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The relationship between children's executive functioning, theory of mind, and verbal skills with their own and others' behaviour in a cooperative context: Changes in relations from early to middle school-age

Keywords: Social development; Cooperation; Children; Executive Functions; Theory of Mind; Verbal Skills

Abstract

Learning to behave in socially competent ways is an essential component of children’s development. This study examined the relations between children’s social, communicative, and cognitive skills and their behaviours during a cooperative task, as well as how these relationships change at different ages. Early school-age (5-8 years old) and middle school-age (9-12 years old) children completed tasks to assess their executive functioning (i.e., inhibitory control, working memory, planning), theory of mind, and verbal skills, and participated in an interactive cooperative task. Because children participated in pairs, dyadic data analysis was used to examine the effect of individual characteristics on children’s own and their partners’ social behaviour. Results indicated that better theory of mind was related to lower levels of the competitive behaviours demonstrated by younger children, as well as by partners. In contrast, for older children, planning and verbal skills related to lower levels of competitive behaviour. The associations of theory of mind and planning skills with behaviour were significantly different between the early and middle school-age groups. Findings suggest that children may utilize different skills at various developmental stages to guide their social behaviours. Findings have implications for theories of children’s social development, as well as for interventions aimed at enhancing social skills.

Introduction

Being able to successfully navigate social interactions is key to children’s current and later adjustment (Ashiabi, 2007; Bonino & Cattelino, 1999; Ciairano, Visu-Petra, & Settanni, 2007; Hymel, Rubin, Rowden, & LeMare, 1990; Parker & Asher, 1987), with peer relations playing a particularly pivotal role (Parker, Rubin, Erath, Wojslawowicz & Buskirk, 2006). The importance of peer-to-peer encounters underscores the need to identify the factors that support the development of appropriate behaviours within this context. This study investigated children’s ability to coordinate their behaviour with a partner in a cooperative context and the cognitive and socio-cognitive skills that relate to such behaviour. Dyadic data analysis revealed the effect of children’s characteristics (e.g., executive functioning, theory of mind, verbal skills) on their own behaviour as well as that of their social partner. Importantly, relations were compared between early school-age and middle school-age children to assess whether the strength of relation between particular skills and social behaviour depends on developmental stage.

Within the broader social environment children encounter many different contexts, including cooperative contexts, in which one’s goal is convergent or shared with another individual. Social competence in a cooperative context involves appreciating the shared goal and following a strategy that involves combining efforts with another to effectively reach that goal (Brownell & Carriger, 1990; Tomasello, 2007). This behaviour contrasts with competitive actions in which one follows a strategy which involves reaching a self-interested goal in opposition to another’s goal. Social competence entails children recognizing the social context and mobilising their behaviours accordingly, that is, employing behaviours that match the context.

Development of Social Behaviour

The ability to collaborate with others develops rapidly over the first few years of life. Specifically, by the end of their first year children demonstrate skills pertinent to working cooperatively with others (e.g., understanding others’ intentional actions, coordinating attention with another person and an object of shared interest). For example, 10-month-old children exhibit an understanding of collaborative goals, but only after engagement with a collaborative activity (Henderson, Wang, Matz, & Woodward, 2013) and 14-month-olds show a basic understanding of collaborative goals (Henderson & Woodward, 2011; Tomasello, 2007; Tomasello & Carpenter, 2007). Throughout their second year, children begin to cooperate and share more with others; while developing important socio-cognitive skills (e.g., understanding and differentiating self versus others; representing causal relations between one’s actions and a partner’s actions; Brownell & Carriger, 1990; 1991; Hay, 1979). Despite these advances, by the middle of their second year children continue to demonstrate difficulty joining their own efforts with others, however, by the end of the second year, children can coordinate their behaviour with a peer to achieve a common goal (Brownell & Carriger, 1990; 1991; Warneken, Chen, & Tomasello, 2006).

With regard to children’s understanding of competitive actions, by 5 years old, children appreciate that, within a competitive context, it is expected that social partners will engage in behaviours that are conducive to winning (Schmidt, Hardecker, & Tomasello, 2016). However, within a cooperative context, competitive or self-serving behaviours decrease between the ages of 2 and 3. In one study, for example, once it was established that children were working towards a joint goal, 3-year-olds (but not 2-year-olds) continued to assist a partner even if they had already received a reward for themselves (Hamman, Warneken, Greenberg, & Tomasello, 2011; Hamman, Warneken, & Tomasello, 2012).

Skills that Relate to Social Behaviour

Being able to collaborate with another requires the coordination of many actions, such as attending to cues within the environment, identifying self/other goals, coordinating behaviour accordingly, and flexibly applying strategies to different contexts. A range of skills are required to assist children with this complex task. In particular, children require the ability to reason about the goals and intentions of social partners (i.e., "Theory of Mind" [ToM]; Bosacki & Astington, 1999). However, children also require the skills to make use of such information to guide behaviour (i.e., executive functioning; Nilsen & Fecica, 2011). Thus, these areas are the main focus in the present investigation.

ToM allows one to attribute independent mental states to others and use information about others' intentions, desires, thoughts, and beliefs to make sense of the social world—that is, to interpret and predict the actions of others (Ashiabi, 2007; Bosacki & Astington, 1999; Decety, Jackson, Sommerville, Chaminade, & Meltzoff, 2004). While there are different aspects within the broad concept of ToM (e.g., intuitive versus reflective; decoding versus reasoning; cognitive versus affective, etc.; Hughes, 2011; Sabbagh, 2004), there is a consensus in the literature that, generally speaking, recognition of others' thoughts and emotions is essential to children's ability to engage successfully in everyday interactions with their peers (Bosacki & Astington, 1999; Hughes, Fujisawa, Ensor, Lecce, & Marfleet, 2006; Hughes & Leekam, 2004; Razza & Blair, 2009). For example, Dunn and Cutting (1999) found that preschool children's ToM skills (false belief and deception skills), affective perspective-taking skills, and emotion understanding correlated with their cooperative play with another child (and conversely, weak ToM related to more conflict behaviour). Five- to 10-year-olds' ToM skills (1^{st} and 2^{nd} order false belief) were also found to relate to increased cooperative behaviours within ultimatum and prisoner's dilemma games (Sally & Hill, 2006; Takagishi, Kameshima, Schug, Koizumi, & Yamagishi, 2010). For example, in the ultimatum game, wherein children were asked to allocate candy to themselves and their partner, children who passed false belief tasks proposed higher offers than those who failed (Sally & Hill, 2006; Takagishi et al., 2010). At 6 years old, children use information about their partners’ beliefs during cooperative tasks (Grueneisen, Wyman, & Tomasello, 2015); specifically, children were able to make use of 1st and 2nd order false belief understanding to guide their behaviour which in turn allowed for successful completion of the task. Within the context of competitive games, theory of mind skills assist children in understanding their partners’ behaviours. For example, Sher and colleagues found that 6-year-olds made use of inferences about their partners’ beliefs to guide their competitive behaviours, while younger children were unable to do so (Sher, Koenig, & Rustichini, 2014). Thus, theory of mind appears to play a role in assisting children to understand the intentions of social partners, which in turn allows them to generate behaviour that is appropriate for the context. However, the direction of such relations may be the reverse such that the experience of interacting with others enhances a child’s social understanding/ToM (Carpendale & Lewis, 2004).

Executive functioning (EF) is generally referred to as higher-order, self-regulatory cognitive processes that facilitate goal-directed behaviour by enabling the maintenance of behaviour on a goal set and calibration of behaviour to a context (Carlson, 2005; Pennington & Ozonoff, 1996; Hughes, 1998), and is comprised of components including inhibitory control, cognitive flexibility, working memory, and planning (Blair, Zelazo, & Greenberg, 2005; Diamond, 2006; Garon, Bryson, & Smith, 2008). EF plays an important role in guiding individuals’ social interactions and in promoting social competence (Decety et al., 2004; Nigg, Quamma, Greenberg, & Kusche, 1999; Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006). That is, one must not only understand the thoughts and intentions of others, but also have the cognitive skills to use this information to regulate one's behaviours (Nilsen & Fecica, 2011). Several studies reveal that children's EF abilities relate to effective behaviours within cooperative contexts. For example, Bonino and Cattelino (1999) demonstrated that 7-year-olds with better cognitive flexibility had significantly more cooperative interactions during a dyadic task. Inhibitory control also appears to be important for cooperative behaviour. A longitudinal study by Ciairano and colleagues (2007) found that child dyads (7-, 9-, and 11-year-olds initially) with better inhibitory control displayed significantly more cooperative behaviours during a cooperative task during an initial assessment and a second evaluation one year later. Similarly, Giannotta and colleagues found that 8-, 10-, and 12-year-old children's inhibitory control was associated with more cooperative behaviours during a collaborative task (Giannotta, Burk, & Ciairano, 2011). Huyder & Nilsen (2012) also found that 6- to 8-year-olds with more proficient inhibitory control demonstrated fewer competitive behaviours during a cooperative task. Recent work also suggests that planning skills play a role in children's cooperation. Warneken and colleagues assessed 3- and 5-year-old children's ability to plan and divide labour for a collaborative task by having the children choose which tools each partner would need to complete the task. It was found that 5-year-olds, but not 3-year-olds could successfully make the correct choice of tool that would allow their dyad to complete the task (Warneken, Steinwender, Hamann, & Tomasello, 2014). Lastly, work by McQuade and colleagues (2013) showed that children's (9- to 12-year-olds) working memory abilities were significantly negatively related to different aspects of non-collaborative behaviours, such as, peer rejection, physical aggression, and deficits in conflict resolution skills.

One factor limiting previous work is that studies have isolated one particular EF component and/or ToM rather than taking into account the relations amongst a broader range of these cognitive skills (e.g., Ciairano et al., 2007; McQuade et al., 2013). For example, past work examining the role of EF for social behaviour has often neglected to include children’s verbal skills and/or ToM (e.g., Ciairano et al., 2007; Giannotta et al., 2011). That is, there are interrelations between EF, ToM, verbal ability, and social competence (Bosacki & Astington, 1999; Carlson & Moses, 2001; Dunn & Cutting, 1999; Jacques & Zelazo, 2005; Im-Bolter, Agostino, & Owens-Jaffray, 2016; Nigg et al., 1999), which are not always accounted for. Due to these interrelations, this study sought to clarify the *unique* contributions of EF, ToM, and verbal skills for children’s social behaviour. Knowledge of the EF, ToM, and verbal components children recruit during complex problem solving tasks with peers is important not only for theoretical reasons, but also for practical ones, such as developing interventions for children with weak social skills.

Moreover, past work has not always accounted for the role of a child’s social partner when examining the relations between EF, ToM, and behaviour. Due to the reciprocal nature of human interactions, the influence of one’s partner needs to be accounted for when trying to explicate the specific skills that facilitate appropriate social behaviour. Given the expected reciprocity that occurs in peer interactions (i.e., that one child’s behaviour impacts his/her partner’s behaviour) and the influence of one child’s individual characteristics on another peer, the use of dyadic data analyses is important in order to control for and understand the impact of individual characteristics on a child’s own/peer’s behaviour (Kenny, Kashy, & Cook, 2006).

Another factor limiting the conclusions that can be drawn from previous work is that relations between socio-cognitive / cognitive skills and social behaviour often are examined at one age point (e.g., Bonino & Cattelino, 1999; Dunn & Cutting, 1999; Grueneisen et al., 2015). However, because both EF and ToM undergo changes throughout the preschool and school years, albeit at different rates, the relationship that each has with children's social behaviours may change across development. For instance, while EF skills emerge as early as infancy, become more refined through the preschool years, and show systematic improvements through childhood into adolescence (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Best, Miller & Jones, 2009; Diamond, 2006), different components of EF go through periods of change at different ages (Best et al., 2009). Inhibitory control shows marked improvements during the preschool period (3- 5 years old) and improvements continue to be seen between 5-8 years old (Best et al., 2009; Diamond, 2006). Working memory has a longer developmental trajectory (Huizinga, Dolan, & van der Molen, 2006; Huizinga & Van der Molen, 2007), showing gradual increases in capacity through the school-age and adolescent years (Best et al., 2009; Diamond, 2006). Planning ability, perhaps the pinnacle of EF, may be the last component to develop and is built on other EF components (Best et al., 2009). This ability develops rapidly within late childhood and continues to develop in adulthood (Best et al., 2009; Huizinga et al., 2006). In addition, with respect to ToM, a developmental progression within the preschool period emerges whereby children first appreciate intentions, then desire, knowledge, belief and then discrepant emotions (Carlson, Koenig, & Harms, 2013). While children as young as 18-months-old show implicit appreciation of others' mental states (Senju, Southgate, Snape, Leonard & Csibra, 2011), and pass false belief tasks between 3 to 5 years old (Calero, Salles, Semelman, & Sigman, 2013; Wellman, Cross, & Watson, 2001), the efficiency with which they employ their ToM abilities continues to develop throughout childhood and adolescence (e.g., Bosacki & Astington, 1999; Calero et al., 2013; Dumontheil, Apperly, & Blakemore, 2010; Wang, Ali, Frisson, & Apperly, 2016).

Because EF/ToM components develop at different ages, the skills that may be drawn upon to solve complex problems may change over the course of development (Best et al., 2009). Indeed, the interrelations between EF and ToM show different patterns in middle childhood versus adolescence (Im-Bolter et al., 2016). Unfortunately, many studies have not used a broad age range when assessing the relations between EF components, ToM, and social behaviour. Consequently, it is unclear whether specific EF components and/or ToM, which come on line at different ages, show differential relationships with socially competent behaviour at various ages. Addressing this key point, the present research assessed whether the relationship between EF, ToM, and verbal skills with social behaviour changes based on a child's age.

In sum, the present investigation had two main aims. First, this study examined the unique contributions of EF components, ToM, and verbal skills on social behaviours, while taking into account a partner's skill/behaviour. Second, this work investigated whether the relations between EF skills, ToM, verbal skills and social behaviour would change with age. To address these aims, children's behaviours were assessed during a task with a peer. We were interested in capturing the degree to which cooperative behaviours (i.e., those that assisted the collaborative goal), as well as, competitive behaviours (i.e., those that advanced individual interests at the expense of the group goal) were demonstrated.

Method

Participants

Two-hundred and sixty-two participants were recruited from schools from a mid-sized Canadian city. Eleven participants were removed from the analyses because they did not have a partner to complete the social task with (*n* = 6) and/or they had a diagnosis of Autism Spectrum Disorder or Intellectual Disability (*n* = 5). Because the study entailed dyadic relationships, if a child was excluded, his/her partner's data were also removed (*n* = 3). The resulting sample was 130 children in the younger age group (69 males) between the ages of 5 to 8 years old (61.00 to 98.90 months of age; *M* = 6 years; 8 months, *SD* = 10.19 months) and 118 children in the older age group (52 males) between the ages of 9 to 12 years old (108.40 to 154.40 months of age; *M* = 10 years; 6 months, *SD* = 12.03 months).

The younger sample was comprised of children identified as White/European (73.1%), Asian (7.7%), Eastern European (3.8%), Latin American (2.3%), Middle Eastern (0.8%), Other (2.3%) and the older sample was comprised of children identified as White/European (62.7%), Asian (11.0%), Eastern European (7.6%), Black (2.5%), Latin American (2.5%), Aboriginal (1.7%), Other (9.3%). Eighty-one percent of mothers and 77% of fathers in the younger sample indicated they had college/university education. Seventy percent of mothers and 66% of fathers in the older sample reported having college/university education.

Procedure

The data presented here was from a larger study investigating individual differences in social behaviour. All procedures adhered to ethical guidelines and were reviewed by the Office of Research Ethics at the University of Waterloo. Children, tested in their school, were assigned to pairs by randomly selecting names from the class roster (of those children whose parents consented). Partners were of a similar age and, whenever possible, from the same classroom. Children first completed the cooperative task with their partner and then completed tasks individually with a researcher (i.e., in separate rooms) in the following order: inhibitory control task, working memory task, planning task, ToM task, verbal skills task. Tasks were presented in this fixed order to ensure that individuals were exposed to identical stimulus contexts (Carlson & Moses, 2001).

Cooperative task. The cooperative task used to measure children's social behaviours was designed to elicit a variety of behaviours from children (i.e., cooperative, competitive, neutral). Pairs of children completed the "block game" as a team. Children were each presented with a wooden frame (13" X 13"), located in front of them. They were instructed to earn the most points for their team by correctly placing as many of the 150 coloured blocks (15 blocks for each of the 10 different colours), placed randomly face-down, as possible on their wooden frame (i.e., correctly match the colour of the block to the colour on the wooden frame; See Figure 1). Children sat beside each other, having been randomly assigned to sit in front of one of the frames (i.e., left or right side of the other child), and were instructed to complete the wooden frame in front of them; however, children were also told that they were allowed to help each other.

Before beginning the task, each pair was asked to choose a team name to highlight the collaborative nature of the task. A model was used to demonstrate the point system: children would receive 1 point for each correctly placed block and 10 bonus points if they correctly placed all the blocks for one colour. Children were informed that there were not enough blocks for each of them to complete all the colours on each of their wooden frames. They would need to coordinate who would use which blocks to the best advantage of the team. Children were given one rule to follow: if they picked up a block they must put it back face down, unless they or their partner was actively using that block to complete one of the wooden frames. This rule ensured that children would have to make a decision with each block that they or their partner may need; they could either use the piece on their own frame or turn it back over and not help their partner by providing the block. Children had 3 minutes to complete the task and their behaviours were video-recorded.

Coding. Children's cooperative, competitive, and neutral behaviours, including both verbal and non-verbal behaviours, during the task were coded by a research assistant who was blind to the research hypotheses. Behaviours were coded as cooperative if they helped their partner to serve the team's shared goal (e.g., giving the other child a block to put on his/her wooden frame, asking the other child if he/she needs help). Behaviours were coded as competitive if they demonstrated self-interested objectives or intentions to hinder the other child's completion of his/her wooden frame (e.g., picking up a coloured block that the other child said they needed and either using it on one's own frame or putting it back face-down, verbal bragging about one's own half in comparison to the other child's [e.g., "I'm doing better than you!"]). A scoring system was employed to account for behaviours that demonstrated more direct helping or hindering (e.g., putting a block in the correct location on the other child's half or picking up a block that the other child has explicitly indicated a need for and putting it on one's own model). These types of behaviours were given 2 points, whereas less direct behaviours (e.g., planning who would work on which colours versus ignoring verbal advice from the other child and continuing with previous action) were given 1 point. Behaviours were coded as neutral if they neither aided nor hindered the other child (e.g., picking up a block that the other child does not want and putting it on one's own model). Every relevant behaviour was counted separately, even when two or more different behaviours occurred simultaneously (e.g., a child making a verbal comment and a non-verbal behaviour at the same time). This coding scheme was based on previous studies using similar tasks to assess on-line social behaviours in children (e.g., Ciairano et al., 2007; Huyder & Nilsen, 2012).

The two main variables of interest were cooperative and competitive behaviours and only these behaviours were included in the main analyses; however, neutral behaviours were coded in order to account for the varying number of behaviours each child was performing during the task that were neither cooperative nor competitive. Proportions were calculated (e.g., the proportion of cooperative behaviours was calculated by dividing the total number of cooperative behaviours by the total number of cooperative, competitive and neutral behaviours).

To ensure reliability, a second research assistant coded the behaviours of 70 randomly chosen participants (25% of the total sample). The interrater reliability of the child's total number of behaviours was calculated for each of the three different types of behaviour: cooperative behaviour $ICC(69) = .99$, $p < .01$, competitive behaviour $ICC(69) = .24$, $p = .13$, and neutral behaviour $ICC(69) = .99$, $p < .01$. The ICC for competitive behaviours was lower due to the less frequent rate at which competitive behaviours occurred. To account for this, the total number of times raters agreed versus disagreed on the number of competitive behaviours occurring for each participant was also tallied (e.g., rater 1 coding participant A as having "zero" behaviour and rater 2 coding participant A as having "zero" behaviour would equal one tally for agreement; whereas, rater 1 coding participant B as having "one" behaviour and rater 2 coding participant B as having "two" behaviours would equal one tally for agreement and one tally for disagreement).[1] Using this analysis, raters were found to agree 82% of the time, comparable to their agreement for the cooperative behaviours (i.e., 90%).

Measures

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[1] A third researcher (VH) reviewed instances of disagreement between the two raters (i.e., when one rater identified competitive behaviour as occurring and the other rater did not) and resolved disagreements. The agreement rates provided are based on the reliability prior to this resolution.

Executive functioning. Tasks designed to capture the elements of working memory and inhibitory control were included as these domains are viewed as separable, low-level constructs within the larger EF umbrella (Huizinga, et al., 2006; Miyake et al., 2000). We were also interested in including a more complex form of EF, that is, planning, viewed as the pinnacle of EF (Best et al., 2009).

Inhibitory control. A computerized version of the Go/No-go task was used as a measure of inhibitory response control (i.e., the number of commission errors on this task). This task is appropriate for elementary-aged and older children (Araujo et al., 2009; Berlin, Bohlin, & Rydell, 2003), has decent reliability (Berlin & Bohlin, 2002), and loads on to a factor of inhibition (McAuley & White, 2011). Children were seated in front of a computer screen and presented with 1 of 4 shapes one at a time in a random order. Children were instructed to press the spacebar as fast as they could when 3 of these 4 shapes were presented ("go"); however, when the remaining 1 of these 4 shapes was presented ("no-go") they were to withhold this response. The "no-go" shape was chosen at random by the computer program before a participant began. Participants were presented with 20 practice trials, then with 4 blocks of 50 test trials. This task measured children's ability to refrain from performing certain actions/behavioural responses. As in previous studies (e.g., McAuley & White, 2011), a measure of inhibitory control from the Go/No-Go task was computed by dividing the number of incorrect responses on a no-go trial by the total number of no-go trials (i.e., higher score means worse inhibitory control). Individual scores that exceeded 3 standard deviations from the mean were removed from further analyses (n = 1 for the younger group; n = 2 for the older group).

Working memory. The Finger Windows subtest from the Wide Range Assessment of Memory and Learning Second Edition (WRAML2; Sheslow & Adams, 2003) was used as a measure of children's spatial working memory due to its strong reliability (Sheslow & Adams, 2003) and the fact that span tasks generally have been found to load on to working memory dimensions of executive functioning in factor analyses (Fournier-Vicente, Larigauderie, & Gaonac'h, 2008; Pennington, 1997). This test was administered according to standardized procedures, except that children were told to imitate the same sequence in the reverse order instead of the same order (as has been used in previous studies; e.g., Manassis, Tannock, Young & Francis-John, 2007; Murray et al., 2011). The researcher indicated a series of spatial locations by inserting a pencil through a series of randomly spaced holes ("windows") on an 8 X 11 inch card at a rate of one hole per second. The child was then required to reproduce the same sequence in backward order by putting his/her finger through the hole in the reverse order of that presented by the researcher. Items presented gradually increased in length from 2 hole sequences to 6 hole sequences. Children began testing at the age appropriate start point (i.e., Item 1 for 8 year olds and younger; Item 7 for 9 year olds and older) and were administered preceding items, if relevant, if they did not receive a perfect score on the first item administered. There were a total of 27 items and testing discontinued after 3 consecutive scores of 0. Raw scores (/27), computed by totalling all correct items and perfect scores on all items preceding the basal if relevant, were used in analyses.

Planning. The Tower subtest from the Developmental Neuropsychological Assessment (NEPSY; Korkman, Kirk, & Kemp, 1998), designed to be appropriate for ages 5-12 years old, was used to assess children's planning abilities. Tower tasks are frequently used to assess children's planning ability (Best et al., 2009), and this specific task was chosen due to its decent reliability estimates (Korkman et al., 1998). Children were instructed to replicate different patterns of cylinders using three balls on three pegs in as few moves as possible while following three rules: 1) Only one ball may be moved at a time; 2) A ball may not be placed on the table or be held in hand while moving a ball with the other hand; and 3) A move cannot be changed once the child has taken his or her hand off the ball. Children began testing at the age appropriate start point (i.e., Item 3 for 5 year olds and older) and were administered preceding items, if relevant, if they did not receive a perfect score on the first two items administered. There were a total of 20 items and this task was discontinued after 4 consecutive scores of 0. Raw scores (/20), computed by totalling all correct items and perfect scores on all items preceding the basal, were used in analyses.

Verbal skills. The Listening Comprehension subtest from the Wechsler Individual Achievement Test – Third Edition (WIAT-III; Wechsler, 2009) was administered as an assessment of children's verbal skills. This test was administered according to standardized procedures. Children were shown four pictures on each page and asked to point to the picture that showed the word spoken by the researcher. All children began at item 1. There were a total of 19 items and testing discontinued after 4 consecutive scores of 0. Raw scores (/19), computed by totalling all correct items, were used in analyses.

Theory of mind. The Theory of Mind subtest from the NEPSY-II was used to measure children's cognitive theory of mind, that is their abilities to understand mental functions (e.g., belief, intention and deception) and another's point of view (Korkman, Kirk, & Kemp, 2007). This task has been found to be a comprehensive and reliable measure of children's abilities to attribute and understand the mental states of others, a skill that has been found to relate to social behaviour (Korkman et al., 2007; Sally & Hill, 2006; Takagishi et al., 2010). The Theory of Mind subtest of the NEPSY-II consists of two tasks; however only the Verbal Task was used. Children were read various scenarios or shown pictures and then asked questions that, to be successfully answered, required knowledge of another's point of view. Children began testing at the age appropriate start point (i.e., Item 1 for 5-6 year olds; Item 4 for 7-8 year olds; Item 6 for 9 year olds and older) and were administered preceding items, if they did not receive a perfect score on the first two items administered, in reverse order until two perfect scores were obtained. There were a total of 15 items and testing discontinued after 4 consecutive scores of 0. Raw scores (/22), computed by adding the score received (0, 1, or 2 for some items) on each item and perfect scores on all items preceding the basal, were used in analyses.

Results

Initial Analyses

A MANOVA with gender as the grouping variable was conducted for the younger and older age groups on the EF/ToM/Verbal tasks, as well as on the social task. For both age groups, there were no significant effects of gender, *p*s > .05, and thus, gender was not included in further analyses.

EF, ToM, Verbal tasks. Children's performances on the tasks are presented in Table 1. All measures showed good variability, with no floor or ceiling effects, suggesting that they were age-appropriate for both age groups.

Similar to previous research, analyses revealed significant interrelations between the predictor variables and age (Table 2), particularly for the younger group (Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002; Carlson, Moses, & Claxton, 2004; Hughes & Ensor, 2007). Thus, age (within each group) was controlled for in the main analyses.

Cooperative task. The total number of cooperative, competitive and neutral behaviours for both age groups is presented in Table 3. As can be seen, the competitive and cooperative behaviours occurred infrequently compared to the neutral behaviours; thus, some of the cooperative and competitive proportions were positively skewed. Due to these skewed variables, any significant or marginally significant results in the main analyses, as described below, were re-analyzed using bootstrap analysis in order to better account for the proportions of cooperative and competitive behaviours being skewed variables[2].

Analyses revealed significant correlations between the children's behaviour and their partner's behaviour (Table 4). Thus, appropriately, the Actor Partner Interdependence Model (APIM) was used to examine relations between children's cognitive skills and their behaviour (Kenny et al., 2006). This allowed us to investigate both actor effects (i.e., when an individual's score on a predictor variable affects that same individual's score on an outcome variable) and partner effects (i.e., when an individual's score on a predictor variable affects his/her partner's score on an outcome variable).

Relations between Skills and Social Behaviour

Dyadic models: EF/ToM/Verbal skills and behaviours. To keep the APIM models as simple as possible, the effect of each EF component (i.e., planning, working memory, and inhibitory control) on social behaviour was examined in separate models, that is, as: 1) Planning, ToM, and Verbal Skills, 2) Working Memory, ToM, and Verbal Skills, and 3) Inhibitory Control, ToM, and Verbal Skills – for each age group. Figure 2 shows the generic model with executive function and social behaviour, without age added to the model. If results indicated a significant effect of more than one EF component, these components were to be combined into one larger model to control for the other EF components.

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[2] The bootstrap analysis involves a procedure that randomly draws a large number of resamples (with replacement) from the original sample data to create a large number of bootstrap samples, of which we used 5000 (Razza & Blair, 2009; Stine, 1989). This type of analysis was used because it deals with skewed data better than the APIM. By using the bootstrap analysis, we can be confident in the results and that they were not just a result of having skewed data.

Figure 3 shows the structural model for the social task using the dependent variable of the proportion of competitive behaviours as an example, without age included. In this type of model, the dyad members are treated as interchangeable (i.e., either could be assigned to partner A or partner B), and so all paired parameters are set equal across the members (Kenny et al., 2006). Each variable for a dyad is labelled as either A or B for each partner in the dyad. In this model, the actor effects for planning, ToM, and verbal skills are represented by paths *a*, *c*, and *e*, respectively; while the partner effects for planning, ToM, and verbal skills are represented by paths *b*, *d*, and *f*, respectively. To control for age, a composite of each pair's average age in months was calculated and added to the model, with a path going to partner A's behaviour and a path going to partner B's behaviour. This same type of model was run for each dependent variable (i.e., competitive or cooperative behaviour) and three sets of predictor variables—1) planning, ToM, and verbal skills, 2) inhibitory control, ToM and verbal skills, or 3) working memory, ToM and verbal skills—always controlling for age. Significance was determined by an alpha value of less than .05. All parameter estimates are reported in standardized form.

As mentioned previously, any significant or marginally significant results in the main analyses, were re-analyzed using bootstrap analysis. As a conservative approach, only results that demonstrated a consistent pattern using the APIM and bootstrap analyses are reported as significant.

Competitive behaviour. The model for planning included planning (Tower task), ToM, vocabulary, and age as predictors of competitive behaviour. Because the dyads were interchangeable (i.e., indistinguishable dyad members), the fit of the model was adjusted using the I-SAT model (i.e., a saturated model where everything is modeled as related to everything else in a completely unconstrained way). This model fit well, $\chi^2(6, N = 65) = 6.69$, *ns*, RMSEA =

.04. Results for the actor effect of planning on the proportion of competitive behaviours in the younger group was significant, while controlling for age and the actor and partner effects of the other predictor variables, (β = .19, $p < .05$), indicating that younger children with better planning skills displayed a greater proportion of competitive behaviours. On the other hand, the actor effect of ToM on the proportion of competitive behaviours was significantly negatively related, while controlling for age and the actor and partner effects of the other predictor variables, (β = -.37, $p < .01$). Finally, the partner effect of ToM on the proportion of competitive behaviours was significantly negatively related, while controlling for age and the actor and partner effects of the other variables (β = -.23, $p < .05$). Thus, for the younger group, children with better ToM displayed a smaller proportion of competitive behaviours; furthermore, their ToM was negatively related to their partners' behaviours such that partners displayed a smaller proportion of competitive behaviours.

For the older group, the model including planning, ToM, vocabulary (controlling for age) as predictors of competitive behaviour fit well, $\chi^2(6, N = 59) = 3.84$, *ns*, RMSEA = .00. Results for the actor effect of planning (i.e., Tower task) on the proportion of competitive behaviours was significant, while controlling for age and the actor and partner effects of the other predictor variables (β = -.24, $p < .01$), indicating that older children with better planning skills displayed a smaller proportion of competitive behaviours. Furthermore, the actor effect of verbal skills (i.e., Vocabulary task) on the proportion of competitive behaviours was significant, while controlling for age and the actor and partner effects of the other predictor variables (β = -.35, $p < .01$). Finally, the partner effect of verbal skills on the proportion of competitive behaviours was significant, while controlling for age and the actor and partner effects of the other variables (β = -.21, $p < .05$). These results indicate that, for the older group, those with better verbal skills displayed a smaller proportion of competitive behaviours; furthermore, their verbal abilities had an effect on their partners' behaviours such that partners displayed a smaller proportion of competitive behaviours. Table 5 presents all significant results for the models including planning, theory of mind, verbal skills and age as predictors for competitive behaviour for the younger versus older age groups.

When controlling for age, ToM, and verbal skills, the models which included inhibitory control, as well as the one that included working memory, revealed that for both older and younger children's these executive functions did not predict competitive behaviour displayed during the social task (*p*s > .05).

Cooperative behaviour. Next, the effect of cognitive skills on the proportion of cooperative behaviours was investigated, with each model including the specific EF component, ToM, vocabulary, and age. The models for inhibitory control, working memory, and planning for both age groups demonstrated that, once ToM, verbal skills and age were controlled, these executive skills did not influence the cooperative behaviour of the children (*p*s > .05). In addition, ToM and verbal skills did not significantly predict the cooperative behaviour of either age group in the models (*p*s > .05).

Dyadic models: Impact of age. To determine whether the younger and older groups differed with respect to the relations between cognitive skills and behaviours during the task a multiple-sample SEM in which a model for each dependent variable (i.e., competitive and cooperative behaviours) was applied simultaneously to the younger and older groups. Specifically, to test the hypothesis that the slopes of the predictor variables (both actor and partner effects) are different across the two age groups, the fit of models was compared where all paths were set different between the younger and older groups except a specific path of interest.

For example, in one model the path for the actor effect of planning was set equal for both the younger and older groups. A difference in fit for the original model and the constrained model, would mean that there was a significant difference in the relation between planning and social behaviours between the two age groups. Only models with significant results in one of the age groups, as described above, were compared.

Planning. The model with the predictor variables of planning, ToM, verbal skills, age and the dependent variable of the proportion of competitive behaviours was compared between the two age groups. In the first model, the path for the actor effect of planning abilities was set equal for both the younger and older groups. The difference in fit between the original model and the constrained model was significant, $\Delta\chi^2(1) = 8.67$, $p < .01$. This indicates that the slope in the younger group was significantly different from the slope in the older group, meaning that planning abilities were having different effects on competitive behaviours of the younger versus older children. Whereas better planning was related to more competitive behaviours in the younger group, better planning was related to fewer competitive behaviours in the older group.

ToM. The path for the actor effect of ToM was set equal for the younger and older groups. The difference in fit was significant, $\Delta\chi^2(1) = 12.90$, $p < .01$. Also, when the path for the partner effect of ToM abilities was set equal for both the younger and older groups, the difference in fit was significant, $\Delta\chi^2(1) = 5.11$, $p < .05$. These results suggest that, when compared to the older group, ToM played a more significant role in the younger group such that better ToM was related to fewer competitive behaviours from oneself and one's partner.

Verbal skills. The path for the actor effect of verbal abilities was set equal for the younger and older groups. The difference in fit was not significant, $\Delta\chi^2(1) = 0.85$, $p > .05$. Also, when the path for the partner effect of verbal abilities was set equal for both the younger and older groups, the difference in fit was not significant, $\Delta\chi^2(1) = 0.98$, $p > .05$. These results suggest that, verbal abilities did not play a significantly different role in affecting competitive behaviours across the age groups.

In summary, results indicate that individual skills had different effects on the competitive behaviours displayed by younger versus older children. While better planning skills were related to more competitive behaviours in younger children, better planning was related to fewer competitive behaviours in older children. Furthermore, ToM had a stronger effect on one's own and one's partner's competitive behaviour for the younger group (i.e., better ToM was related to fewer competitive behaviours) relative to the older group (See Table 5).

Discussion

The aims of the present work were to determine the unique contributions of EF, ToM and verbal skills for children's social behaviour, as well as on their partners' behaviour; and to examine whether the relations between the various skill areas and social behaviour differed across the developmental span.

Providing an important backdrop to the main analyses, the behaviour between partners during the interactive task was significantly related. Specifically, partners' cooperative and competitive behaviours were positively related, suggesting that, similar to past work, children have an influence on each other during a social interaction (e.g., Huyder & Nilsen, 2012). Such findings also confirmed that it was indeed appropriate to examine both actor and partner effects when looking at the relation between children's skills and social behaviour during an interaction with a partner, a noted gap in the previous literature.

With respect to our first aim, within the EF domain, children's planning performance (but not their inhibitory control or working memory capacity) was related to their social behaviour.

Consistent with work highlighting children's demonstrated planning within a collaborative context (Warneken et al., 2014), individual differences in planning skills were significantly related to social behaviour, even when controlling for other socio-communicative factors such as ToM and verbal skills. Interestingly, planning skills had a unique and opposite relationship with the competitive behaviours of early school-age (5-8 years old) versus middle school-age (9-12 years old) children. While better planning skills were related to *more* competitive behaviours in the younger group, better planning skills were related to *fewer* competitive behaviours in the older group. Thus, as per our second aim, the relation between planning skills and social behaviour significantly changes with age. It was interesting to find that better planning in younger children was related to increased 'inappropriate' competitive behaviours during the cooperative task. It may be that younger children generally hold a more self-focused goal in mind, concentrating more on completing their individual portion of the task. Indeed, literature on the development of social competence highlights that younger children are more self-focused and gradually become more aware of others' thoughts, feelings, and expectations and place more value on peer acceptance beyond early childhood (Rose-Krasnor, 1997). Thus, younger children with better planning skills may show more behaviours that are in line with such self-serving goals (e.g., taking and using a block that their partner needed to complete their own half of the wooden model). In contrast, older children with better planning abilities were able to utilize these skills to guide behaviours that were appropriate for the context. Older children with better planning skills were likely better able to focus on the collaborative goal and determine how to most effectively coordinate one's own goals with another's. For the cooperative task used in this study, planning could allow children to recognize how different actions would lead to the end goal of winning the most points for their team, and thus, choose to limit actions that would be beneficial for oneself but would hinder this team effort (e.g., taking a partner's block that would be needed by that partner to get more bonus points).

Outside of the EF components, it was found that ToM was related to younger children's social behaviours. Specifically, within this age group, better ToM was related to fewer competitive behaviours. Moreover, these actor effects were significantly different from the effects of ToM in older children; thus, ToM seems to play a more prominent role in guiding younger children's behaviours during the cooperative social task. Taken together, results indicate that ToM skills may be especially important in helping younger children enact social behaviours that lead to more appropriate interactions with their peers – even when controlling for EF (i.e., planning, inhibitory control, and working memory) and verbal skills. Such findings are consistent with the notion that being successful in social interactions during early childhood involves an increasing awareness of others and being able to successfully engage in play with peers (i.e., being able to understand the mental states of others; Denham, Salisch, Olthof, Kochanoff, & Caverly, 2002). Preschool-age children who better understand mental states and feelings may understand another's perspective in order to act in a way that is socially appropriate, thereby having more successful play interactions with peers (Razza & Blair, 2009; Hughes & Leekam, 2004; Bosacki & Astington, 1999). Indeed, ToM has been shown to be an important predictor of children's social competence (Hughes & Leekam, 2004; Razza & Blair, 2009), including within populations who have had restricted early access to social and communicative experiences, such as deaf children; Peterson, O'Reilly, & Wellman, 2016). As well, preschool-age children with weaker ToM demonstrate more conflict behaviour with peers (Dunn & Cutting, 1999) and more friendlessness (Fink, Begeer, Peterson, Slaughter, & de Rosnay, 2015). In turn, ToM skills may be constructed through the quality of social interactions a child has (i.e., as opposed to assuming ToM operates as a necessary precursor to social behaviour). Specifically, results found here could reflect the notion that those children who demonstrate more appropriate social behaviour, through such interactions are building their ToM skills (Carpendale & Lewis, 2004). Importantly, we show that relations exist when controlling for other possible influences, such as EF and verbal skills. Moreover the developmental differences suggest that ToM is less influential within the older age range, potentially because the majority of children were able to meet the ToM demands of the task (e.g., that the intentions of their partner would be in line with their own, etc.).

Interestingly, younger children's own ToM was also significantly related to their partners' competitive behaviours. That is, when a child had better ToM skills, his/her partner demonstrated behaviours that were more socially appropriate for the context, as per reduced competitive behaviours. These partner effects were significantly different from the effects of ToM in older children. Representing a novel finding in this area, the partner effect may occur because younger children with better ToM act in a manner that demonstrates understanding and consideration for the other person, which in turn, would lead the other person to behave less competitively than they would otherwise. In other words, younger children may be more inclined to behave in a less self-serving way with someone who demonstrates more consideration for others. This is an interesting finding when considering constructivist views of theory of mind, that is, that children develop social understanding through their interactions with others (e.g., Carpendale & Lewis, 2004). It may be the case that engaging with a peer with better ToM facilitates social behaviour within that context, which in turn lays groundwork for more advanced social understanding.

Finally, when examining the unique contribution of verbal skills on social behaviour, it was found that verbal abilities related to the competitive behaviour of older children during the social task. Specifically, even when controlling for other cognitive skills, older children with better verbal skills displayed fewer competitive behaviours; and interestingly, their partners also displayed fewer competitive behaviours. It may be the case that children with better verbal skills were simply better able to guide their own behaviour and use self-talk during the task to keep themselves on course for their goals. Children with better verbal skills also may be better able to communicate with their partner in a manner that decreases their partner's self-serving (competitive) behaviours. Specifically, better verbal skills would allow a child to negotiate more effectively with their partner and assert what each person should be doing during the task, such as reminding the partner of their joint goal and behaviours that will not benefit the team. Our findings add to recent research highlighting the role of verbal ability for aspects of social functioning, including decreased antisocial behaviours and conflict with teachers (Hernández et al., 2016; McEachern & Snyder, 2012), by showing its importance for behaviour within peer-to-peer interactions.

In contrast to the effects of planning, ToM, and verbal skills, working memory and inhibitory control did not have unique effects on children's social behaviours. It may be that these EF components were not particularly helpful for guiding children's behaviours, particularly once children's ToM and verbal skills (which were found to relate to working memory) were controlled (or conversely that social performance does not facilitate growth in these areas). It is also possible that the specific tasks used to assess inhibitory control and working memory in the present study were generally not relevant to social behaviours. For example, while one recent study did find relations between *verbal* working memory and peer rejection (as assessed by teacher reports), it did not find a relationship between *spatial* working memory (assessed in the present work) and social competence (McQuade et al., 2013). Interestingly, Huyder and Nilsen (2012) found that children with better inhibitory control showed less competitive behaviours during a joint task with a peer – which was not found in the current work. Such differential findings may be accounted for by the type of inhibitory control task employed (i.e., the "Simon Says" game in Huyder & Nilsen as opposed to the computerized task in the present study).

It is also noteworthy that none of the predictor variables significantly related to the cooperative behaviours. One possible explanation for this null finding is that children's cooperative behaviours were a powerful predictor of partners' cooperative behaviours, which may have left little room for individual skills to exert a strong influence. Consistent with this, while past research has found relations between EF and ToM skills and cooperative behaviours, these studies did not control for the mutual influence between social partners. Of note, the one other study to use dyadic data analysis (Huyder & Nilsen, 2012) to control for these effects, similarly found that EF only related to competitive behaviours and not cooperative behaviours. Thus, EF and ToM skills may play a more prominent role in regulating *in*appropriate behaviours (i.e., competitive) as opposed to facilitating appropriate behaviours (i.e., cooperative) per se.

Implications and Future Directions

Results have implications for theoretical accounts of social functioning, highlighting the relations planning, ToM, and verbal skills have with children's social behaviour. For example, findings highlight that in addition to being able to reason about a social partner's goals, children may require the cognitive abilities to make use of such information (e.g., Nilsen & Fecica, 2011). Moreover, findings highlight that statements about the importance of such skills for social functioning need caveats related to the developmental stage of the children being examined. As one key example, planning ability related to more inappropriate social behaviour within the cooperative context for young children, but decreased inappropriate behaviour for the older children. Thus, researchers would be prudent to consider multiple age ranges when examining the individual differences that relate to children's social behaviour.

Findings also have implications for early intervention or prevention programs. Specifically, the results suggest that intervening to improve EF (i.e., planning) may be helpful in improving children's social functioning. In recent years, there has been an increased effort to determine whether EF can be enhanced through focused interventions. Studies have conducted EF training in a number of ways, such as providing practice with task-switching (i.e., switching between two simple cognitive tasks), working memory and inhibition training (e.g., computerized training), neurostimulation or neurofeedback, or specific curricula (e.g., Tools of the Mind curriculum) (for reviews, see Diamond & Lee, 2011; Enriquez-Geppert, Huster, & Herrmann, 2013). Several studies have shown that EF training does indeed lead to improvements in EF and academic performance (e.g., Dowsett & Livesey, 2000; Enriquez-Geppert et al., 2013; Karbach & Kray, 2009; Kray, Karbach, Haenig, & Freitag, 2012; Malekpour & Aghababaei, 2013). To these authors' knowledge, most research has not yet looked at the impact of EF training specifically on social skills; however, one study examining the use of martial arts training found that this lead to increased prosocial behaviour (Lakes & Hoyt, 2004). Given that early social interactions may conversely have an impact on EF development, it may also be important to attend to children's early social experiences and activities as a way to improve later EF skills, and perhaps, later social skills (Diamond & Lee, 2011; Moriguchi, 2014).

Findings suggest that ToM skills may be important in guiding early school-age children's socially appropriate behaviours; thus, early identification of children experiencing ToM difficulties is important. Specifically, ToM training may be particularly helpful for children in order to improve their social functioning (Allen & Kinsey, 2013). ToM training has typically focused on training in false-belief understanding, perspective shifting, dual representation or pretence (Kloo & Perner, 2008; Moses & Tahiroglu, 2010). Although some studies have found that ToM training leads to increases in EF but not ToM, other studies show that ToM and even EF training can lead to increases in ToM (Allen & Kinsey; Moses & Tahiroglu). Thus, training ToM and/or EF appears to be a fruitful area of exploration for future research with the goal of improving social functioning. Of course, conversely, it may be that the quality of social experiences facilitates ToM. Indeed, training studies employing a conversational approach have found that when children engage in dialogues that focus on mental states they show a more mature ToM understanding (Bianco, Lecce, & Banerjee, 2016).

On another note, there were a number of findings suggesting that children's characteristics elicited specific behaviours from their partners, which has interesting educational implications with respect to partner-work and how some pairings may be more beneficial for children's social functioning. For example, pairing a child with another child who has more advanced ToM and verbal skills may elicit less competitive behaviour. When considering these pairings, one would also need to consider the developmental stage of children, as the abilities have differential effects on partner's behaviours depending on age. In the end, children may learn from their more socially and cognitively skilled partners to behave less competitively and more collaboratively. An interesting area for future research would be to investigate whether the influence of a child with better cognitive and social skills on another child's functioning would generalize to that other child's interactions with others, as well as to their general social understanding.

There are other possible ways in which the findings here could be extended. For example, while we did not find an effect of participants' gender on our variables, it would be of interest to see if this factor is important as children progress in their development, as well as examining whether the match between gender is relevant (as per findings that the latter may be important for cooperation, Balliet, Li, Macfalan, Van Vugt, 2011). In addition, findings from this study pertain specifically to a predominantly White/European sample and as such generalizations to other cultures are limited. Given recent findings that cultural factors may be important to children's cooperative behaviour (Cárdenas, Dreber, Essen, & Ranehill, 2014), as well as executive functioning and theory of mind (Sabbagh, Xu, Carlson, Moses, & Lee, 2006; Wang, Devine, Wong, & Hughes, 2016), examining such relations in diverse populations or cross-culturally would be of interest. It is also important to note that various factors that may relate to social behaviour were not controlled for/examined in the present investigation (e.g., attentional switching, visual-spatial ability, the number of siblings, nor school climate).

Conclusion

This study is the first to use a dyadic model to control for partner and actor effects when investigating the unique relations of EF, ToM and verbal skills with children's social behaviours and the first to explore how such relations are influenced by developmental stage. The results chart a specific developmental trajectory in that different skills (i.e., planning, ToM, and verbal skills) seem to be utilized in different ways by early school-age versus middle school-age children to guide social behaviours. By using dyadic data analyses, this study was also able to provide a clearer picture of how specific characteristics of children relate to the social behaviours of other children with whom they are interacting.

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Table 1

Means (Standard Deviations) of the Cognitive Tasks for the Younger and Older Groups

	Younger Group		Older Group	
Cognitive Task	*n*	*M (SD)*	*n*	*M (SD)*
No-Go False Alarm Rate	121	0.21 (0.15)	113	0.13 (0.10)
Finger Windows	130	7.72 (3.98)	118	12.80 (3.89)
Tower	130	10.52 (3.08)	118	12.89 (1.97)
ToM	130	13.08 (3.80)	118	18.84 (2.93)
Vocabulary	130	7.68 (2.77)	118	12.25 (2.45)

Note. No-Go False Alarm Rate = proportion out of 1; Finger Windows = total score out of 24; Tower = total score out of 20; ToM = total score out of 22; Vocabulary = total score out of 19.

Table 2

Bivariate Correlations between the No-Go False Alarm Rate, Finger Windows, Tower, ToM, Vocabulary, and Age for the Younger and Older Groups

	No-Go False Alarm Rate	Finger Windows	Tower	ToM	Vocabulary	Age
No-Go False Alarm Rate	--	-.13	-.12	.00	-.13	-.12
Finger Windows	-.13	--	.14	.20*	.27**	.07
Tower	-.07	.42***	--	.15	.14	.21*
ToM	-.17	.51***	.43***	--	.36***	.24*
Vocabulary	.04	.39***	.28***	.46***	--	.22*
Age	-.16	.60***	.41***	.51***	.41***	--

Note. Older Group is on the upper half and Younger Group is on the lower half of the table. No-Go False Alarm Rate = proportion out of 1; Finger Windows = total score out of 24; Tower = total score out of 20; ToM = total score out of 22; Vocabulary = total score out of 19; Age = Age in months.
*p < .05 (2-tailed). **p < .01 (2-tailed). ***p < .001 (2-tailed).

Table 3

Means (Standard Deviations) of the Cooperative, Competitive, and Neutral Behaviours for the Younger and Older Groups

	Younger	Older
Total Behaviours	*M (SD)*	*M (SD)*
Cooperative	1.45 (8.39)	8.14 (18.10)
Competitive	0.85 (2.90)	0.28 (0.97)
Neutral	50.87 (12.42)	59.44 (15.81)

Note. *N* = 130 (Younger group) and 116 (Older group); Cooperative = total number of cooperative behaviours; Competitive = total number of competitive behaviours; Neutral = total number of neutral behaviours.

Table 4

Bivariate Correlations between Each Pairs' Behaviours in the Cooperative Task for the Younger and Older Groups

	Proportion Cooperative B		Proportion Competitive B		Proportion Neutral B	
	Younger	Older	Younger	Older	Younger	Older
Proportion Cooperative A	.88***	.83***	-.05	-.07	-.84***	-.82***
Proportion Competitive A	-.07	.03	.78***	.47***	-.15	-.07
Proportion Neutral A	-.61***	-.82***	-.51***	.03	.74***	.82***

Note. N = 65; A = partner A; B = partner B; Proportion Cooperative = total number of cooperative behaviours divided by the total number of behaviours; Proportion Competitive = total number of competitive behaviours divided by the total number of behaviours; Proportion Neutral = total number of neutral behaviours divided by the total number of behaviours.
*p < .05 (2-tailed). ** p < .01 (2-tailed). ***p < .001 (2-tailed).

Table 5

Results for the APIM Model including: 1) Planning skills 2) Theory of mind skills 3) Verbal skills and Differences between the Younger and Older Groups

	Proportion Competitive Behaviour		Significant Difference between Younger and Older?
	Younger	Older	
Planning Actor Effect	.19*	-.24**	Yes**
ToM Actor Effect	-.37**	.12	Yes**
ToM Partner Effect	-.23*	.06	Yes*
Verbal Actor Effect	-.02	-.35**	No
Verbal Partner Effect	.04	-.21*	No

Note. Each partner and actor effect is reported as the standardized estimate (β). Actor Effect = the effect of one's own skill on one's own proportion of competitive behaviour while controlling for all other variables in the APIM model; Partner Effect = the effect of one's own skills on one's partner's proportion of competitive behaviour while controlling for all other variables in the APIM model.
*p < .05 (2-tailed). **p < .01 (2-tailed). ***p < .001 (2-tailed).

Figure 2. Generic Model for the Relationship between Executive Function, Theory of Mind, and Vocabulary and Social Behaviours in the Cooperative Task.

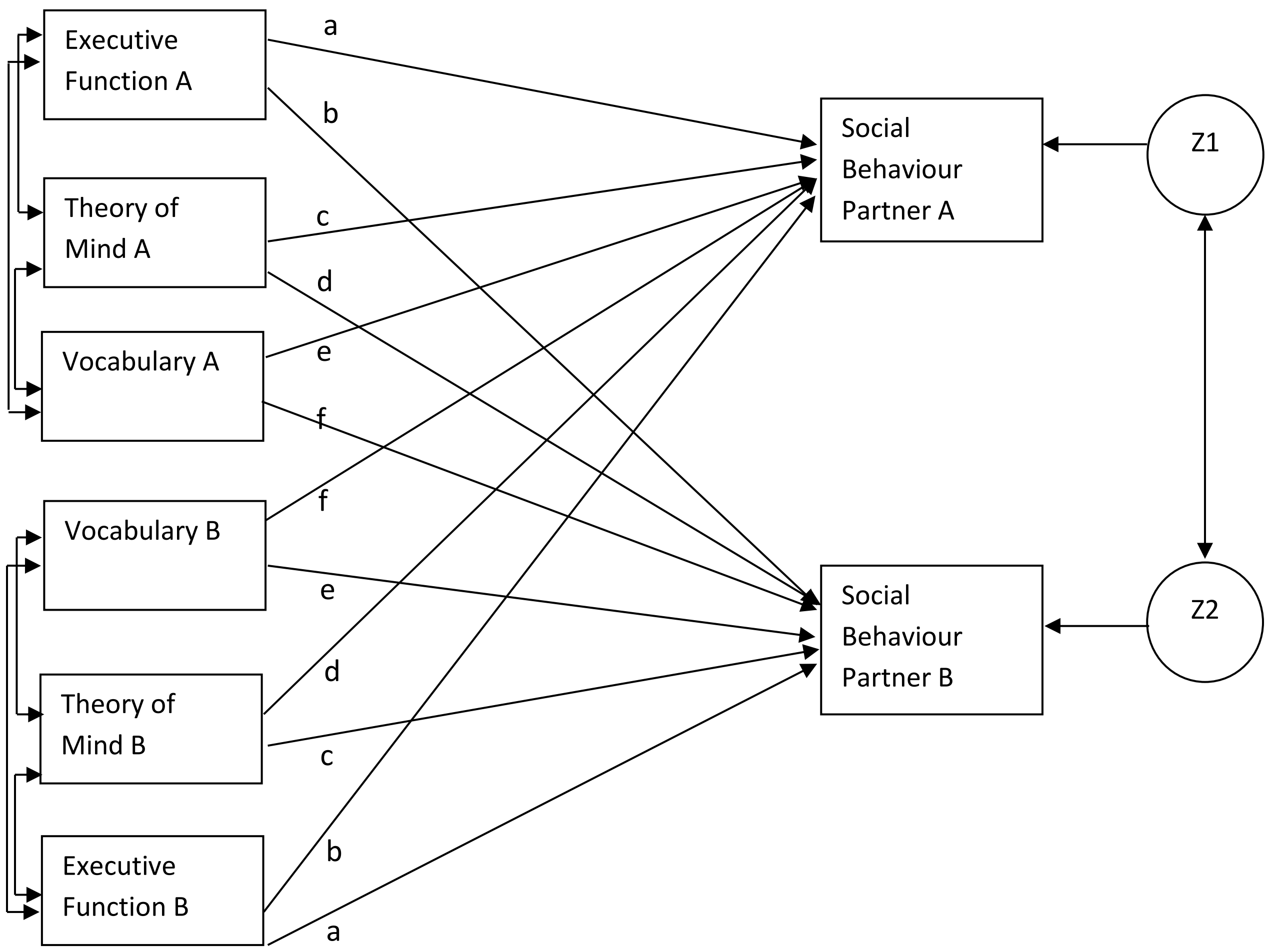

Figure 3. Model for the Relationship between Planning, Theory of Mind, and Vocabulary and the Competitive Behaviours in the Cooperative Task.