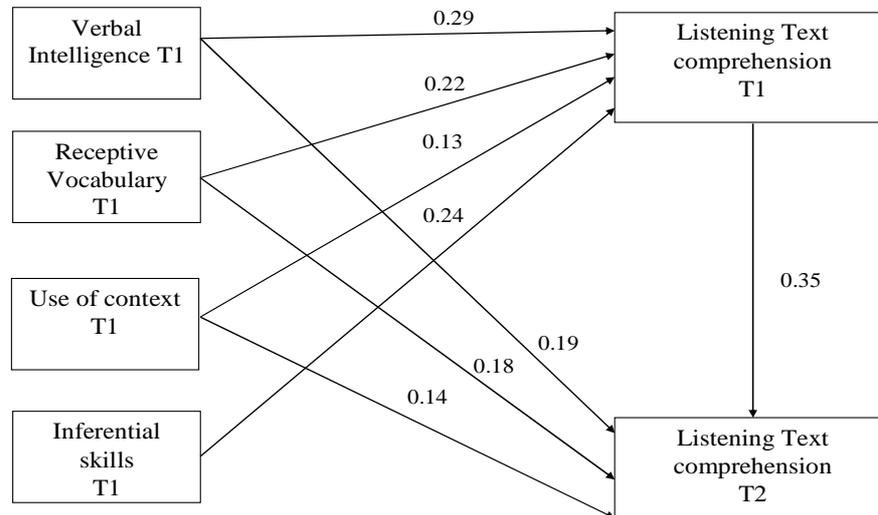
In the following Path Models indirect relations between predictors at Time 1 and text comprehension at Time 2 were considered. In Path Model 5, short-term memory was deleted form the model because it had not an indirect effect on listening text comprehension at Time 2. The exclusion of this variable did not impact on the overall fit of the model that was good ($\chi^2(2, n = 152) = 0.70, p = 0.71, RMSEA = 0; NNFI = 1.03; CFI = 1; AIC = 52.71$). Verbal intelligence, receptive vocabulary and inferential skills showed significant indirect effects on text comprehension at Time 2. In Path Model 6 the indirect effects between working memory and the ability to use linguistic context, on one hand, and listening comprehension at Time 2, on the other hand, were took into account; neither of the two indirect effects was significant and the path between the two predictors and text comprehension at

Time 1 had almost the same weight, with the coefficient for working memory being slightly higher than the one for the use of context (β = .13 and β = .11, respectively). We choose to delete working memory from the model and to maintain the indirect relation between the ability to use linguistic context and text comprehension at Time 2. This choice was mainly based on the evidence of a direct relation between the ability to use context evaluated at Time 1 and text comprehension at Time 2; due to the presence of this direct path, the exclusion of the indirect relation will result in a less stable model. The model provided a good fit to our data (χ^2(1, n = 152) = 0.11, p = 0.74, *RMSEA* = 0.00 ; *NNFI* = 1.03; *CFI* = 1; *AIC* = 40.11); the path between the ability to use context at Time 1 and text comprehension at Time 1 became significant (β = .14, see Figure 1), the indirect effect between the ability to use context at Time 1 and listening text comprehension at Time 2 was only marginally significant (z = 1.85). Although marginally significant, we did not delete this path based on the same rationale used for selecting predictors in Path Model 6. This choice was supported by the results obtained on an additional model in which the path between the ability to use linguistic context and text comprehension at Time 1 was deleted; the fit of the model was worse than the one of Path Model 5 as indicated by the higher AIC (χ^2(2, n = 152) = 2.13, p = 0.12, *RMSEA* = 0.09 ; *NNFI* = 0.99; *CFI* = 0.99; *AIC* = 42.26). In conclusion, the more parsimonious model is Path Model 6 which is represented in Figure 1. Path Model 6 showed that listening text comprehension was causally predicted by verbal intelligence, receptive vocabulary and the ability to use linguistic context. In addition, inferential skills were specifically related to later listening text comprehension.

Figure 1. Standardized solution for Path Model 6 (χ^2(1, *n* = 152) = 0.11, *p* = 0.74, *RMSEA* = 0.00 ; *NNFI* = 1.03; *CFI* = 1; *AIC* = 40.11) [27]

6.4 Discussion

The present study analyzed both longitudinal and causal relations between specific concurrent predictors and listening text comprehension evaluated at a later point in time in preschool children. The predictors and listening text comprehension were evaluated at two time points at a distance of 6- to 8-months. Studies that analyzed longitudinal and specifically causal relations are crucial to: a) inform theoretical models of text comprehension development in that these investigations identify some component skills that play a significant role in text comprehension development and b) inform educational and practical interventions in that these investigations identify component skills that might be fruitfully trained to foster text comprehension and to remediate text comprehension difficulties (e.g. Cain & Oakhill, 2007b).

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[27] Correlations between independent variables at Time 1 are considered but not reported in the path diagram (the standardized coefficients for correlations between verbal intelligence, on one hand, and receptive vocabulary, use of linguistic context and inferential skills, on the other hand, were 0.55, 0.42 and 0.28 respectively; correlations between receptive vocabulary, on one hand, and use of linguistic context and inferential skills, on the other hand, were 0.36 and 0.26 respectively; correlation between use of linguistic context and inferential skills were 0.31)

Study 5. Longitudinal and causal relations

The results of the present investigation showed that the pattern of relations between skills at both points in time was similar and that all the specific predictors at Time 1 were associated with text comprehension at Time 2. The path analysis was carried out to identify possible causal relations and longitudinal predictors. In the final model verbal intelligence, receptive vocabulary and the ability to use linguistic context were directly related to later text comprehension; these skills have a causal effect, at least in the short-time, on the development of text comprehension ability. The other higher-level component we took into account, namely inferential skills, was only indirectly related to later text comprehension ability; this skill has a specific effect on later text comprehension which is accounted for by its relationship with listening text comprehension evaluated at an earlier time point. Nor short-term neither working memory were retained in the final model. The main findings of the present study are discussed below.

As far as verbal intelligence is concerned, we found that this variable was related to later listening text comprehension and the specific role played by verbal intelligence was confirmed in the path analysis, in which verbal intelligence was related, both directly and indirectly, to text comprehension across time, even when the contribution of other specific predictors was taken into account. The most relevant result, however, was that verbal intelligence showed a direct effect on listening text comprehension at Time 2 over and above the effect of listening text comprehension at Time 1. This result is in line with and extends findings of previous studies which have adopted either a CAM or a longitudinal design, in which verbal intelligence or vocabulary depth was causally related to reading comprehension (e.g., Oakhill & Cain, 2007b; Roth et al., 2002; Stothard & Hulme, 1996). It is worth noting that verbal intelligence had the larger effect on later listening text comprehension ability compared to all the other components: the total effect of this variable (i.e., the sum of direct and indirect effects) was (β) .29. Catts and colleagues (Catts, Fey, Zhang, & Tomblin, 1999) claimed that IQ, should not be included as a control variable in longitudinal studies on text comprehension, because this general measure that usually accounts for a large proportion of variance, has not a clear relation with text understanding and therefore it is difficult to understand what this measure actually explains. However, in our investigation, the verbal intelligence or vocabulary depth measure was expected to be related to listening text comprehension because it reflects the complexity of the semantic representations of the words and their organization in the semantic system.

The results we found for receptive vocabulary resemble those reported for verbal intelligence; receptive vocabulary was a specific predictor of later text comprehension and was causally related to listening text comprehension evaluated at 6- to 8- months of distance. These findings are in line with

and extend previous studies which evaluated receptive vocabulary in school-age and preschool children and found specific longitudinal and causal relations with reading comprehension (e.g., de Jong and van der Leij, 2002; Seigneuric & Ehrlich, 2005; Sénéchal et al., 2006). In addition, in line with the results reported by Cain and Oakhill (2007) the effect of receptive vocabulary was not completely intertwined with that of verbal intelligence, even though a large correlation emerged between the two skills at Time 1 and with text comprehension at Time 2. Based on this result, it may be argued that both the amount of words a child knows, namely the size of the lexicon (i.e., vocabulary breadth, see Study 4, Chapter 5 of this work), evaluated with measures of receptive vocabulary, and more complex measures that evaluate the child's knowledge of the meaning of the words (i.e., verbal intelligence or vocabulary depth) have a causal effect on listening text comprehension. The total effect of verbal intelligence and receptive vocabulary on text comprehension was similar ($\beta = .29$ and $\beta = .25$ for verbal intelligence and receptive vocabulary respectively) and the two skills together had the largest effect on later listening text comprehension. Overall, these results support the important role played by general verbal ability in young children's listening text comprehension.

The results of our study showed that not only more basic or lower-level component skills such as verbal ability, but also higher-level component skills, namely the ability to use linguistic context, were casually related to listening text comprehension. This component was both directly and indirectly related to later listening text comprehension and its total effect on text comprehension, even though lower than the total effect of verbal ability, was not trivial ($\beta = .18$). Based on these results, it may be concluded that a skill that has been shown to be related to the meaning-based aspects of text processing in older children (Cain & Oakhill, 2007b), is also causally involved in young children's text comprehension. Moreover the minor role played by the ability to use linguistic context with respect to verbal ability is in line with claims that lower-level skills might play a more relevant role than higher-level components in younger children's text comprehension (e.g., Scarborough, 2005). The ability to generate inferences from short and simple sentences was not causally related to later text comprehension. The presence of a causal effect for the ability to use context but not for inferential skills needs to be further examined. However, a possible explanation might be proposed considering that the use of context mainly evaluates the ability to link-up information provided in the text, namely information that is explicitly given but has to be connected, on the other hand, the inferential task also required to search for relevant knowledge in long-term memory in order to fill in missing information in a text. It might be possible that in the young participants of the present study the ability to make knowledge-based inferences is not well developed enough to have a causal relation with listening text

comprehension. Findings reported by Cain and Oakhill (1999) in part support this interpretation; poor comprehenders obtained lower performance than the younger comprehension-match group on the text-based inferences but not in the knowledge-based inferences, suggesting a causal role for the first type of inference. In future work, the use of a new version of the inferential task adopted in the present investigation, with an higher number of items that allows a more fine-grained distinction between the ability to integrate information in a text and with previous world knowledge to be made, might further clarify the current results. In the interpretation of these findings one should also bear in mind that higher-level skills were assessed using experimental tasks constructed on purpose for the present investigation. The different results obtained for the two higher-level components might be explain, among other reasons, considering that these measures are not robust as the measures we used for the evaluation of verbal ability. These results clearly need further investigation, nevertheless their relevance in supporting an involvement of higher-level components as predictors of listening text comprehension development in very young children is not negligible.

Finally, short-term and working memory were associated with listening text comprehension evaluated at Time 2 but neither of the two variables were related directly or indirectly with later listening text comprehension. The absence of a causal relation between short-term memory and listening text comprehension was expected based on previous studies on reading comprehension (e.g., Dufva et al., 2001; Stothard & Hulme, 1992). As far as the causal role of working memory is concerned, mixed findings have been reported in the literature (Oakhill & Cain, 2007b; Seigneuric & Ehrlich, 2005); the results emerged in the present work support the absence of a causal relation between working memory and listening text comprehension are in line with previous literature in which the working memory did not emerged as a direct predictor of text comprehension when compared to other skills that include higher-level components (Oakhill & Cain, 2007b). Future studies in which the longitudinal relations between working memory and text comprehension are evaluated at more than two time points are needed to establish whether working memory might emerge as a direct predictor of text comprehension at a later time point compared to other variables such as receptive vocabulary, as found by Seigneuric and Ehrlich (2005). In addition, working memory was not indirectly related with later listening text comprehension at Time 2; this result means that working memory was not specifically related to text comprehension at Time 2 through its effect on listening text comprehension evaluated at an earlier time point. This finding however should treated with caution based on the results emerged in Path Model 5 in which working memory and the ability to use linguistic context showed similar indirect effects on text comprehension at Time 2.

Study 5. Longitudinal and causal relations

In sum, this is the first investigation that explored longitudinal and causal relations between concurrent predictors and listening text comprehension in preschool children. The results of the present study suggest that the development of listening text comprehension, at least in a short-time period, rests mainly on verbal ability but also on higher-level component skills such as the ability to use linguistic context.

Chapter 7

General Discussion and Conclusions

7.1 Concurrent and longitudinal relations between cognitive and linguistic components and listening text comprehension: Main findings

The main aim of the present work was to analyze the role played by some relevant cognitive and linguistic component skills in listening text comprehension in 4- to 6-year-old Italian children who are not yet exposed to formal instruction. Five studies were described in which the concurrent and longitudinal relations between listening text comprehension and relevant component skills were considered; the results showed that not only more basic cognitive and lower-level linguistic components but also text- or discourse-level components play a specific and in some case a causal role in young children's text comprehension. These lower-level and higher-level components account for a satisfactory amount of variance in listening text comprehension in both the cross-sectional and longitudinal investigations. The relations between listening text comprehension, on one hand, and individual variables, namely age and gender, and each component skill, on the other hand, are discussed in turn below. As far as component skills are considered, firstly, basic cognitive and lower-level linguistic components and secondly, higher-level components are taken into account. The role of each component is discussed with reference to the results emerged in both the concurrent and longitudinal studies.

In the four cross-sectional studies of the present investigation, no evidence of a significant effect of gender emerged whereas a significant and quite strong effect of age was evident. As far as the role of gender is considered, results showed that boys and girls' ability to understand the meaning of a text did not significantly differ. In addition, boys and girls' performance on the component skills was comparable. These results are in line with some studies which found that gender did not affect the language and cognitive skills of children aged 4- to 6-years (e.g., Alloway et al., 2006; Le Normand et al., 2008; Levorato & Roch, 2007). A significant and quite strong effect of age on listening text comprehension emerged in the cross-sectional study: age affected performance on listening text comprehension and on the majority of the component skills. Results of the cross-sectional study showed that the older children are, the higher is the ability to understand the meaning of a text. The significant development between 4- and 6- years was evident for both the ability to understand explicit and implicit information; no differences for the two types of information were detected even though

explicit information was easier to understand than implicit information. These findings support claims that text comprehension starts to develop early in childhood and are also in line with evidence of a significant evolution in its component skills (Alloway et al., 2006; Levorato, 1988; Phythian-Sence & Wagner, 2007; Skarakis-Doyle & Dempsy, 2008; van den Broek et al., 2005). Results of the cross-sectional studies also showed that, even though text comprehension and cognitive and linguistic component skills increased between 4 and 6 years, the relation between these skills did not change as children get older. In fact, a stability in the relations between listening text comprehension and the component skills was evident; the role played by lower- and higher-level cognitive and linguistic components on listening text comprehension was not affect by age, namely did not change in the considered two-years period. The results concerning the effect of age on listening text comprehension and the component skills, were supported by the evidence emerged in the longitudinal investigation that a period of 6- to 8-months is sufficient for a significant increase in listening text comprehension and the majority of the components to occur. In the longitudinal study, we controlled for the effect of age on listening text comprehension at Time 2 but we did not analyzed the effect of age on the longitudinal relation of each component with later text comprehension. This choice was guided by the results of the cross-sectional investigation based on which an effect of age on the relation between the considered components and text comprehension was not expected, at least when longitudinal relations are analyzed after a relatively short-period of time as in this work.

In line with most of the research on text comprehension, the results of the cross-sectional investigation showed that non verbal intelligence was not specifically related to text comprehension in the cross-sectional investigation. More generally, this result is in line with evidence that measures of cognitive abilities that require to manipulate visuo-spatial material (e.g., visuo-spatial working memory) are not related to text comprehension ability (e.g., Floyd et al., 2006). On the other hand, verbal intelligence was associated with listening text comprehension. Therefore in preschoolers, in line with results obtained with older children (e.g., Stothard & Hulme, 1996), a better and more flexible ability to manipulate verbal information is associated with a better ability to understand texts. In addition, this verbal measure which is meant to evaluate the complexity of the semantic representations of the words and their organization in the semantic system or vocabulary depth, plays a similar role in the understanding of both explicit and implicit information in the text; this result is not trivial given that explicit information is easier to process and therefore might rely on this complex ability to a lesser degree. Findings from the longitudinal investigation further clarify the nature of the relation between verbal intelligence and text comprehension, showing that this skill was both indirectly and directly

related to later listening text comprehension. These results support the existence of a longitudinal relation and more importantly, of a causal link between the two skills.

The results of the present investigation showed that listening text comprehension was related not only to verbal intelligence or vocabulary depth but also to receptive vocabulary or vocabulary breadth. In fact receptive vocabulary which evaluates the size of the lexicon, was both concurrently and causally related to listening text comprehension. It is worth noting that even though measures of vocabulary depth and breadth were related to each other (indeed the largest correlations between component skills were found for these measures), each measure uniquely accounted for text comprehension both in the cross-sectional and longitudinal investigation. In other words, individual differences in the ability to understand a text depend upon individual differences in both quantitative and more qualitative aspects of vocabulary knowledge; in order to understand a text not only most of the words presented in the text must be known, that is a semantic representation of the word's meaning must be available in the semantic system, but also the quality and the complexity of this semantic representation (i.e., the stability/the specification of the semantic representation) affect the ability to construct a coherent mental representation of the text (Perfetti, 2007; see also Pearson et al., 2007 and Phythian-Sence & Wagner, 2007 for a discussion of the alternative conceptualizations of vocabulary, its assessment and how these issues are related to the research on text comprehension). Different explanations for the relation between vocabulary (i.e., receptive vocabulary/vocabulary breadth), and text comprehension has been proposed (see Chapter 1 of this work); the results of both cross-sectional and longitudinal studies showed that the role of vocabulary breadth in listening text comprehension is not completely mediated by more complex measures of verbal intelligence or vocabulary depth and support the existence of a causal link between receptive vocabulary and listening text comprehension. In the cross-sectional investigation, there was some evidence that individual differences in vocabulary breadth influence to a different degree the ability to understand explicit and implicit information in a text. However, given that differences in the effect of vocabulary breadth on the understanding of the two types of information were small, conclusions on the role played by this component are mainly based on the results obtained when a unitary comprehension score was used in the analyses. In sum, based on the findings emerged in the present investigation, there is no doubt that verbal ability assessed using measures of vocabulary breadth and depth, plays a crucial role in young children's listening text comprehension; in fact results emerged form both the cross-sectional and longitudinal investigation showed that verbal ability plays the most relevant role.

General discussion and conclusions

As far as more basic cognitive component skills are considered, there was evidence that verbal short-term and working memory were related to preschoolers' text comprehension, at least when specific concurrent relations were considered. In fact both verbal short-term and working memory accounted for a specific amount of variance in listening text comprehension, over and above verbal ability. These results showed that, in line with most of studies on text comprehension, individual differences in the ability to store and manipulate verbal information in memory, namely in the functional capacity of working memory, are related to text comprehension; in fact in the construction of an integrated mental representation of the text, the ability to maintain pieces of information in memory but also to merge information presented in the text with information contained in other parts of the text and with previous world knowledge is crucial. Working memory also accounted for additional variance in listening text comprehension over and above the function of storage, namely short-term memory. Nevertheless, as anticipated, short-term memory also specifically contributed to listening text comprehension; these results are in line with those reported in the few studies in which the relation between short-term memory and language/listening text comprehension has been analyzed in preschoolers (Adams et al., 1999; Daneman & Blennerhassett, 1984; Dufva et al., 2001). In sum, findings emerged from the cross-sectional investigation support the existence of a direct relation between verbal short-term and working memory, on one hand, and listening text comprehension, on the other hand. In the longitudinal investigation, neither short-term nor working memory have been shown to be casually related to text comprehension. Early measures of verbal short-term and working memory were associated with listening text comprehension across time, but neither variable was directly or indirectly related with later text comprehension when the other predictors and early listening text comprehension were considered. These results suggest that the effect of verbal short-term and working memory on later text comprehension is explained by their relation with the other components and with early text comprehension. To conclude, based on the results emerged in this work, short-term and working memory are involved in preschoolers' listening text comprehension but these components do not play a causal role.

Findings of the present work showed that syntactic knowledge or the ability to understand sentences, unlike the basic or lower-level components previously taken into account, did not play a specific role in listening text comprehension. In fact, the results of the cross-sectional investigation showed that the role played by the ability to understand sentences was mediated by lower-level lexical, semantic and cognitive components, and by a higher or text-level component, that is the ability to use linguistic context.

General discussion and conclusions

The above mentioned result concerning the role played by the ability to use linguistic context and the one concerning the role played by the ability to generate inferences in listening text comprehension showed that preschoolers' text comprehension was also explained by text- or discourse-level component skills. As far as concurrent relations were considered, the ability to use linguistic context explained a specific amount of variance in text comprehension over and above verbal ability, working memory and the ability to understand isolated sentences. In a similar way, inferential skills accounted for unique variance over and above verbal ability and working memory. These findings are in line with evidence that preschool children are able to engage in this kind of processes in order to understand a text (e.g., Kendeou et al., 2008; Skarakis-Doyle, 2002; see also Cain et al., 2009) and extend results obtained in older children showing that higher-level components account for additional variance in text comprehension over and above more basic or lower-level components (e.g., Cain, Oakhill, & Bryant, 2004). In addition, these text- or discourse-level components affect the processing of every type of verbal information in a text in a top-down manner; in fact they facilitated the understanding of both explicit and implicit information presented in a meaningful linguistic context. Results from the longitudinal study showed the existence of longitudinal relations between text-level components and listening text comprehension; both the ability to generate inferences and to use linguistic context were indirectly related to later text comprehension. More importantly, the ability to use linguistic context was also causally related to listening text comprehension, as showed by the existence of a direct relation with later listening text comprehension. Therefore, overall the results confirm that text-level components are prerequisites or at least, facilitates the development of text comprehension in young children. The presence of a causal effect for the ability to use context but not for inferential skills clearly needs to be further explored. However a possible explanation proposed in this work is that the inferential task does not only evaluate the ability to link up information in the text as the task of the use of context, but also evaluates the ability to search for relevant knowledge in long-term memory to fill in missing information in the text; this latter ability might be not well developed enough in the young participants of the present work to exert a causal influence on listening text comprehension.

In sum, in the present investigation the concurrent and longitudinal relations between text comprehension and different component skills were analysed in children aged 4- to 6-years. Overall, verbal ability, namely vocabulary breadth and depth, is the most relevant factor in accounting for individual differences in listening text comprehension in both the concurrent and longitudinal investigations. However, other components play a significant role over and above verbal ability, and

specifically the most relevant finding is that text-level components are specifically and causally related to listening text comprehension.

This work addresses some important aspects related to individual differences in text comprehension in preschoolers; even though some limits of the present analysis need to be acknowledged. The results have important theoretical and educational/practical implications. These implications as well as limits and future directions of the present investigation are discussed in the next paragraphs.

7.2 Theoretical implications

This investigation has relevant theoretical implications for the understanding of the development of text comprehension from the first phases of its acquisition and for the identification of the components involved in the process and their role at different points of development. The previously discussed findings support multi-component models of text comprehension, whose validity have been tested mainly for reading comprehension in school-age children, for listening text comprehension in preschool-children. In fact, based on the results emerged in this work, listening text comprehension may be described as a complex construct that involves many different cognitive and linguistic components that allow the processing of textual information at word-, sentence- and text or discourse-level to be made. These components interact in the construction of a coherent mental representation of the text and the processing of the linguistic information at a specific level affects the processing of linguistic information at the other levels in both a bottom-up and top-down manner. These results therefore are in line with claims and recent evidence that the processes necessary to construct a mental representation of the text as well as the product of text comprehension are the same for both written and oral texts (Cain & Oakhill, 2007; Gernsbacher, 1990; Kendeou, Savage, & van den Broek, 2009; Kendeou, White, van den Broek, & Lynch, 2009; Kintsch, 2005; Hoover & Gough, 1990). The first statement expresses a conceptualization of the relation between reading and listening text comprehension that has originally been proposed in the eighties (e.g., Sticht & James; 1984 who proposed the *"unitary process view"*) and has been further developed by Hoover and Gough (1990) in the "*Simple View of Reading*" model. The Simple View of Reading is a model of written text comprehension, but it is relevant for the present discussion because it has analyzed the relation between reading and listening text comprehension and its development over time (see also the next paragraph). Based on this model reading comprehension can be conceptualized as the product of decoding and listening (or language) comprehension and with the exception of translating written symbols in spoken

forms (decoding), listening and reading comprehension are based on the same general comprehension process. Evidence from studies carried out on English speaking children (e.g., Cutting & Scarborough, 2006; Hoover & Gough, 1990; Kendeou, Savage et al. 2009; Kendeou, White et al., 2009; Muter et al., 2004; Nation & Snowling, 1997; Roth et al., 2002; Sears & Keogh, 1993; Spear-Swerling, 2006) but also on children speaking more transparent languages such as Italian (e.g., de Jong & Van der Leij, 2002; Droop & Verhoeven, 2003; Megherbi, Seigneuric, & Ehrlich, 2006; Pazzaglia, Cornoldi & Tressoldi, 1993) has showed that different underlying skills contribute to the development of general comprehension skills and decoding. Therefore the outcome of skilled comprehension is not "modality specific"; this product, whether the text is written or oral, always involves more than simply memory for the words and propositions in the text in that it requires the construction of a representation of the meaning of the text that is coherent, integrated, and complete[28].

The results of the present work also allow the role played by the different components of text comprehension in different points of development to be compared. As discussed above, there is evidence that the relation between some relevant components and listening text comprehension is stable between 4- and 6-years. However some changes in the role played by lower-and higher-level components might be apparent when older school-age children are considered. The present investigation is not concerned with the relations between reading and listening text comprehension, but indirect comparisons with the results obtained for written text in older children could be made. Overall, the present findings, in line with research on school-age children, support the relevant role played by several components: verbal memory as far as concurrent relations are concerned and general verbal ability and text-level components as far as both concurrent and longitudinal/causal links are considered. In sum, there are important similarities in the components involved in listening and reading comprehension at different points of development. However, some differences also are evident in that the relative importance played by some components seems to change during development; particularly, the role played by text-level components seems to be more important in older than in younger children, on the other hand, the role of verbal ability seems to be more important (or at least not less important) in younger than in older children. In sum, these results support an involvement of the same relevant components in both listening and reading comprehension, however at the same time they suggest that their relative importance might change during development (e.g. Scarborough, 2005). In the interpretation of these results, it is worth noting that the overall amount of variance explained by the

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[28] The literature on the "Simple View of Reading" presented in this and in the next paragraph was analyzed in a review carried out between January-April 2009 under the supervision of Dr. Kate Cain at Lancaster University (UK).

components analyzed in the present investigation seems to be lower than that explained in written text comprehension in older children (see also below).

7.3 Educational and practical implications

The present investigation also has important educational and practical implications for interventions aimed to foster text comprehension development and to prevent text comprehension failure from an early age. These implications are relevant for the development of general comprehension process, namely for both the development of listening and later reading comprehension. In fact there is not only evidence that listening text comprehension affects later reading comprehension, but also that the influence of listening text comprehension on reading comprehension increases during the course of development [29] (e.g., Catts at al., 2006; Chen & Vellutino; 1997; Florit, Levorato & Roch, 2008; Gough, Hoover, & Peterson, 1996; Megherbi et al., 2006; Müller & Brady, 2001; Storch & Whitehurst, 2002). Moreover, the present work is particularly important because it identifies some specific components that are causally related to the development of listening text comprehension which, based on indirect comparisons, also play a critical role in reading comprehension.

Findings of this work indicate that early educational practices and interventions on text comprehension should mainly focus on verbal ability and integrative and inferential skills. Specifically, these practices should aim to increase both the number of the meanings of the words known by the children and the organization and the stability of these representations in the semantic system. These improvements might be accomplished through direct methods of instruction in vocabulary and also through methods focused on the ability to infer new words meanings form context (Phythian-Sence & Wagner, 2007). The latter method has been shown to be effective in school-age children and the present investigation has shown that even preschool children are able to use the linguistic context to acquire new information, suggesting that this method might be applied to very young children (see Study 3, Chapter 4 of this work). Overall, the results on the role played by the ability to use linguistic context and inferential skills emerged in the present investigation underline the importance of early interventions aimed to foster children's ability to link up ideas in a text and with previous world knowledge. There is evidence that trainings and interventions studies focused on integrative and inferential skills are effective in improving text comprehension in older children (see Chapter 1 of this work) and, as for the interventions on vocabulary discussed before, evidence from this research that

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[29] It is also worth mentioning that the influence of listening text comprehension on reading comprehension increased even earlier in children speaking transparent languages (e.g., Megherbi et al., 2006).

preschoolers are able to engage in this processes, suggests that these skills may usefully be taught also to younger children.

In sum, the findings of the present investigation showed that listening text comprehension ability is related to the semantic aspects of language and emphasize the importance of educational practices and interventions aimed to improve the ability to access and use previous word and world knowledge.

7.4 Future directions

This conclusive paragraph aims to underline some limitations of the present investigation and issues that future research on text comprehension in young children should further explore.

The present investigation analyzed the concurrent and longitudinal relations between relevant cognitive and linguistic component skills and listening text comprehension and therefore allow the nature of the relations between these skills in preschool children to be explored and clarified. The longitudinal study has specifically considered the direct paths of causality between specific components and text comprehension, however, it is likely that the pattern of relations is far more complex. In fact, the present work (in particular the cross-sectional analysis) showed that the components involved in text comprehension are correlated and tend to interact with each other. Moreover, reciprocal relations, where expertise in one component leads to gains in text comprehension which in turn leads to further gains in the specific component, are likely to exist. Therefore, future research should explore in more detail how the component skills involved in text comprehension interact as far as longitudinal relations are considered, and moreover, reciprocal relations should also be analyzed. Based on the results emerged in the present work, future research should specifically explore the reciprocal relations between verbal ability and higher-level component skills; in fact recent research on older children (see Chapter 1 of this work) supports the existence of reciprocal (causal) relations between both components and text comprehension. The analysis of the reciprocal relations has important theoretical and practical implications because it can explore whether and how the ability to understand texts, which are pervasive in young children's lives, might affect the development of other linguistic and cognitive skills. As far as the longitudinal investigation of the present work is considered, it is also worth noting that it has analyzed longitudinal relations in a relatively short period of time. Even though the present findings have shown that this period of time is sufficient for a significant development in text comprehension and related skills to occur, future research should consider a more extended period of time in order to analyze longitudinal and causal relations in the long-term. In a future analysis, the

effect of age on the longitudinal relations between cognitive and linguist components and listening text comprehension should also be considered. Finally, future longitudinal work should also extend the analysis of the role played by these components to reading comprehension; in fact in the present investigation conclusions about the development of text comprehension and practical/educational implications were based on the well established evidence of a relation between the ability to understand oral and written texts. Future work, however, should provide direct evidence of the influence of the considered components on reading comprehension.

In one of the previous sections (see the paragraph on theoretical implications) it has been noted that the overall amount of variance explained by the components analyzed in this investigation seems to be lower than that explained in text comprehension in older children exposed to formal instruction. A possible interpretation of this result could be provided by research that has analyzed the influence of genes and environmental factors on children's early progress on literacy (Byrne et al. 2009; Harlaar, Hayiou-Thomas, Dale, & Plomin, 2007; Hoekstra, Bartels, van Leeuwen, & Boomsma, 2009; Keenan, Betjemann, Wadsworth, DeFries, & Olson, 2006). For the purpose of this discussion, the work carried out by Byrne and colleagues is mainly considered and briefly described. The International Longitudinal Twin Study (for a review of the work carried out by the researchers who have contributed to this project see Byrne et al., 2009) analyzed the relative influence of genetic and environmental factors on early literacy in monozygotic and same-sex dizygotic twin children. The sample included children from Australia, Norway, Sweden and USA. Monozygotic twins share all of their genes whereas same-sex dizygotic twins share on average half of their segregating genes; based on the assumption that within families both types of twins share equally similar environments, research on these two types of twins allow the identification and separation of the effects of genetic influences, on one hand, and environmental influences, on the other hand, to be realized. This work is relevant for the present discussion because it analyzed genetic and environmental influences on language and literacy skills among which reading comprehension is included, form preschool to the early school years. Results have shown that preschool language skills such as vocabulary/syntax were relatively more influenced by the environment whereas genetic factors exerted substantial influence on both language and reading comprehension in the first years of school. This work suggests that the extent to which genes and environments affect language and literacy skills depend in part upon the exposure to formal instruction and that in preschool, when children are not yet exposed to formal instruction, variability in language is highly determined by environmental influences. In present work, therefore, it might be argued that the variance explained by the cognitive and linguistic components in listening text comprehension was

lower because in preschoolers environmental factors, which were not the focus of the present investigation, might exert a higher influence on language and text comprehension. This consideration suggests that future research on text comprehension in young children should consider to the role played by environmental factors, such as home literacy environment and preschool educational practices. It is also worth noting that an in depth analysis of the role played by the environment might also help to clarify which factors account for the quite strong effect of age, a general variable in which both genetic and environmental factors are likely to be involved, detected in this work and the low performance obtained by the participants in the receptive vocabulary task. In the discussion of the present work, as far as the methodological aspects are considered, it is also worth mentioning that single indictors of the constructs of interest were used; the use of multiple indicators which is frequent in large-scale text comprehension studies, would obviously lead to more robust results.

A final aspect that deserves some discussion concerns the text- or discourse- level components considered in the present work. A very important result emerged in this investigation is that text- or discourse- level components, namely the ability to use linguistic context and inferential skills, play a specific and causal role in early text comprehension. Research on text comprehension in young children has also provided evidence that preschool children are able to engage in other text- or discourse- level components such as comprehension monitoring and knowledge of the story structure. In addition, there is evidence that these components play a relevant role in school-age children written text comprehension (see Chapter 1 of this work). Taken together these findings suggest that future research should also analyze the role of these components in order to test whether or not they play a role in early text comprehension and whether their role changes during development.

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Appendix A

Lists of words used in the forward and in the backward word span to evaluate short-term and working memory.

Practice trials:
PONTE (BRIDGE), TESTA (HEAD)
TORO (BULL), FORNO (OVEN)

2a	GAMBA	MAMMA			
2b	CASA	SOLE			
2c	GATTO	NONNA			
2d	CANE	PERA			
3a	LUNA	APE	ACQUA		
3b	TERRA	CORVO	MELA		
3c	MANO	CIELO	FIORE		
3d	VOLPE	PALLA	NASO		
4a	MARE	GALLO	CALZA	SCUOLA	
4b	CARTA	AUTO	GIOCO	LATTE	
4c	BOSCO	CLASSE	TOPO	OCCHIO	
4d	OCA	BOCCA	STELLA	PRATO	
5a	PORTA	FESTA	SCIMMIA	FIUME	LIBRO
5b	NEVE	DONNA	CUORE	FOGLIA	PESCE
5c	UOMO	VENTO	LUCE	MUCCA	GONNA
5d	PIOGGIA	PIEDE	ERBA	RANA	TAZZA

6a	ORSO	LAGO	PENNA	FUOCO	DITO	ROSA
6b	BARCA	FOGLIO	LUPO	CROCE	PASTA	BORSA
6c	VISO	PIZZA	CHIESA	BUSTA	TIGRE	SCIARPA
6d	FIABA	PESCA	NAVE	LETTO	SOLDI	FOCA

The forward word span task was presented as the "Parrot's game" in that children were required to repeat the list of words in the same order. The backward word span task was presented as the "Crazy Parrot's game" in that children were required to repeat the list of words in the reverse order.
In the more complex backward word span task, one of the child's hands was used as a visual support; for instance, when lists of two words were considered, the experimenter pronounced the first word (e.g., PONTE-BRIDGE) and at the same time touched the thumb of the child, then she pronounced the second word (e.g., TESTA-HEAD) and touched the index finger. Afterwards the experiment touched the two fingers in the reverse order one at time and asked the child to firstly say the second word (e.g., TESTA-HEAD) and then the first word (e.g., PONTE-BRIDGE).

Appendix B

Example of one linguistic context used in Study 4B ending with a target sentence (in bold)

Linguistic context

It is evening time. The dog wants its puppies to go to sleep.

Target sentence from the PVCL (test of sentence comprehension out of context).

The dog goes into the doghouse after the puppies went in.

The experimenter told the child that she was going to tell him/her short stories and he/she had to pay attention. Firstly, the experimenter pronounced the two sentences that constituted the linguistic context and secondly she presented the set of four pictures provided for each item of the test of sentence comprehension out of context (PVCL). Finally, the target sentence (i.e., the item from the PVCL) was presented and the child was required to choose among the four pictures, the one that correctly represented the target sentence.

Test of sentence comprehension in context for children aged 4 to 4;6 years

1. Facciamo finta che tu sia in un negozio di frutta. Non puoi toccare tutti i cesti. Il negoziante ti dice: (guarda bene le figure) "**Tocca il cesto con le mele o tocca quello con le banane**"
2. La ragazza ha un fiocco nei capelli. La ragazza toglie il fiocco. (guarda bene le figure) Poi **la ragazza si pettina.**
3. Facciamo finta che tu cerchi dei funghi. Vedi una coccinella. (guarda bene le figure) **La coccinella è sul fungo.**
4. La signora ha fatto le pulizie. E ha sudato. (guarda bene le figure) Ora **la signora si lava**.
5. Fai finta di essere al mare. Vedi una bottiglia. (guarda bene le figure) **La bottiglia è nell'acqua.**
6. La bambina ha sete. La bambina prende un bicchiere d'acqua. Guarda bene le figure e **Tocca….beve**.
7. La bambina abita in campagna. In una vecchia casa. (guarda bene le figure) È **la casa di sassi**.
8. Ci sono dei bei frutti sul tavolo. Sono buoni da mangiare. Guarda bene le figure e **Tocca…prende**.
9. E' il primo giorno di scuola. La mamma ha comprato la cartella. (guarda bene le figure) **La bambina va con la cartella**.
10. È sera. Il cane vuole che i suoi cagnolini vadano a dormire. (guarda bene le figure) **Il cane entra nella cuccia, dopo che sono entrati i cagnolini.**
11. Il bambino vede le caramelle. Il bambino vuole le caramelle. (guarda bene le figure) **Il bambino, che è sul tavolo, prende le caramelle**.
12. Fa freddo. Il bambino vuole uscire fuori. (guarda bene le figure) **La mamma gli ha detto "se fa freddo copriti bene" (fammi vedere qual è il bambino che ha ubbidito).**

Appendix B

Test of sentence comprehension in context for children aged 4;6 to 5 years

1. La bambina torna a casa. La bambina è contenta di vedere la mamma. (guarda bene le figure) **La mamma è accarezzata dalla bambina**.
2. Il bambino ha preso il gelato. Anche la bambina vuole il gelato. (guarda bene le figure) **Il bambino non dà il gelato alla bambina.**
3. Il signore si è comprato il giornale e le sigarette. Il signore è tornato a casa. (guarda bene le figure) **Il signore**, **mentre legge, fuma.**
4. Il bambino è molto vivace. Il bambino corre e non sta attento. **Il bambino è caduto** (si mostra la figura grande nel libretto utilizzato)**. Perché**? (Si mostrano le figure piccole, dicendo guarda bene le figure).
5. La maestra dice di disegnare un albero. Al bambino piace disegnare i fiori. (guarda bene le figure) **Il bambino disegna un fiore, invece di disegnare un albero.**
6. In camera c'è un televisore. Il programma è noioso. **(**guarda bene le figure) **La televisione è accesa, ma nessuno la guarda**.
7. Mario e Anna sono fratello e sorella. Anna è sempre una brava bambina. (guarda bene le figure) **Invece di abbracciare Mario, la mamma abbraccia Anna**.
8. Il bambino ha giocato col pallone in giardino. Poi si è stancato e vuole andare a casa. Guarda bene le figure e **Tocca…è entrato**.
9. L'estate è finita ed è ora di tornare a scuola (guarda bene le figure) **L'autunno è arrivato, ma le foglie degli alberi non sono ancora cadute**.

Appendix B

Test of sentence comprehension in context for children aged 5 to 5;6 years

1. La mamma ha raccolto fiori. La mamma vuole bene alla bambina. (guarda bene le figure) **La mamma dà i fiori alla bambina**.
2. La signora ha un cane birichino. **La signora sgrida il cane** (Si mostra la figura grande). **Perché? (**Si mostrano le figure piccole, dicendo guarda bene)
3. Fa freddo. Gli alberi sono senza foglie. (guarda bene le figure) **La neve cade sull'albero**.
4. C'era un bruco. La foglia è caduta dal ramo. (guarda bene le figure) **La foglia è sul bruco**.
5. Il bambino ha giocato a pallone. La mamma lo chiama per la cena. (guarda bene le figure) **Il bambino porta il pallone a casa**.
6. La ragazza ha comprato diversi frutti. Ne vuole mangiare qualcuno. (guarda bene le figure) **La ragazza ha sistemato tutta la frutta nel frigorifero, tranne le banane**.
7. I padroni hanno lasciato a casa il cane e il gatto. Loro non sono amici. (guarda bene le figure) **Il cane vuol mordere il gatto**.
8. Il bambino vorrebbe giocare col gatto, Il gatto però è stanco. (guarda bene le figure) **Il gatto, che il bambino guarda, è sdraiato**.
9. Il bambino è un po' birichino e disturba gli animali. (guarda bene le figure) **Il bambino è rincorso dall'oca**.
10. Il bambino e la bambina hanno giocato insieme tutto il pomeriggio. E' ora di tornare a casa. (guarda bene le figure) **I bambini si salutano**.
11. La signora ha lavorato molto per pulire la casa. Però la casa non è ancora pulita. (guarda bene le figure) **La signora è stanca, ma non si siede**.
12. Un uomo deve trasportare molti tavoli. Il camion è piccolo e i tavoli non ci stanno tutti. (guarda bene le figure) **L'uomo ha caricato sul camion tutti i tavoli, tranne quelli rotondi**.
13. La bambina ha giocato con le palle. Ora deve mettere in ordine. (guarda bene le figure) **La bambina ha raccolto tutte le palle, tranne quelle piccole**.
14. Una signora e una bambina hanno mangiato insieme. Adesso bisogna ripulire. La signora chiede un aiuto. (guarda bene le figure). **Mentre la signora scopa il pavimento, la bambina toglie la tovaglia**.
15. Un bambino ha bevuto un bicchiere d'acqua. Poi ha appoggiato male il bicchiere sul tavolo. (guarda bene le figure). **Il bicchiere è caduto, ma non si è rotto**.
16. La signora vuole bene al bambino, deve andare via e lasciarlo. È triste. (guarda bene le figure) **La signora, che piange, accarezza il bambino.**
17. I bambini si preparano per la recita. Devono imparare una canzone. Guarda bene le figure e **tocca….cantano**.
18. L'oca vuole che i suoi anatroccoli vadano a mangiare. (guarda bene le figure) **L'oca entra nel pollaio, dopo che sono entrati gli anatroccoli**.

Appendix B

Test of sentence comprehension in context for children aged 5;6 to 6 years

1. Ci serve da bere, bisogna prendere la bottiglia. (guarda bene le figure) **La bottiglia non è vuota**.
2. La nonna abita lontano. La bambina la vuole salutare. (guarda bene le figure) **La bambina telefona alla nonna**.
3. Un bambino ha rubato la palla alla bambina. Se la vuole tenere lui. (guarda bene le figure) **Il bambino, che gioca, guarda la bambina**.
4. Una fratello e una sorella sono arrivati in campagna. Non vedono l'ora di vedere il cavallo. (guarda bene le figure) **I bambini vanno dal cavallo**.
5. Ci sono dei nonni. Fanno fatica a camminare. Guarda bene le figure e **tocca vecchi**
6. Il bambino è andato a trovare la nonna. Ha mangiato tanto tanto. Ora va a casa. (guarda bene le figure) **Il bambino, che la nonna saluta, è grasso**.
7. Una signora e una bambina hanno mangiato insieme. Adesso bisogna ripulire. La signora chiede un aiuto. (guarda bene le figure) **Mentre la signora porta il vaso, la bambina toglie la tovaglia**.
8. Il cane sta sempre in casa in mezzo ai mobili. (guarda bene le figure) **Il cane è fra il tavolo e il televisore**.
9. Il bambino ha raccolto un cesto di mele e le ha portate in casa sulla sedia. Ora le vuole portare alla nonna. (guarda bene le figure) **Il bambino prende il cesto di mele dalla sedia**.
10. A scuola il bambino ha colorato e disegnato tutto il tempo. (guarda bene le figure) **Tocca disordinato**.
11. Il bambino per andare a scuola deve passare su un ponte. Va con la sua palla. (guarda bene le figure) **Il bambino tira la palla dal ponte**.
12. La signora prepara tutto per la colazione. Ora si siede. (guarda bene le figure) **La signora si versa il caffè**.
13. È pomeriggio. La bambina ha finito scuola. (guarda bene le figure) **La bambina torna da scuola**.

Test of sentence comprehension in context for children aged 6 to 7 years (this form has been used in the longitudinal investigation only)

1. Una farfalla vola in un prato. Poi va vicino a dei fiori. (guarda bene le figure) Ora **la farfalla è tra i fiori.**
2. La bambina ha fatto una passeggiata e ha raccolto dei fiori. (guarda bene le figure) Ora **la bambina dà i fiori alla nonna.**
3. La mamma ha sporcato il vestito. Poi lo ha lavato. (guarda bene le figure) Ora **la mamma stende il vestito ma è ancora macchiato**.
4. Un bambino ha fatto i compiti. Il bambino è un pasticcione. Ora (guarda bene le figure) **il foglio di quaderno che è sul tavolo è sporco**.
5. Un bambino dice che i suoi compagni di classe sono simpatici e che le compagne sono….guarda bene le figure e **Tocca**…**grasse**.
6. A scuola la bambina ha disegnato e colorato tutto il tempo (guarda bene le figure) **Tocca…Sporca**
7. Tra fratelli c'è stato un gran litigio. Ora (guarda bene le figure) **I bambini si picchiano**.
8. Come compito per casa devi scrivere un pensierino. Allora prendi (guarda bene le figure) **Il foglio di quaderno**.
9. Nel bosco ci sono gli alberi e gli uccellini. (guarda bene le figure) **Solo sull'albero che è in mezzo al bosco ci sono tanti uccellini**.
10. La bambina ha fame. La mamma le dà una minestra buonissima. Ora la mamma dice: (guarda bene le figure) **Non è vero che la bambina non mangia.**
11. Il bambino è a scuola. Quando è ora della merenda, (guarda bene le figure) **Il bambino mangia la mela dopo aver fatto un disegno**.
12. Il bambino va al parco con il suo cane. Il cane però non vuole camminare. (guarda bene le figure) **Il cane è tirato dal bambino**.
13. La signora ha riordinato dei vestiti. La signora vede un vestito rovinato. **La signora prende l'ago e il filo** (si mostra la figura grande). (guarda bene le figure) **Perché**?
14. C'è qualcosa che non va. Ora il signore deve rimediare. **Questo signore prende il martello e i chiodi** (si mostra la figura grande). (guarda bene le figure) **Perché**?
15. Il bambino ha giocato a pallone. La mamma dice che è tutto sporco. Lui dice che (guarda bene le figure e **Tocca)…..Si laverà.**
16. Il bambino aveva tanti compiti da fare e ora è stanco. (guarda bene le figure) **Il bambino invece di scrivere, gioca**.

Appendix C

Example of a Trial in the Inferential Task

Peter was playing all the day with a trowel and a bucket.

Where did Peter spend the day? (knowledge-based inference)

Then Peter picked up the trowel and the bucket. He put the toys on a bag.

Where are the trowel and the bucket now? (text-based inference)

Trial 1

Piero ha giocato tutto il giorno con la paletta e il secchiello.
Dov'è stato Piero tutto il giorno? (knowledge-based inference)

Poi Piero ha raccolto la paletta e il secchiello. Ha messo i giochi nella borsa.
Adesso, dove sono la paletta e il secchiello di Piero? (text-based inference)

Trial 2

Il topo vede il gatto. Il topo scappa.
Perché? (knowledge-based inference)

Il topo ha rubato una cosa da mangiare. Il pane era squisito.
Cosa ha rubato il topo? (text-based inference)

Trial 3

In cucina, la mamma è con le mani nel lavandino con acqua e schiuma.
Che lavoro sta facendo la mamma? (knowledge-based inference)

Dopo la mamma asciuga le forchette e i coltelli e mette le posate nel cassetto.
Adesso, dove sono le forchette e i coltelli? (text-based inference)

Trial 4
Luca ha ricevuto un regalo. Ora tutto contento pedala in giardino.
Cha regalo ha ricevuto Luca? (text-based inference)

Per terra ci sono dei vetri rotti. La gomma della bici (o triciclo o altro) ora è sgonfia.
Perché? (knowledge-based inference)

Trial 5
Marco vuole altri biscotti. La mamma dice basta. Adesso Marco aspetta che la mamma esca.
Perché? (knowledge-based inference)

I biscotti sono nella scatola blu. La scatola è nell'armadietto.
Allora, dove sono i biscotti? (text-based inference)