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Research Article

Comprehension of Inferences in a Narrative in 3- to 6-Year-Old Children

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Purpose: This study aimed to describe the development of inferential abilities of children age 3 to 6 years in a narrative using a dialogic reading task on an iPad.
Method: Participants were 121 typically developing children, divided into 3 groups according to age range (3–4 years old, 4–5 years old, 5–6 years old). Total score of inferential comprehension, subscores by causal inference type targeting elements of the story grammar, and quality of response were examined across groups.
Results: Inferential comprehension emerged early, from 3 to 4 years old, with considerable interindividual variability. Inferential comprehension scores increased significantly in relation to age, leading to developmental steps with regards to the type of causal inferences. The ability to infer the problem of the story, the internal response of a character, and predictions were easier starting at age 4 years. Then, the 5- to 6-year-olds were better able to infer the goal, the attempt to solve the problem, and the resolution. Last, between the ages of 3 and 6 years, children improved in terms of the quality of response they provided.
Conclusion: This study addresses important gaps in our knowledge of inferential comprehension in young children and has implications for planning of early education in this realm.

Inferential abilities play a critical role in reading comprehension and, therefore, in the educational success of children (Cain, Oakhill, & Elbro, 2003; Gineste & Le Ny, 2002; Kendeou, van den Broek, White, & Lynch, 2009; Lynch & van den Broek, 2007; Paul, 2000; van Kleeck, 2008). This has been the topic of numerous studies relating to school-age children (Bishop & Adams, 1990; Catts, 2009; Oakhill & Cain, 2000; Serpell, Baker, & Sonnenschein, 2005). Indeed, the link between good inferential skills and reading comprehension has often been highlighted (Cain & Oakhill, 1999; Cain et al., 2003; Oakhill & Cain, 2000; Trabasso & Wiley, 2005; van den Broek, Tzeng, Risden, Trabasso, & Basche, 2001).

Besides this interest, recent studies have demonstrated that inferential abilities emerge within the preschool period, before children enter school (Blanc, 2010; Filiatrault-Veilleux, Bouchard, Trudeau, & Desmarais, 2015; Florit, Roch, & Levorato, 2014; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Makdissi & Boisclair, 2006; Reed, Hurks, Kirschner, & Jolles, 2015; Tompkins, Guo, & Justice, 2013; van Kleeck, Vander Woude, & Hammett, 2006). From the age of 3 or 4 years, children begin to be able to construct a coherent mental representation of a story heard by using complex cognitive processes such as inference production (Filiatrault-Veilleux, Bouchard, et al., 2015; Florit et al., 2014; Kendeou et al., 2008; Potocki, Ecalle, & Magnan, 2012; Tompkins et al., 2013; van den Broeket et al., 2005). Moreover, some authors suggest that fostering inferential abilities would be beneficial in the preschool period (Desmarais, Nadeau, Trudeau, Filiatrault-Veilleux, & Maxes-Fournier, 2013; Reed et al., 2015; van Kleeck, 2008; van Kleeck et al., 2006) due to the likely impact on later reading comprehension (Cain & Oakhill, 1999; Cain et al., 2003; Kintsch & Kintsch, 2005; Trabasso & Wiley, 2005; van den Broek et al., 2001).

Although there is growing interest in this topic, it is still not well known when and how inferential comprehension emerges and develops in young children because

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few studies have been conducted on this subject. Hence, a better description of the developmental steps in inferential comprehension that occur in the preschool period is needed. Such information would provide evidence to the field of early intervention and would foster new initiatives to promote the development of inferential comprehension in young children. We sought to address this important gap in the research by investigating the inferential comprehension of typically developing (TD) children between 3 and 6 years in a narrative using a dialogic reading task.

Inferential Comprehension Within a Dialogic Reading Task

Inferential comprehension is defined as the ability to understand a message in a context where some elements are not explicitly known (Bishop, 1997; Gineste & Le Ny, 2002; van Kleeck, 2008). To obtain a valid measure of this ability with children who have not yet learned to read, a task that does not rely on reading must be used (van den Broek et al., 2005). In recent studies, *dialogic reading* stands out as the task of choice (Ford & Milosky, 2008; Makdissi & Boisclair, 2006; Price, van Kleeck, & Huberty, 2009; Tompkins et al., 2013; van Kleeck et al., 2006). For both assessment and intervention, a storybook is read aloud to children, and inferential questions about elements that are not explicitly presented in the story are embedded in the interaction between the adult and the child (Blanc, 2010; Justice & Kaderavek, 2004; Price et al., 2009; van Kleeck, 2008). To answer correctly, children must make connections between what is heard in the story, the context in which it is occurring, and their world knowledge (Desmarais et al., 2013; Paul, 2000; van Kleeck, 2008). Beyond their role of potentially fostering comprehension, the questions help maintain the child's participation and interest in the story (Ford & Milosky, 2008; Makdissi & Boisclair, 2006; van Kleeck et al., 2006; Wenner, 2004).

Dialogic reading with children optimally relies upon a format of a predictable story structure minimally comprising the following story grammar elements: a setting, a triggering event, a problem that generates an internal response, a goal that motivates the character's actions during the narrative, an attempt to solve the problem and its consequence and, finally, a resolution to the story (Mandler & Johnson, 1977; Stein & Glenn, 1979). A variety of inference questions can be asked within a story. For the preschool population, the most pertinent questions target *causal inferences* that are directly related to elements of story grammar (Bowyer-Crane & Snowling, 2005; Makdissi & Boisclair, 2006; van Kleeck, 2008). This is important because causal inferences are crucial to establishing causal connections between events in the story (Bianco & Coda, 2002; Blanc, 2009, 2010; Filiatrault-Veilleux, Bouchard, et al., 2015; Graesser, Singer, & Trabasso, 1994; Lefebvre, Bruneau, & Desmarais, 2012; Reed et al., 2015; Richards & Anderson, 2003; Tompkins et al., 2013). As they listen to narratives, children learn to create coherent and meaningful representations of a story that include concepts about causal relationships between story elements (Lever & Sénéchal, 2011; Reed et al., 2015). This is why most studies of young children have specifically focused on causal inferences (Lynch & van den Broek, 2007; Makdissi & Boisclair, 2006; Reed et al., 2015; Tompkins et al., 2013; Wenner, 2004).

Causal Inferences Targeting Elements of Story Grammar

To date, some studies have attempted to propose developmental steps in the acquisition of inferential comprehension, but results are heterogeneous, which is largely due to methodological differences between studies including the definition of inferences, the tasks used, the diversity in the age groups that are examined, and so on (Blanc, 2009, 2010; Filiatrault-Veilleux, Bouchard, et al., 2015). Nevertheless, van den Broek et al. (2005) proposed broad developmental steps in the comprehension of inferences without associating them with precise age ranges because of the many factors involved in inference comprehension, including the influence of the child's knowledge and experience, as well as the variability in the complexity of inferences. In this proposal, the first step is the ability to establish inferential links between concrete physical events that occur close together (e.g., a simple prediction about a doll breaking if a child pulls its arm). The second type of inference concerns the ability to identify relationships between more distant events. Third, children learn to identify causal relationships involving characters' goals, emotions, and desires (e.g., consequently, the little girl is sad and wants her mom to repair the doll). As they get older, children can then more easily recognize the hierarchical and thematic relations between clusters of events. Last, children will understand the translation of the story theme into a moral or lesson (e.g., it's important to play carefully with toys).

As mentioned before, researchers have paid particular attention to causal inferences because of their centrality to the comprehension of narratives. At this time, the two inference types that have been most examined in the literature are the internal response and the goal/purpose of the protagonist in a story (Adams, Clarke, & Haynes, 2009; Florit, Roch, & Levorato, 2011; Ford & Milosky, 2008; Gnepp & Gould, 1985; Makdissi & Boisclair, 2006; Spackman, Fujiki, & Brinton, 2006; Wenner, 2004). For example, if a child listens to a story about a little boy who lost his favorite toy, this child could infer that the boy is sad (the internal response) and that he would want to find it (the goal), even if these elements are not explicitly stated. Some studies show that the ability to infer the internal response of a character appears early in the development, between 3 and 4 years of age (Adams et al., 2009; Blanc, 2010; Ford & Milosky, 2008; Gnepp & Gould, 1985; Lynch & van den Broek, 2007). In addition, from the age of 4 years, children may also demonstrate some ability to infer the problem (Makdissi & Boisclair, 2006) and the goal of the character in a story (Wenner, 2004). It should be highlighted that the goals are important because they provide the motivation for the actions that are carried out throughout

a narrative (Lynch & van den Broek, 2007). From the age of 5 years, children begin to spontaneously produce characters' goals in narrative recall (Trabasso & Nickels, 1992). Children between the age of 5 and 6 years are able to make inferences concerning the consequences of events in short pictorial sequences (Schmidt & Paris, 1978), infer the attempt to solve a problem (e.g., the little boy will look in the playroom for his toy; Kendeou et al., 2008), and demonstrate the ability to predict the next event of a story (Adams et al., 2009; Crais & Chapman, 1987). In sum, these studies suggest that children as young as 6 years of age can make all these inference types while listening to a story. In light of these results, there may be predictable developmental steps in the acquisition of inferential comprehension with regard to the causal inference types related to story grammar elements (Blanc, 2010; Filiatrault-Veilleux, Bouchard, et al., 2015; Makdissi & Boisclair, 2006; van den Broek et al., 2005). There is a gap in the literature in that regard because none of the studies to date have examined all these inferences types in one task, and no study has included children across the age range from 3 to 6 years.

Quality of Response

In a dialogic reading task, children's responses to inferential questions illustrate whether or not they understand the links between events presented in the story. Recent studies have been interested in the quality of responses that children provide to inferential questions because it most likely reflects a refinement in the ability to infer (Adams et al., 2009; Desmarais et al., 2013; Lynch & van den Broek, 2007). For example, to the question "What will the boy do next?" in reference to the lost toy, a child who answers "The boy will look everywhere to find the toy" instead of "The boy will go to sleep" could demonstrate a higher quality level of comprehension. Thus, some authors suggest using a classification system to categorize the children's responses in order to take into account the quality of responses provided (Adams et al., 2009; Barnes, Dennis, & Haefele-Kalvaitis, 1996; Desmarais et al., 2013; Spackman et al., 2006). The categorization of children's responses allows a nuanced analysis of their performance, thus determining the quality level of a response and providing information for effective strategies that can be used in clinical practice. In a recent intervention study with children with speech language impairment (SLI), coding the quality of responses revealed that most children progressively reached the expected target (Desmarais et al., 2013). In TD children, it would be of interest to investigate whether the quality of response develops with age. Such information would be of great value to clinicians in selecting and sequencing intervention targets and strategies.

This study aimed to describe inferential abilities in the context of a narrative of children age 3 to 6 years. A task, created on the iPad (Apple Inc., Cupertino, CA), was used to collect data that were then compared across three age groups: (a) 3- to 4-year-olds; (b) 4- to 5-year-olds, and (c) 5- to 6-year-olds. The first objective was to compare the total score obtained across groups as well as the subscores on each causal inference type targeting elements of story grammar. The second objective was to compare the groups in terms of the quality of responses produced by the children.

Method

Participants

One hundred twenty-one (59 girls and 62 boys) French-speaking TD preschoolers ranging from 3 to 6 years of age were recruited in collaboration with daycare centers and schools in Québec City, Canada. Some children were also recruited through an email invitation to students and employees of Université Laval in Québec City, Canada. All parents signed informed consent on behalf of their children. The participants were divided into three groups according to the age range (3- to 4-year-olds, 4- to 5-year-olds, and 5- to 6-year olds) and the preschool program they were enrolled in (daycare centers or kindergarten). The gender distribution was comparable across groups (M = 51.2% boys, $\chi^2 = 0.042$, $p = .959$). On the basis of information collected from questionnaires completed by the parents, children were excluded from the study if a language delay or any other cognitive or developmental problem had been identified. To verify the typical language development status, the French version of the Peabody Picture Vocabulary Test–Revised (Dunn, Thériault-Whalen, & Dunn, 1993) was administered. On the sociodemographic questionnaire, parents reported that the children spoke French as their native language, all mothers had completed high school, and the majority of the families were above the low-income cutoffs as calculated by the Institut de la Statistique du Québec. Participant characteristics are presented in Table 1.

Material

For the purpose of this study, an application (app) for the iPad entitled "Évaluation de la Compréhension Inférentielle en Récit" (ÉCIR; Assessment of inferential comprehension in a Narrative) was designed (Filiatrault-Veilleux, Desmarais, Bouchard, Trudeau, & Leblond, 2016). This tool consists of a 20-page story that follows a predictable narrative structure (i.e., initiative event/problem, internal response, goal, prediction, attempt to solve the problem, and resolution). It is a story of a bird named Pinson. It starts when Pinson's parents go away to find food and he stays alone in his nest. A storm begins and his nest falls. He is wet and scared and goes to look for a new place to stay. He meets three characters (a skunk, a porcupine, and a beaver) who try to help him, but nothing works. In the end, a boy builds a new house for Pinson and his parents come back. Nineteen questions are asked online, within the story, to assess six causal inference types that target the story grammar elements. The inference types, story context, examples of questions, and scoring of the task on iPad are shown in Table 2 (inspired by Botting & Adams, 2005; Makdissi & Boisclair, 2006; van Kleeck, 2008). Each question targeted

Table 1. Participants' characteristics.

Group	*n* (Girls: boys)	*M* age, months (*SD*)	PPVT-R percentile rank (*SD*)	Income > LICOs (%)
3–4 years old from daycare center	30 (14:16)	42.2 (3.4)	70.43 (25.23)	100
4–5 years old from daycare center	37 (18:19)	56.2 (6.2)	87.49 (14.2)	91.9
5–6 years old from kindergarten	54 (27:27)	73.3 (3.7)	90.17 (16.88)	94.4

Note. PPVT-R = Peabody Picture Vocabulary Test–Revised; LICO = low-income cutoffs.

information never mentioned explicitly by the narrator within the story and thus required some form of inference.

Administration and scoring were finalized after a thorough validation process reported in a previous article (Filiatrault-Veilleux et al., 2016) and summarized here. The responses obtained to questions are scored in four categories following a quality continuum ranging from expected to inadequate (A = *expected*, B = *incomplete*, C = *low contingency*, D = *inadequate or off topic*). This scale was inspired by the scoring system of the Preschool Language Assessment Instrument–Second Edition (Blank, Rose, & Berlin, 2003) and was used in a previous experimental task of inferential comprehension in story context (Desmarais, Archambault, Filiatrault-Veilleux, & Tarte, 2012; Desmarais et al., 2013; Filiatrault-Veilleux, Tarte, & Desmarais, 2015). The total score is calculated out of 78 points and then converted to a percentage score. The definitions, examples of responses, and scores attributed for each category are presented in Appendix A. In order to create the scoring system, the first step was carried out by three experts in the field who read the verbatim transcription of the children's responses and coded the quality of the responses according to the scale from A (*expected*) to D (*inadequate or off topic*). These external experts also provided recommendations for scoring. For each response to the 19 questions provided by the 121 participants, assignment to a category was done according to the number of judges who had selected that category. In the next step of the validation of the scoring system, two independent judges coded 20% of the responses with the scoring scale obtained in Step 1. This yielded a high interrater reliability (Gwet's first-order agreement coefficient [AC1] value = 0.99, $p < .01$).

The tool's adequacy with regards to psychometric properties was confirmed and is reported in a previous article (Filiatrault-Veilleux et al., 2016). Of note, the Kaiser–Meyer–Olkin value resulting from the factorial analysis of the six inference types of the tool indicated good sampling adequacy (Kaiser–Meyer–Olkin value = .87, $p < .01$). Therefore, a principal components analysis with varimax rotation was performed (Tabachnick & Fidell, 2001). Four factors were selected because their eigenvalue was greater than 1 (Factor 1: eigenvalue = 1.5, saturation = 855; Factor 2: eigenvalue = 1.4, saturation = 930; Factor 3: eigenvalue = 1.3, saturation = 917; and Factor 4: eigenvalue = 1.2, saturation = 867; Filiatrault-Veilleux et al., 2016).

The concurrent validity of the tool was assessed in comparison with the previous experimental task of inferential comprehension used to create the four-quality continuum of responses (Desmarais et al., 2012, 2013; Filiatrault-Veilleux, Tarte, & Desmarais, 2015). As expected, the concurrent validity was high, $r(119) = .77$, $p < .01$, whereas the convergent validity demonstrated a moderate link with receptive vocabulary, $r(119) = .43$, $p < .01$ (as assessed with the French version of the Peabody Picture Vocabulary

Table 2. Inference types, number of questions asked, story context, examples from the task, and scores.

Inference types	*n*	Story context	Examples of questions	Scores
Problem	2	The storm breaks Pinson's nest.	What is happening?	/6
Internal response	4	Afraid because his parents leave the nest and the storm arrives. / Sad because his nest is broken. / Discouraged because he cannot find a shelter. / Happy because his parents are back and has a new home.	How does Pinson feel? Why?	Emotions/12 Justification/12
Goal of the character	2	He is searching for a shelter.	What is Pinson looking for?	/6
Attempts to solve the problem	7	He meets three animals that try to help but cannot do it (a skunk, porcupine, and beaver).	Do you think Pinson will be OK with this animal? Why?	Prediction/16 Evaluation/12
Prediction	2	The tree branch will break due to the storm. / Tom will build him a wood birdhouse.	What do you think will happen next?	/6
Resolution	2	Tom built him a solid wood birdhouse.	Who helped him the most? Why?	/8

Note. Inference types, number of questions asked, story context, examples from the task, and scores from Filiatrault-Veilleux et al. (2016).

Test–Revised; Dunn et al., 1993), which is consistent with previous studies in which the link between receptive vocabulary and inferential comprehension has been shown (Currie & Cain, 2015; Florit et al., 2014; Kendeou et al., 2008). The test–retest reliability 2 weeks post on 20% of participants was excellent, intraclass correlation coefficient (33) = .95, $p < .01$.

Procedure

Children were seen individually by an experimenter in a quiet room at their daycare or school. They were instructed to listen closely to the story so that they could answer the questions embedded into the story in the app. On each page, the child looked at the illustration while listening to the narration in audio output from the app and, subsequently, to a question also in audio output from the app. The first two pages of the story served as training for the task with five literal questions. On pages 3–20, one inferential question per page was programmed into the app except for one page comprising two questions. The data collection was videotaped for subsequent analysis. Each participant's responses were coded in four categories (A = *expected*, B = *incomplete*, C = *low contingency*, D = *inadequate or off topic*) on the basis of the scoring system described above. The administration of the task lasted approximately 15 min.

Data Analysis

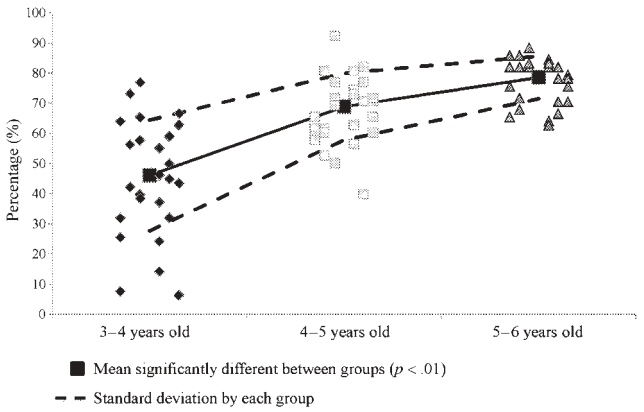
Data analysis was performed using SPSS Version 22. Analyses of variance (ANOVAs) and multivariate analyses of variance (MANOVAs) were used to verify if there were differences between the three groups in terms of total inferential score, subscores by inference type, and number of expected responses obtained. On the basis of the significant differences that emerged, post hoc analyses using the Bonferroni correction were performed due to the multiple comparisons tested. In addition, a *t* test was also used to verify if there was a gender effect.

Results

Total Score of Inferential Comprehension

The total scores obtained by each group on the task are presented in Figure 1. The ANOVA revealed a significant difference between groups, $F(2, 118) = 71.389$, $p < .001$. Post hoc analysis showed that 3- to 4-year-olds' results ($M = 46.1\%$, $SD = 18.4$, range = 6.4–76.9) were significantly weaker than those of 4–5 year olds ($M = 68.9\%$, $SD = 11.1$, range = 39.7–92.3), who in turn obtained results also significantly weaker than those of kindergarteners 5–6 years of age ($M = 78.6\%$, $SD = 7.1$, range = 62.8–89.7). The majority of the 3- to 4-year-old children were able to answer some inferential questions and to get through the task. However, as we can see in Figure 1, there was greater variance in scores for the youngest age group compared to the two older age groups.

Figure 1. Scatter plot by groups of the means and standard deviations for the total score of inferential comprehension.



Subscores by Inference Types

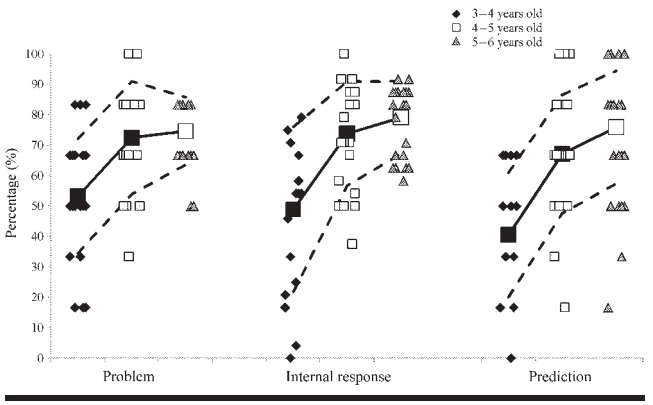
Table 3 provides the descriptive statistics by groups for each subscore, corresponding to the six types of causal inferences included in the task (i.e., internal response, problem, goal, attempt to solve the problem, predictions, and resolution). Figures 2 and 3 illustrate the performance of children, with means and standard deviations of each group for each inference type. The MANOVA showed a significant effect of age group on inference type: problem, $F(2, 118) = 19.397$, $p < .001$; internal response, $F(2, 118) = 27.497$, $p < .001$; goal, $F(2, 118) = 23.342$, $p < .001$; attempt to solve the problem, $F(2, 118) = 50.077$, $p < .001$; prediction, $F(2, 118) = 33.008$, $p < .001$; and resolution, $F(2, 118) = 34.628$, $p < .001$. For the inferences targeting the problem, the internal response, and the prediction (see Figure 2), there was a significant difference between the 3- to 4-year-old children and the two older groups. However, no difference was found between the two older groups (problem: $t(2) = -0.647$, $p = 1.00$; internal response: $t(2) = -1.367$, $p = .523$; prediction: $t(2) = -2.143$, $p = .103$). For the goal, the attempt to solve the problem, and the resolution inference types (see Figure 3), the 3- to 4-year-olds were significantly weaker than the 4- to 5-year-olds, who were also

Table 3. Subscores in percentage (*SD*) for the six inference types of each group.

Inference types	3–4 years old (*n* = 30)	4–5 years old (*n* = 37)	5–6 years old (*n* = 54)
Problem	53.3* (18.8)	72.5 (18.5)	74.7 (11.1)
Internal response	48.9* (27.1)	73.8 (17.1)	79.1 (11.9)
Prediction	40.6* (20.4)	67.1 (19.4)	75.9 (18.5)
Goal of the character	52.8* (28.4)	71.6* (23.5)	85.2 (12.4)
Attempts to the problem	41.5* (21.3)	62.7* (14.1)	76.6 (12.1)
Resolution	47.1%* (26.8)	72.6%* (20.8)	84.3% (13.1)

*Significantly lower scores than the older group, $p < .01$.

Figure 2. Scatter plot by groups of the means and standard deviations of the inferences targeting the problem, the internal response, and the prediction.

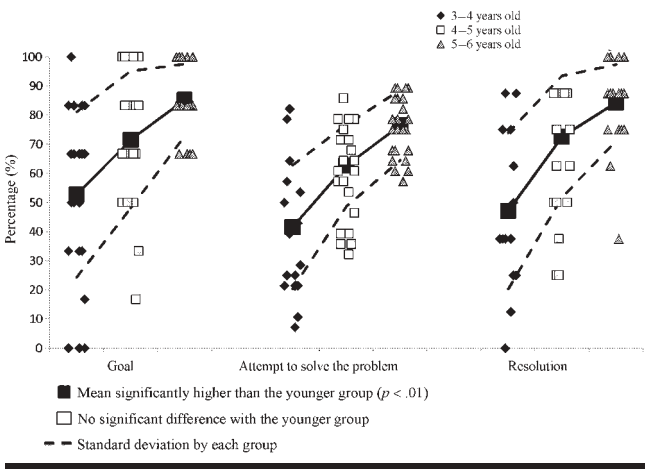


significantly weaker than the kindergarteners of 5–6 years old. Again, the variance in scores for the participants in each group and for each inference type decreased with age. Last, independent *t*-test analyses revealed no gender effect for the total inferential score ($p = .608$), age (3–4 years: $p = .656$; 4–5 years: $p = .952$; 5–6 years: $p = .754$), or inference type (internal response: $p = .81$; goal: $p = .96$; problem: $p = .05$; attempts to solve the problem: $p = .75$; prediction: $p = .92$; resolution: $p = .38$).

Quality of Responses Obtained

To address the second objective, we compared the three groups on the quality of responses obtained. A cumulative frequency histogram shows the mean number of responses per category (A = *expected*, B = *incomplete*, C = *low contingency*, D = *inadequate or off topic*) obtained by each group. As can be seen in the histogram, the quality of responses increased with age (see Figure 4). Indeed, an ANOVA confirmed the significant difference between groups for the expected response category, the most contingent response to the question, $F(2, 118) = 53.186$, $p < .001$. The 3- to 4-year-olds produced significantly fewer expected responses than the 4- to 5-year-olds, who in turn produced significantly fewer expected responses than the 5- to 6-year-olds. As for the production of the acceptable response, which may be imprecise or incomplete, the ANOVA showed no difference between groups, $F(2, 118) = 2.957$, $p = .056$. With regards to low-contingency and inadequate responses categories, the two ANOVAs were significant (low contingency: $F(2, 118) = 18.879$, $p < .001$; inadequate: $F(2, 118) = 43.306$, $p < .001$). The frequency of low-contingency responses, in which the information is not relevant to the question, decreased significantly with age by comparing the three groups. Last, the group of 3- to 4-year-olds produced more inadequate responses than the two older groups. In sum, children improved with age in terms of the quality of response they provided. Appendix B shows the changes from 3 to 6 years of age in terms of the quality of responses provided to an inference question about the "Attempts to solve the problem."

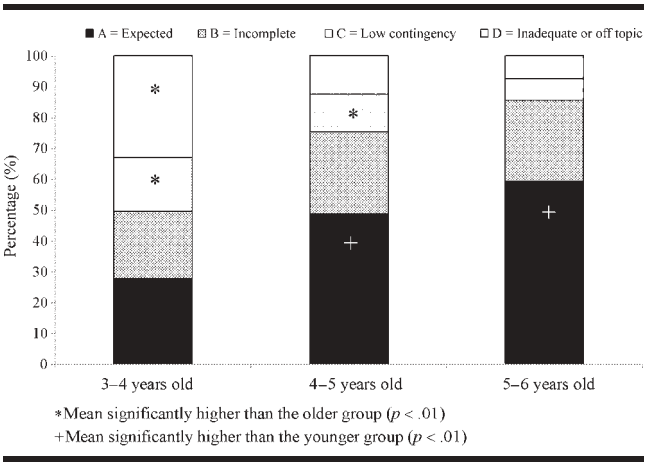
Figure 3. Scatter plot by groups of the mean and standard deviation of the inferences targeting the goal, the attempt to solve the problem, and resolution.



Discussion

The aim of the current study was to describe the inferential abilities of children between the ages of 3 and 6 years in the context of a story. Children's performance, using a dialogic reading app entitled "ÉCIR" was measured across three groups (i.e., 3–4 years old, 4–5 years old, and 5–6 years old. The first objective was to compare the total quantitative score (i.e., responses to the 19 inferential questions, obtained across groups as well as the subscores by causal inference type targeting elements of story grammar). The second objective was to assess whether the groups varied in terms of the quality of responses produced by children.

Figure 4. Cumulative frequency histogram of mean number of responses per category.



The results for the first objective indicate that inferential comprehension in the context of a story emerges early, from 3 years of age, and increases gradually afterwards. Moreover, increments in the development of inferential comprehension by inference type were related to the children's age, supporting the notion of a developmental trajectory for that ability. From 4 to 5 years of age, children more easily inferred the problem of the story and the internal responses of the character. They were also providing good predictions for the next steps in the story. For their part, children at age 5–6 years were better at making inferences about the goal of the main character, the attempts to solve the problem, and the resolution of the story. The results of the second objective reveal that the quality of responses produced by children also increased and evolved significantly with age.

Taken together, these results contribute to a better understanding of young children's inferential comprehension. They provided answers to important research questions that have received little attention to date. This understanding could subsequently lead to innovative educational and interventional strategies in preschool contexts.

Developmental Changes in Inferential Comprehension

With regards to the total score of inferential comprehension, our results support previous studies by demonstrating that inferential comprehension emerges early in the development of children, within the preschool period and certainly well before reaching school (Filiatrault-Veilleux, Bouchard, et al., 2015; Florit et al., 2014; Kendeou et al., 2008; Makdissi & Boisclair, 2006; Potocki et al., 2012; Reed et al., 2015; Trabasso & Nickels, 1992; van den Broek et al., 2005; van Kleeck, 2008). As anticipated, with an appropriate tool taking into account developmental considerations (Filiatrault-Veilleux, Bouchard, et al., 2015; van den Broek et al., 2005), even very young children are able to answer questions, suggesting that they are able to construct a mental representation of a story heard by using complex cognitive processes such as inference generation (Kendeou et al., 2008; Potocki et al., 2012; Trabasso & Nickels, 1992; van den Broek et al., 2005; van Kleeck, 2008). Furthermore, the use of an iPad in this research is in line with recent studies arguing that using nontraditional narrative media presentations, such as television or interactive e-books, may reduce cognitive load, improve recall of narrative events, and enhance story comprehension for children (Burris & Brown, 2014; Verhallen, Bus, & de Jong, 2006).

Another result of note is the greater variance in scores for the youngest age group when compared to the two older age groups. This interindividual variability may be linked to the young age of children, a phenomenon well documented in the literature relating to other language abilities (Fenson et al., 1994) and may also depend on many factors such as experience with dialogic reading or socioeconomic background (Justice, Chow, Capellini, Flanigan, & Colton, 2003). Indeed, the link between exposure to language and literacy at home or in preschool contexts and the development of oral language abilities and emergent literacy has been clearly demonstrated (Frijters, Barron, & Brunello, 2000; Justice et al., 2003; Leseman & de Jong, 1998; Purcell-Gates, 1996). Yet these factors require further examination in order to more clearly understand their impact, particularly with regards to the emergence of inferential comprehension and its development. Therefore, expectations about the performance of very young children should take interindividual variability into consideration. With age, inferential scores become more homogeneous, a finding that is consistent with general cognitive development.

Our study also described the performance of children, with a considerable age range, in terms of six causal inference types targeting the story grammar elements in a unique tool of dialogic reading. Looking at our results chronologically, at 4–5 years old, children were able to infer the problem of the story and the internal responses of characters and make predictions as accurately as those who were 5–6 years old. For the internal response and the problem of the story, these results were consistent with other studies. It has been previously highlighted that the internal response inferences appear early in development, at approximately 3–4 years of age (Ford & Milosky, 2003, 2008; Spackman et al., 2006), and may be one of the first causal relations understood by young children within a story. It has further been suggested that the visual characteristics of the character's expressions present in the illustrations may help children to infer the character's emotions in relation to specific situations (Desmarais et al., 2013; Makdissi & Boisclair, 2006).

The problem of the story also relies upon salient and concrete information in the story that children have been able to infer early in development (Makdissi & Boisclair, 2006). With regard to the ability to make predictions, the literature to date has mostly addressed this type of inference with older children ranging from 5 to 6 years of age (Adams et al., 2009; Crais & Chapman, 1987). However, our results suggest that prediction questions could be understood earlier in development. This is not surprising because predictions about future events as well as internal response inferences are known to be more often stimulated by adults and educators in dialogic reading activities (Girolametto, Weitzman, Lefebvre, & Greenberg, 2007). The results of our study are also consistent with the developmental steps proposed by van den Broek et al. in 2005. Young children begin by making inferences that link physical relations and concrete events (van den Broek et al., 2005) as measured in our task by questions about the problem faced by the character (e.g., the storm breaks Pinson's nest) and prediction questions (e.g., the tree branch will break due to the storm). The internal responses on the basis of the character's facial expression and on the story context also appear to be understood early in development. In light of these results, knowing that TD 3- and 4-year-olds can make these types of inferences, they would be excellent first targets in educational or clinical contexts.

There are, however, inference types that are more challenging for young children. For example, the goal, the

attempt to solve the problem, and the resolution of the story were harder to infer at 4–5 years of age. As was expected, the 5- to 6-year-olds performed significantly better than the two younger groups with regards to those three inference types. Once again, these results align with previous findings. Kendeou et al. (2008) obtained a clear developmental pattern related to the ability to infer the goal of the character from children between the ages of 4 and 8. An interesting feature of our results was that the goal was harder to understand than the problem of the story for the 4- to 5-year-old group. In interpreting the children's responses, it appears that the goal of the character (Q: "What is Pinson looking for?" A: "He wants to find a shelter") may have been more abstract for them than the problem the character was facing (Q: "What is Pinson's problem?" A: "His nest is broken"). As Kendeou et al. stated, it might be easier for young children to focus their attention on observable, concrete actions rather than on internal elements such as the character goal. This could also be related to the ability to consider another person's perspective, in this case the character of the story, that increases with age (Frye, Zelazo, & Palfai, 1995).

Turning to the attempt to solve the problem, in this study the children needed to rely on specific world knowledge to give an adequate answer (i.e., knowledge about each animal Pinson met: a skunk that smells bad, a porcupine that may release his quills, and a beaver that lives in a dam with underwater entrances). The two younger groups might not have acquired that specific knowledge yet or might experience difficulties in retrieving it (Cain & Oakhill, 1999). Another possible explanation is that the plot episodes, consisting of the attempts to solve the problem, may carry less crucial information required for global comprehension of the story and thus may appear less relevant for the two younger groups (Morrow, 1985). Moreover, on the basis of the proposal by van den Broek et al. (2005), it is possible that the ability to infer the attempts to solve the problem could involve links between clusters of events instead of between unique events and thus be more challenging for younger children.

Last, as for the resolution of the story, the results confirm previous findings indicating that this element is understood later in development (Makdissi & Boisclair, 2006). In fact, to properly infer the resolution, hierarchical integration of other causal chain elements is required (Makdissi & Boisclair, 2006; van den Broek et al., 2005). The ability to understand the causal links between the character's goal and consequences of the attempts to solve the problem could gradually lead to the ability to infer the resolution. This developmental trajectory of inferential comprehension with regard to causal inferences makes sense as children gradually produce more connections between episodes constituting the narrative. These connections appear gradually, resulting in a causal chain that helps create a complete representation of a narrative (Kendeou et al., 2008; Makdissi & Boisclair, 2006; Trabasso & Nickels, 1992; van Kleeck, 2008). Again, our results are in line with the developmental steps proposed by van den Broek et al. (2005). As they get older, children get better at making links between abstract and internal events (e.g., to infer the goal of the character), and they increasingly connect groups of events as measured with inferences about attempts to solve the problem and the resolution of the story. Tompkins et al. (2013) obtained similar results with 4- to 5-year-old children who were good at recognizing key elements in the story. For instance, they inferred what the protagonist was thinking and seeing and responded well to questions about the causal relationships among events in a story that had been read to them. Targeting these crucial inferences in young children could potentially provide them with the tools necessary to better comprehend text once they begin formal reading instruction.

Changes in Term of Quality of Responses

The method consisting of classifying children's answers in different levels of quality has been recently used with a population of children with SLI in order to follow their response to intervention (Desmarais et al., 2013). With TD children, our study observed a progression in terms of the quality of responses children provided as they get older. For 3- to 4-year-olds, the results show that children experienced difficulties producing the right response or the expected target. In fact, 3- to 4-year-old children produced more inadequate and low-contingency responses than the two older groups. In Appendix B, examples of responses to the questions "Will Pinson be OK in the skunk's house?" and "Why?" and "Is it a good shelter for Pinson?" illustrate the development of inferential comprehension as a process that is refined qualitatively over time. In shared-book reading activities in preschool programs, adults should thus foster the development of inferences that becoming increasingly more abstract and more elaborate to follow the progression in the thinking process of children. This is in line with the expectation that, over time, children progressively learn to disengage from their own perspective (Frye et al., 1995; Wellman, Cross, & Watson, 2001; Westby & Robinson, 2014) to provide answers to questions about a story that are closer to the answers an adult might provide. Another hypothesis relates to the cognitive development of children, namely that cognitive flexibility could be less developed in the younger group (Blaye & Chevalier, 2011; Chevalier & Blaye, 2006, 2008). More specifically, cognitive flexibility is involved when the child must adaptively select a new answer on the basis of a new situation (Chevalier & Blaye, 2006). Thus, in the earlier stages of cognitive flexibility development, children would have more difficulty adjusting their answers with the story. Indeed, it was observed that young children, at 3–4 years of age, often gave the same response to all the questions about attempts to solve the problem (e.g., in Appendix B: "No, because it's too small for him"). It would be interesting to further investigate this hypothesis in relation with cognitive abilities of young children. In sum, considering the quality of 3- to 6-year-old children's responses to inference questions, the results showed progression in function of age.

Limitations of the Study and Future Directions

Despite its strengths, this study has some limitations. The first limitation is the unequal distribution of children within groups due to the recruitment procedure used. The intention was to divide the children in groups of 30 by age (3, 4, 5, and 6 years old). In order to assess inferential abilities of children before learning how to read, all 6-year-old children were attending kindergarten. As a result, the 5-year-old kindergarteners in our sample performed similarly to 6-year-olds. As for 5-year-olds from daycare, their scores were equivalent to those of the 4-year-old group from daycare. For that reason, the division of participants in three groups in function of age range and preschool program (daycare centers and kindergarten) was seen as more advantageous for making developmental observations. Another limit concerns the moderate or high socioeconomic background of the children participating in this study. It is well known that children coming from middle-class families tend to benefit from more exposure to dialogic reading and language stimulation (Frijters et al., 2000; Justice et al., 2003; Leseman & de Jong, 1998; Purcell-Gates, 1996), which might have positively affected the children's performances. Future research may thus investigate how children from lower socioeconomic backgrounds perform on such tasks. Last, because only one narrative was used to evaluate inferential comprehension, it would be great of interest to examine if the results obtained with "ÉCIR" could be generalized with other types of narratives or stories.

Also, to bolster the results and confirm the developmental pattern of inferential comprehension, it would be of great interest to collect data with a longitudinal study design, with follow-up on inferential abilities throughout the preschool years. Last, due to inferential comprehension being an ability frequently affected in children with a diagnosis of SLI, autism spectrum disorder, or other language difficulties or disorders (Adams et al., 2009; Bishop, 1997; Botting & Adams, 2005; Desmarais et al., 2013; Dodwell & Bavin, 2008; Ryder, Leinonen, & Schulz, 2008; Skarakis-Doyle & Dempsey, 2008), comparison studies with these populations during those early years of development would be helpful in providing a better and more complete description of this ability.

Conclusion

By including a larger age range of children, this study confirms and expands previous findings. To be specific, the results show that there is an early emergence of inferential comprehension as young as 3 years of age and that inferential abilities then increase gradually until 6 years old. Therefore, the period that spans 3–6 years of age appears to be critical for the emergence and development of this ability. Moreover, interactive media such the use of the iPad to measure inferential comprehension appears promising. Last, the current study has implications for both educators and speech-language pathologists working with children in special education who could include stimulation of the different inferences types in classroom and therapy activities. Furthermore, describing inferential ability in terms of quality of responses allows tracking of the improvement of children's ability in an in-depth fashion, a relevant consideration for intervention. In summary, this study contributes to knowledge of the early developmental steps of inferential comprehension, a crucial ability to later reading comprehension success.

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Appendix A

Four categories of quality of responses, examples for the question "What does Pinson want?," and scores.

Coding of children's responses	Quality of response continuum			
	Low →			High
Category	D = *Inadequate or off topic*	C = *Low contingency*	B = *Incomplete*	A = *Expected*
Definition	Unrelated to the question or no response	Contains information that is not relevant to the question	Potential justification; may be imprecise or incomplete	Most frequent and contingent response
Examples	He wants to go in the water.	He wants to eat.	He wants to find his parents.	He wants to find a shelter.
Score	0	1	2	3

Appendix B

Examples of responses obtained by each age group to "Attempts to solve the problem" Questions 7 (in prediction) and 8 (in evaluation).

Questions	3–4 years old	4–5 years old	5–6 years old
Will Pinson will be OK in the skunk's house?	No	I don't think so	No
Why?	Because it's too small for him	Because it's too hot	Because it will smell bad
Is it a good shelter for Pinson?	No	No	No
Why?	Because it's too small for him	Because it's too hot … and it will smell bad too	Because the skunk smells bad