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# The individual contributions of three executive function components to preschool social competence

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**Abstract**

The present study explored the role of three components of executive function (EF)—response inhibition, working memory, and cognitive flexibility—in preschool children's social competence. Each component was expected to contribute uniquely to children's abilities to resolve peer conflict in a competent manner, namely, the inhibition of incompetent social responses (response inhibition), maintenance of social goals (working memory), and attentional shift between complex social rules and potential response options (cognitive flexibility). Seventy-two 4- to 5-year-old children were administered measures for each of the EF components and for peer conflict social competence. Positive associations were found between all three EF components and the social competence task, but working memory was the most highly associated with choosing competent responses to peer conflict. In addition, EF accounted for age-related increases in competent responding. The results highlight the importance of representational abilities in the development of social competence during the preschool period.

**Highlights**

- This study examined the normative developmental associations between three components of executive function and social competence in preschool.

The authors do not have any interests that might be interpreted as influencing the research, and APA ethical standards were followed in the conduct of the study.

- Executive function, particularly working memory, predicted age-related changes on a peer conflict task between 4 and 5 years of age.
- The results suggest that the representational abilities associated with working memory may be important in the development of social competence.

**KEYWORDS**

aggression, executive function, peer conflict, preschool, social competence, working memory

## 1 | INTRODUCTION

In childhood, it is important to learn how to interact with peers in a prosocial manner that promotes peer acceptance because of the many developmental benefits that beget the formation and maintenance of quality friendships (for a review, see Hartup, 1996). Children's ability to form these friendships is affected by their level of social competence (Gottman, Gonso, & Rasmussen, 1975; Vaughn et al., 2000), which can be defined as the skilful coordination of cognitive processes to meet social demands and achieve social goals (Iarocci, Yager, & Elfers, 2007). An important aspect of social competence is the navigation of peer conflict situations (Denham, Bouril, & Belouad, 1994; Dodge, Pettit, McClaskey, Brown, & Gottman, 1986). Children must navigate these challenging situations in a way that meets their personal goals and desired outcomes while still maintaining positive relationships with the other children involved in the situation.

Children who respond to challenging peer situations in an aggressive manner may suffer negative social consequences, such as peer rejection (Crick, 1996; Dodge et al., 2003). Children become increasingly less accepting of aggressive behaviour as they get older (Mayeux & Cillessen, 2003), which results in greater amounts of peer rejection for children who continue to exhibit such behaviour in response to conflict throughout childhood. Children with better conflict resolution skills are more likely to have higher ratings of overall social competence (McQuade, Murray-Close, Shoulberg, & Hoza, 2013), higher ratings of school readiness for the transition into kindergarten (Denham, Way, Kalb, Warren-Khot, & Bassett, 2013), and overall better academic skills (Walker & Henderson, 2012).

Because of the negative consequences associated with aggression, a large body of research has investigated the potential causes and correlates of aggressive behaviour, mostly with atypical samples (e.g., children with externalizing behaviour disorders, low birth weight, and poverty). Although this research has been widely informative, it is also important to conduct studies with typically developing samples to understand the processes and development of atypicality (e.g., Cicchetti, 1993). More specifically, normative developmental trends during the preschool years may inform why some children exhibit problematic aggressive behaviours past early childhood. Longitudinal studies have identified an age curve for physical aggression during early childhood (Alink et al., 2006; Hill, Degnan, Calkins, & Keane, 2006; NICHD, 2004; Tremblay et al., 2004), characterized by an increase in aggressive behaviour starting during the second year of life that peaks around 3.5 years of age, then steadily decreases through 5 years of age. Furthermore, the age curve appears to apply to the majority of children; for example, Tremblay et al. (2004) found evidence for the age curve in 72% of their sample. However, a small minority of children may continue on a trajectory of persistent aggression through childhood (e.g., Hill et al., 2006).

Tremblay (2010) attributed the decline in aggression to the development of self-regulation and the ability to replace impulsive aggressive responses with more competent response choices. Indeed, much of the past research with atypical samples studied the proposed association between self-regulatory abilities and aggression under the rubric of executive function (EF), the conscious control of thought, action, and emotion in goal-oriented behaviour (Zelazo & Carlson, 2012) and has revealed a robust association between the two (e.g., Alduncin, Huffman, Feldman, & Loe, 2014; Cole, Usher, & Cargo, 1993; Hughes, White, Sharpen, & Dunn, 2000; Razza & Blair, 2009; Rhoades, Greenberg, & Domitrovich, 2009; Schoemaker, Bunte, Espy, Deković, & Matthys, 2014). The general conclusion gained from this research is that EF supports the inhibition of aggressive impulses, the ability to attend to important information in social situations, and the ability to plan appropriate responses to conflict.

However, there is less research on the association of EF and aggression with typically developing children, particularly during the preschool period, when aggressive behaviour begins to lessen in incidence. Parallel with the normative decrease in aggressive behaviour is the rapid development of EF between 3 and 5 years of age (Zelazo et al., 2013). The development of EF has been attributed to the development of attentional capacities (Garon, Bryson, & Smith, 2008), language ability (Vygotsky, 1978), and representational ability (Marcovitch & Zelazo, 2009; Zelazo, 2004) and is supported by development of the prefrontal cortex (for review, see Zelazo, Carlson, & Kesek, 2008). The underdevelopment of the prefrontal cortex during childhood, in part, has been implicated in aggressive responses in children (Thijssen et al., 2015). Therefore, it is possible that as the prefrontal cortex develops, the underlying mechanisms that support EF also develop and contribute to children's increased abilities to respond to social conflict in a competent manner. Yet very few studies have examined the contribution of the development of EF to the normative decrease in aggressive behaviour during the preschool years. Thus, the first major goal of the current study was to attribute the age-related improvements in EF to the increase in social competence (i.e., a decrease in aggression) in response to peer conflict that occurs during the preschool years.

According to some researchers (e.g., Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000; Wu et al., 2011), EF consists of three separate but related components: (a) working memory or the ability to hold and manipulate information, (b) response inhibition or the ability to suppress an old response, and (c) cognitive flexibility or the ability to shift from an old response to a new response. There is also a notable distinction between hot and cool EF (Zelazo & Carlson, 2012; Zelazo & Müller, 2002); cool EF reflects the purely cognitive skills used in decontextualized goal attainment (e.g., working memory, response inhibition, and cognitive flexibility), whereas hot EF refers to the control skills required in the context of motivation and emotion. Although it seems that hot EF would be particularly relevant in emotion-laden peer conflict, previous research has found that cool EF, rather than hot EF, relates to social competence and aggression in preschool children. For example, Denham et al. (2014) included measures of both hot and cool EFs but found only the cool EF measures longitudinally predicted social competence. Similarly, Poland, Monks, and Tsermentseli (2016) found that cool EF, but not hot EF, related to teacher-reported levels of aggression. Therefore, it is necessary to further explore the individual contributions of the three cool EF components to social competence within this age group.

With the exception of two studies to date (i.e., Granvald & Marciszko, 2016; Poland et al., 2016), much of the past research on EF and social competence has focused on either one specific component (e.g., response inhibition; Denham et al., 2014; Hughes et al., 2000; Kochanska & Knaack, 2003; Nigg, Quamma, Greenberg, & Kusche, 1999; Rhoades et al., 2009) or used an aggregate score of multiple EF components in analyses (e.g., Alduncin et al., 2014; Cole et al., 1993; Razza & Blair, 2009). However, each EF component may support a different aspect of social problem solving. For example, Richardson, Mulvey, and Killen (2012) suggested that each component supports different aspects of children's judgements of social and moral situations. In the example they provided of a situation in which hitting causes pleasure (Zelazo, Helwig, & Lau, 1996), children need to use working memory to consider how their previous knowledge from different social domains (moral, societal, and psychological) fits with the non-prototypical scenario, inhibit the response for the prototypical scenario, and switch to the response for the non-prototypical scenario to make an appropriate social judgement.

Similarly, the development of the unique skills associated with each EF component could individually contribute to the abilities needed to make appropriate social judgments and form appropriate responses in difficult peer situations. Working memory would support the ability to integrate all relevant information from the situation with social rules and goals to form a response (McQuade et al., 2013; Thornton & Conway, 2013). Response inhibition would be needed to suppress an incompetent social response in favour of a more appropriate response (Beauchamp & Anderson, 2010; Nigg et al., 1999). Finally, cognitive flexibility would allow for switching to the appropriate response and for evaluating multiple response options simultaneously (Ciairano, Bonino, & Miceli, 2006). It is also possible that some components are more important for responding to peer conflict than others. Thus, the second major goal of the current study was to examine the relative contribution of each of the EF components in the development of social competence in peer conflict.

Response inhibition has been targeted as particularly important for social competence during preschool and the early years of formal schooling (Denham et al., 2014; Hughes et al., 2000; Kochanska & Knaack, 2003; Nigg et al., 1999; Rhoades et al., 2009). Perhaps response inhibition has received so much attention because the behavioural output of a competent response may necessitate the inhibition of a dominant aggressive response. Indeed, Kochanska and Knaack (2003) found that performance at 22, 33, and 45 months on a battery of tasks that required the suppression of a dominant response significantly predicted externalizing behaviours (e.g., fighting with others, destroys other's belongings, and quick to "fly off the handle") at 73 months. In another longitudinal study, Nigg et al. (1999) found that measures of response inhibition in first grade predicted teacher-rated social competence in third grade. Finally, Denham et al. (2014) specifically measured responses to peer conflict in 3- to 4-year-old children. They presented participants with various difficult social situations (social provocation and physical provocation) and asked them to choose which type of response they would enact from a choice of four actions characterized as prosocial, inept, passive, or aggressive. They found that aggregate performance on three tasks that required inhibition of a dominant or desired response (i.e., Pencil Tap, Tower Task, and Balance Beam) predicted both prosocial and aggressive responses.

Studies that measured working memory or cognitive flexibility revealed significant associations between these components and social competence in older children (Ciairano et al., 2006; McQuade et al., 2013; Schoemaker et al., 2014), but no studies have focused on either component individually in preschool age children. Ciairano et al. (2006) observed that dyads of 7- to 11-year-old children with higher amounts of cognitive flexibility were more cooperative and less likely to display non-cooperative behaviour when they completed a puzzle together than their lower flexibility peers. McQuade et al. (2013) measured verbal, spatial, and central executive working memory and different aspects of social competence in 9- to 11-year-olds. Central executive working memory was associated with most of the social competence variables, but particularly with conflict resolution skills. The associations between working memory and both peer rejection and overall social competence were fully mediated by conflict resolution skills. The relations with the central executive working memory task but not the other two working memory tasks suggest the importance of both the storage and manipulation of information for social competence. Children not only have to be able to remember social goals and rules but actively use and manipulate them during distracting peer conflict situations.

The few studies that have measured and analysed all three EF components separately have found differential associations with social competence. Granvald and Marciszko (2016) found that all three components were related to a teacher-reported aggression composite score in 9-year-old children, but only working memory and cognitive flexibility were related specifically to reactive aggression (aggressive acts in response to provocation, such as peer conflict). In contrast, Poland et al. (2016) found that inhibition was the component that was most associated with teacher-reported reactive aggression in 4- to 5-year-old children over two verbal working memory tasks (forward and backward digit spans) and planning abilities. The difference in findings between these two studies is important to note because there is reason to believe that the structure of the EF components changes across childhood (e.g., Lee, Bull, & Ho, 2013). Also, Poland et al. did not include the component of cognitive flexibility in their study and it is possible that this component plays an important role in social competence during the preschool period.

## 1.1 | The current study

We addressed two main goals in the current study. The first goal was to determine the extent to which normative age-related changes in social competence are related to the development of EF. The second goal was to examine the unique contributions of each EF component in socially competent responses to peer conflict. In service of these goals, we administered a child-based measure of responses to peer conflict and a task for each of the three EF components (i.e., working memory, response inhibition, and cognitive flexibility) to 4- and 5-year-old typically developing children. We chose this specific age group because of the exponential gains in both EF and social competence that are observed during this developmental time period. We assert the importance of studying these associations during this time in typical samples to establish a general developmental trend for EF and social competence.

We expected that EF would account for age differences in socially competent responses to peer conflict. We also expected that the association between EF and competent responses would exist independent of age. For example, a 5-year-old with high EF should be more likely to respond competently to peer conflict than a 5-year-old with low EF. We also predicted that performance on each of the EF components would positively correlate with the peer conflict measure, primarily because individual associations between social competence and each of the components have been found in previous research. However, we expected that the magnitude of the correlations would differ. Specifically, we hypothesized that response inhibition would be the most associated to the peer conflict measure and would account for variance in social competence above and beyond the other two components. Indeed, the overall goal of social competence in difficult situations may be to inhibit incompetent tendencies (e.g., Beauchamp & Anderson, 2010; Denham et al., 2014; Kochanska & Knaack, 2003; Nigg et al., 1999; Poland et al., 2016; Rhoades et al., 2009), and research within the preschool period in particular has found that response inhibition is a critical factor for social competence (Denham et al., 2014; Poland et al., 2016).

The results from the current study adds to the literature on the causes and correlates of aggression by providing insight on normative age trends and a focus on how EF can support the development of social competence in non-clinical or atypical populations. In addition, the current study adds to theories of EF (e.g., Howard, Okely, & Ellis, 2015; Marcovitch, Boseovski, Kane, & Knapp, 2010; Zelazo, 2004) by highlighting the importance of these skills in social contexts. There is debate among researchers as to the structure of EF during the preschool period (i.e., what components are present and how they relate to one another; for review, see Lee et al., 2013). The results of the current study may provide more clarity into the structure of EF during the preschool period as it pertains to social behaviour. Furthermore, the current study adds to theories of social competence by providing data on the role of specific cognitive skills in children's social decision making. The social information processing (SIP) model (Crick & Dodge, 1994), for example, provides a framework for the cognitive processes that result in aggressive or competent responses to social situations. SIP researchers have long contended that EF plays an important role in these processes but have not included EF as a specific component of the model (e.g., Crick & Dodge, 1994; Fontaine, Yang, Dodge, Pettit, & Bates, 2009). Although Denham et al. (2014) sought to address this gap, the current study is designed to provide additional information about how the specific components of EF support responses to provocation.

The current study also expanded on previous empirical findings by including measurements of three EF components, including cognitive flexibility, and through the use of a behavioural measure to assess social competence in peer conflict as opposed to a parent or teacher questionnaire. The use of a behavioural measure can provide important information on how EF skills relate to children's own decisions about how they would respond to provocation. The inclusion of measures for three major EF components provides a more comprehensive view of how EF supports social problem solving during the preschool period. We assert that an understanding of which EF skills specifically support social competence provides important information for interventions that seek to reduce abnormal aggression in preschool children.

## 2 | METHOD

### 2.1 | Participants

We tested 36 4-year-olds ( $M = 52$  months,  $SD = 3.11$ ) and 36 5-year-olds ( $M = 65$  months,  $SD = 3.08$ ). The sample was 50% girls. Out of those who reported demographic information ( $n = 58$ ), the majority of the children identified as White (71%), followed by African American (17%), Multi-Racial (8%), Asian (2%), and Hispanic (2%). Children came from a variety of socioeconomic status backgrounds; 17% reported earning less than \$40,000 per year, 50% reported earning \$40,000–\$90,000 per year, and 33% reported earning over \$90,000 per year. Information about family size was not collected. Participants were recruited through local childcare centres and a participant database for which parents in a mid-sized Southeastern city voluntarily sign-up their children for participation in research studies. The majority of the participants were tested in their childcare centres, with  $n = 12$  children attending kindergarten.

### 2.2 | Materials and procedure

#### 2.2.1 | Procedure

All participants were given a peer conflict measure and a measure for each target area of EF—working memory, response inhibition, and cognitive flexibility (Garon et al., 2008; Müller, Kerns, & Konkin, 2012). The order of the peer conflict task and the EF task block was counterbalanced; the peer conflict task occurred before the EF block for half of the participants and after the EF block for the other half of participants. Within the EF task block, each individual EF measure was presented at a randomized order.

#### 2.2.2 | Challenging Situations Task

The Challenging Situations Task (CST; Denham et al., 2013) consists of three physical provocation scenarios (i.e., knocking over a block tower, taking away a toy, and pushing) and three social provocation scenarios (i.e., peer rejection, being laughed at, and being called a bad name). There were two parallel sets of scenarios that were counterbalanced across participants. The sets contained the same types of scenarios (three physical provocation and three social provocation), but the specific stories differed between sets.

Participants were presented with a picture card of each scenario and a trained experimenter read the accompanying script (e.g., “Mary/John was building a very tall tower of blocks. But suddenly, Bobby knocked it down.”). Then, the participants were asked to indicate what they would do in the same situation (i.e., “What would you do if this happened to you?”) by selecting from four response choices presented in picture form: (a) say something to the perpetrator to directly address the situation (prosocial; e.g., “Ask Bobby to build another tower with you?”); (b) remove self from the situation (passive; e.g., “Go find something else to play with?”); (c) hit, push, or yell at the perpetrator (aggressive; e.g., “Hit Bobby or yell at him?”); and (d) cry (inept; e.g., “Cry”).

The presentation of each scenario and each response choice were randomized across trials. The dependent measure from the CST used in the current study was the total number of competent responses (prosocial + passive responses) chosen across the six scenarios (possible range = 0–6). Consistent with previous research on social competence (Dodge & Price, 1994; Ziv & Sorongon, 2011), passive responses were considered competent for this study. Although passive responses are not entirely prosocial, the ability to disengage and remove oneself from provoking situations may be considered a socially competent response. This type of response is an adequate alternative to aggressive or inept responses and therefore included in the dependent variable in support of the hypothesis that EF assists with the selection of alternate options to incompetent responses. The competent response score for the CST is inversely related to the total number of chosen aggressive and inept responses. However, inept responses

were infrequently endorsed (5% of all responses were an inept response), so the number of competent responses primarily reflects the number of times the participant avoided the selection of an aggressive response.

### 2.2.3 | EF tasks

#### Happy/Sad Stroop

The Happy/Sad Stroop task (Lagattuta, Sayfan, & Monsour, 2011) measures response inhibition by requiring participants to inhibit a natural response in favour of a contradictory one. Participants were told that they have to say "happy" when they see a sad face and "sad" when they see a happy face. Upon successful completion of four practice trials, participants were given 20 additional trials of cards to label in randomized order. If participants mislabelled four cards in a row, the experimenter repeated the rule. Scores reflect the total number of correct trials, with a maximum of 20 points.

#### Visual Counting Span

The Visual Counting Span (Case, Kurland, & Goldberg, 1982) is a complex working memory span task, which assesses the storage and manipulation of information despite interference. The participants were asked to count the green frogs on each card while ignoring the red ladybugs. After counting each set of cards, the cards were removed and the participant was asked to recall the number of frogs on each card. Participants completed three trials each with two cards, three cards, and four cards. Points were allocated based on the proportion of correct responses per trial (i.e., three out of four correct would yield a score on that trial of 0.75), and using a liberal scoring method appropriate for the age of the participants (see Marcovitch, Boseovski, Kane, & Knapp, 2010), credit was given for each correctly recalled number regardless of the temporal position of the card for a maximum of nine points.

#### Dimensional Change Card Sort-Borders

The Dimensional Change Card Sort-Borders (DCCS-Borders; Zelazo, 2006) measures cognitive flexibility by requiring participants to switch the way they sort a series of cards. Participants were first told that they would play a sorting game following either the colour (red and blue) or the shape (boat and bunny) rule. Before each card was sorted, the experimenter reminded the participants of the rule (e.g., "Remember, we are playing the colour game. The blue cards go here and the red cards go here") and labelled each card by the dimension that was being sorted (e.g., "Here's a red one. Where does it go?"). After six trials, the experimenter changed the rule and began the six post-switch trials by handing the participants a card and labelling it by the dimension of the new rule (e.g., "Here's a bunny. Where does it go?"). In this phase, rules were not repeated before every trial.

If participants sorted five out of the six post-switch trials correctly, they moved on to the borders trials. In these trials, the experimenter told the participants that cards that have a border on them are sorted by one dimension (e.g., colour) and the cards without the border are sorted by another dimension (e.g., shape). The experimenter reminded the participants of the new rules before each of the 12 trials. A score was given to each participant based on the level of trials that they passed—1 = passed pre-switch (five out of six cards correctly sorted), 2 = passed post-switch (five out of six cards correctly sorted), and 3 = passed borders (10 out of 12 cards correctly sorted). Fifty-seven participants passed the post-switch level and proceeded to the borders level, and the remaining 15 participants stopped the task following the post-switch level (and they received a score of "1" for correctly passing the pre-switch phase).

## 3 | RESULTS

In the following analyses, age (in months) was coded as a continuous variable and the number of competent responses (prosocial and passive) chosen on the CST was the main dependent measure.<sup>1</sup>

3.1 | Preliminary results

Table 1 displays the descriptive statistics for all tasks. Table 2 shows the frequency distribution for the total number of times across all six trials of the CST that participants chose a competent response. Although a large proportion of the sample (72.1%) chose competent responses on the majority of the trials (four out of six trials), a smaller proportion (45.8%) chose a competent response for all six trials. Thus, the majority of participants chose at least one incompetent response. Within the competent response variable, 60.8% of the responses were prosocial and 39.2% of the responses were passive.

A series of independent sample *t* tests were performed between the two task order options for all dependent measures to determine the presence of any task order effects. Responses on the CST differed by task order so that participants who completed the CST last chose fewer competent responses ( $M = 4.14$ ,  $SD = 1.90$ ) than children who completed the CST first ( $M = 5.00$ ,  $SD = 1.51$ ),  $t(70) = 2.13$ ,  $p = 0.04$ ,  $d = 0.50$ .

Independent sample *t* tests were also performed on all dependent measures by sex. Girls chose fewer competent responses on the CST ( $M = 4.11$ ,  $SD = 1.95$ ) than boys ( $M = 5.03$ ,  $SD = 1.42$ ),  $t(70) = -2.28$ ,  $p = 0.03$ ,  $d = 0.54$ . Task order and sex effects were taken into account for all additional analyses for the CST. There were no task order or sex effects for the EF tasks.

3.2 | Primary results

Pearson correlations were calculated between the three EF tasks, competent responding on the CST, and age (Table 3). As expected, age was positively correlated with choosing a competent response on the CST, the Visual

**TABLE 1** Descriptive statistics for EF tasks and the CST

Tasks	Mean	SD	Observed range
EF Tasks			
Happy/Sad Stroop	13.82	3.37	10–19
DCCS-Borders	1.89	0.55	1–3
Visual Counting Span	4.98	1.82	1.91–7.91
CST			
Competent responses	4.57	1.76	0–6

Note. CST: Challenging Situations Task; EF: executive function.

**TABLE 2** Frequency distribution of choosing a competent response across the six CST trials

Number of competent responses	Number of participants	Percent of sample
.00	2	2.8
1.00	4	5.6
2.00	5	6.9
3.00	9	12.5
4.00	5	6.9
5.00	14	19.4
6.00	33	45.8
Total	72	100.0

Note. CST: Challenging Situations Task.



**TABLE 3** Correlations between age, CST, and EF tasks

	1.	2.	3.	4.
1. Age	--			
2. Competent responses	0.329**	--		
3. DCCS-Borders	0.442***	0.331**	--	
4. Happy/Sad Stroop	0.272*	0.309**	0.196	--
5. Visual Counting Span	0.667***	0.570***	0.396***	0.612***

Note. *n* = 72. CST: Challenging Situations Task; EF: executive function.

\**p* < 0.05. \*\**p* < 0.01. \*\*\**p* < 0.001.

Counting Span, the Happy/Sad Stroop, and the DCCS-Borders. Tests of magnitude difference between the dependent correlation coefficients were then conducted using the calculation method developed by Lee and Preacher (2013). The correlation between choosing competent responses on the CST and performance on the Visual Counting Span,  $r(72) = 0.570$ , was significantly higher than the correlations between the CST and DCCS-Borders,  $r(72) = 0.331$ ;  $z = 2.49$ ,  $p = 0.01$ , and Happy/Sad Stroop,  $r(72) = 0.309$ ;  $z = 2.33$ ,  $p = 0.02$ , and the latter two did not differ significantly,  $z = 0.23$ ,  $p = 0.82$ . This indicates that working memory has a greater association with choosing competent responses to difficult peer situations than response inhibition and cognitive flexibility.

A series of hierarchical linear regressions were then performed. Task order and sex were entered in the first step of each regression series and significantly predicted variance in choosing a response on the CST,  $R^2 = 0.105$ ,  $p = 0.02$ . Age was entered as the second step of the model and significantly predicted choosing a competent response on the CST above and beyond sex and task order,  $b = 0.309$ ,  $t(71) = 2.802$ ,  $p = 0.007$ ,  $\Delta R^2 = 0.094$ . All three EF tasks were then entered in the third step, which resulted in a significant  $R^2$  change,  $R^2 = 0.450$ ,  $\Delta R^2 = 0.251$ ,  $p < 0.001$ . Age reduced to non-significance,  $b = -0.151$ ,  $t(71) = -1.191$ ,  $p = 0.24$ , suggesting that choosing a competent response on the CST improves with age due to EF development. In particular, Visual Counting Span predicted choosing a competent response on the CST over and above the other two EF tasks,  $b = 0.640$ ,  $t(71) = 4.465$ ,  $p < 0.001$ . Finally, a second hierarchical linear regression was performed with the EF tasks entered in the second step followed by age in the third step. The addition of age did not result in a significant  $R^2$  change,  $R^2 = 0.450$ ,  $\Delta R^2 = 0.012$ ,  $p = 0.24$ , suggesting that there is nothing else correlated with age that would predict choosing a competent response of the CST (Table 4).

4 | DISCUSSION

The current study examined the associations between EF and social competence in typically developing preschool children. It is first important to note that part of the normative trend of social competence that was found in the current study is the propensity for the majority of children of this age to choose competent responses over aggressive responses. These results are in line with research that finds an increase in prosocial behaviours (e.g., helping, comforting, and cooperative behaviours) during the preschool years (Eisenberg, Fabes, & Spinrad, 2006). Although the presence of prosocial behaviours does not necessarily mean an absence of aggressive behaviours, nor are they synonymous with socially competent behaviours (Carlo, 2013), prosocial behaviours are considered a dimension of overall social competence (Carlo & de Guzman, 2009). In addition, these results are supported by research on children's bias towards positive personality judgements and reluctance to make negative trait attributions following the presentation of characters who engage in negative behaviours (e.g., Boseovski & Lee, 2006). This bias, termed "the positivity bias," begins to develop during the preschool years, with a peak in middle childhood (Boseovski, 2010). The positivity bias may play a protective role for children of this age who experience social conflict because they may feel less of an urge to retaliate if they believe that the action was done unintentionally or without malintent, particularly in instances when the perpetrator's intent is ambiguous (Boseovski, Lapan, & Bosacki, 2013).

**TABLE 4** Hierarchical linear regression models estimating effects of age and EF tasks on CST competent responding

<b>a</b>									
Variables	Model 1			Model 2			Model 3		
	B	SE	b	B	SE	b	B	SE	b
Sex	-0.779	0.407	-0.222	-0.795	0.388	-0.227	-0.810	0.330	-0.231*
Task Order	-0.712	0.407	-0.203	-0.584	0.390	-0.167	-0.783	0.341	-0.224*
Age				0.080	0.028	0.309**	-0.039	0.033	-0.151
DCCS-Borders							0.101	0.362	0.031
Happy/Sad Stroop							0.031	0.064	0.049
Visual Counting Span							0.617	0.138	0.640***
(Constant)	5.305	0.335		0.567	1.721		3.962	1.806	
F	3.981*			5.538**			8.727***		
R <sup>2</sup>	0.105			0.199			0.450		
Change in R <sup>2</sup>				0.094**			0.251***		
<b>b</b>									
Variables	Model 1			Model 2			Model 3		
	B	SE	b	B	SE	b	B	SE	b
Sex	-0.779	0.407	-0.222	-0.814	0.331	-0.232*	-0.810	0.330	-0.231*
Task Order	-0.712	0.407	-0.203	-0.714	0.337	-0.204*	-0.783	0.341	-0.224*
DCCS-Borders				0.053	0.361	0.016	0.101	0.362	0.031
Happy/Sad Stroop				0.031	0.065	0.050	0.031	0.064	0.040
Visual Counting Span				0.528	0.116	0.547***	0.617	0.138	0.640***
Age							-0.039	0.033	-0.151
(Constant)	5.305	0.335		2.164	0.994		3.962	1.806	
F	3.981*			10.124***			8.727***		
R <sup>2</sup>	0.105			0.438			0.450		
Change in R <sup>2</sup>				0.333***			0.012		

Note.  $n = 72$ . CST: Challenging Situations Task; EF: executive function.

\* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

Despite the high prevalence of competent responses on the CST, notable associations were found between EF and social competence. The first goal of the current study was to determine the extent to which EF accounts for the increase in socially competent responses to peer conflict during the preschool years in a sample of typically developing children. To this end, we found evidence to suggest that developments in EF ability largely contribute to the age-related increase in social competence between 4 and 5 years of age. This is indicated by the findings that age no longer remained a significant predictor of competent responses on the CST following the addition of the EF variables nor did age contribute any additional variance when added after the EF variables. The inclusion of both 4 and 5-year-olds capitalized on the normative developmental trends for social competence (e.g., Tremblay et al., 2004) and EF (e.g., Zelazo et al., 2013) to illustrate how EF development accounts for the development of social competence during the preschool years. This is the first study, to our knowledge, to provide an empirical link between the developmental trends in both EF and social competence during the preschool years.

We also found support for our hypothesis that EF would predict social competence above and beyond age, as indicated by the significant  $R^2$  change when the EF tasks were entered after age. This likely captured the 4-year-olds with higher than age-average EF who chose competent responses and the 5-year-olds with lower than age-average EF that chose aggressive responses, and it suggests that individual differences in EF, regardless of age, are an important predictor of children's social competence in peer conflict. In addition, the inclusion of typically developing children highlighted the importance of EF in social competence for all preschool children, and not solely those at an increased risk for externalizing behaviour disorders.

This leads to the question of how EF supports the development of social competence. The results concerning the second goal of the study—the unique contributions of each EF component to social competence—will help address this question. Working memory, the ability to hold and manipulate information in mind despite distraction, appears to be the most important EF skill that supports social competence in difficult peer situations during the preschool period. Although all the EF components were positively correlated with competent responses on the CST, working memory had a significantly higher correlation than inhibition and cognitive flexibility. Furthermore, working memory was the only EF component that predicted the choice of a competent response above and beyond the other two components. This is counter to our hypothesis and the results from past research that suggested that response inhibition would be the most related component (e.g., Beauchamp & Anderson, 2010; Denham et al., 2014; Kochanska & Knaack, 2003; Nigg et al., 1999; Poland et al., 2016; Rhoades et al., 2009) but is in line with previous research with older children that has found positive associations between working memory and reactive aggression (e.g., Granvald & Marciszko, 2016; McQuade et al., 2013).

These results add information regarding the structure of EF components in regard to social behaviour. According to Jacques and Marcovitch (2010), working memory may be particularly important in social competence because it is the foundational EF component that supports the other two EF components. They argue that the development of response inhibition and cognitive flexibility stems from development of the representational abilities of working memory. Without the ability to keep relevant information in mind to form complete mental representations, cognitive control of behaviour vis-à-vis inhibition or flexibility cannot occur. Applied to difficult peer situations, this theory suggests that the inhibition of an incompetent response and then the switch to a socially competent response is facilitated by first having all relevant information from the situation, as well as social rules and goals, in mind. If children cannot integrate all the information together to form a complete representation of the situation, then they may be more at risk for engaging in incompetent behavioural responses. Although we did not assess verbal working memory in our study, the Visual Counting Span task assessed the ability to store and manipulate information in the face of distraction, a working memory skill that is particularly important for social competence (e.g., McQuade et al., 2013).

The SIP model (Crick & Dodge, 1994) provides additional support for the importance of working memory in social competence. The SIP model postulates that there are six cognitive steps that precede a behavioural response to social situations, the first of which is encoding. In the encoding step, children attend to all relevant information from the external situation to construct a mental representation that combines the details and social cues provided by the situation with their own internal cues. The encoding step provides the foundation for the remaining five steps; thus, disruption at this step can lead to an incompetent behavioural response through its cascading effect on the following steps. Thus, our findings provide additional information about the potential role of EF in the SIP model by suggesting that working memory may be critical for establishing the representation that provides the basis for the actions in the other cognitive steps.

The representational abilities maintained by working memory are also thought to be instrumental in the process of reflection—the deliberate, conscious thought about mental representations that creates a degree of psychological distance from the current experience (Zelazo, 2004; Zelazo, 2015). Theories of EF suggest that as representational abilities develop, children are better able to cognitively control their behaviour because they have an increased capacity to hold information in mind and an increased ability to use that information in service of reflection (Marcovitch & Zelazo, 2009; Zelazo, 2004; Zelazo, Müller, Frye, & Marcovitch, 2003). In addition, reflection aids in

the creation of more complex representations through iterative reprocessing as one consciously considers the information received from the current experience (Zelazo, 2015). More complex representations then allow for more efficient cognitive control when faced with the same situation at a later time.

Thus, working memory, and consequently EF more generally, may further support social competence in response to peer conflict in two different ways. First, children with better EF may be more adept at the immediate inhibition of an incompetent response in favour of reflection prior to the enactment of a response. Indeed, the SIP model also includes a step for response evaluation, which asserts taking the time to consider and evaluate the effectiveness of different response options prior to the enactment of a response facilitates competent responses (Crick & Dodge, 1994). Children who do not engage in reflective processes prior to the engagement of a response are at risk for aggression (Fontaine & Dodge, 2006; Orobio de Castro, 2004).

Second, children with better EF who engage in reflective processing before, and perhaps after, a response may have richer representations of familiar conflict situations via iterative reprocessing. Richer representations consequently allow for more efficient responses to similar situations (e.g., Zelazo, 2015). As such, children with better EF may not need to engage in the same level of cognitive control during any particular peer conflict situation if they have already established complex representations of the situations that can be used to guide future interactions. This is different than the former process, which suggests that children need to use EF in the moment when faced with conflict. We assert that the two processes may follow a developmental timeline such that younger children may be more likely to rely on EF in the moment, but that repeated practice with peer conflict can lead to more efficient social problem solving once children are older. However, future research is needed to untangle which of these two processes are at work when children are faced with peer conflict.

#### 4.1 | Limitations and future directions

As we did not systematically counterbalance gender within order, it turned out that a greater number of girls were in the "CST last" order option than boys (21 vs. 15), creating a partial confound between sex and task order. Is it that girls are more likely to choose an aggressive response, perhaps because the provocateur in each scenario was a boy, as per the original design of the measure obtained from Denham et al. (2013) and that is why we obtained a task-order effect? Or is it the case that girls chose more aggressive responses because there were more girls in the CST last order and fatigue may play a role in responding to peer conflict? Either way, the sex effect was quite surprising given that most of the previous research finds that boys, not girls, are more likely to be physically aggressive (e.g., Crick & Dodge, 1994; Dodge et al., 2003; Rose & Rudolph, 2006).

Another limitation of this study is the use of a third-person social competence measure. In the CST, children are presented with hypothetical scenarios and are then asked to answer how they would respond if they themselves were involved in the situation. These measures remove children from the emotional saliency of being in a difficult peer situation, and this could affect their responses. Strong negative emotions are thought to play an important role in aggressive responses to conflict (Denham et al., 2014; Lemerise & Arsenio, 2000) and can interfere with EF (Blair, 2014). Perhaps we observed less aggression in our sample than what would be observed in this age group if presented with real-life peer conflict situations. Despite this limitation, children still provided a variety of responses on the CST, suggesting that these measures can elicit some aggressive responses without eliciting strong emotions.

Additional research is needed to consider how other factors, such as theory of mind and emotion understanding, fit into the model illustrated by the current results. There is a large body of research that has been devoted to the relation between EF and theory of mind (e.g., Carlson & Moses, 2001; Marcovitch et al., 2015), theory of mind and social competence (e.g., Hughes, Dunn, & White, 1998; Renouf et al., 2010), and emotion understanding and social competence (e.g., Denham et al., 2014; Lemerise & Arsenio, 2000). Future research should seek to link these areas of research together to examine how these constructs development in tandem to support the development of social competence.

Temperamental constructs, such as effortful control and negative reactivity (Rothbart & Bates, 2006), are also important to consider. Children high on negative reactivity, for example, may be more prone to aggression because intense negative emotions may interfere with children's abilities to use EF in social problem situations. Effortful control is also related to social competence (Kochanska & Knaack, 2003), but the measurements used in this research are very similar to measures used in EF research to capture response inhibition. Consequently, this research was cited in the current study as support for response inhibition's role in the development of social competence. Indeed, there is ongoing debate about the theoretical and methodological overlaps between EF and effortful control, with some drawing the conclusion that EF and effortful control are one in the same (Zhou, Chen, & Main, 2012) or are at least part of the same developmental continuum, with effortful control as an aspect of infant behaviour that predicts later EF, which becomes the more relevant construct during the late preschool years (Liew, 2012). Therefore, we assert that any relations found between EF (particularly response inhibition) and social competence also capture relations between effortful control and social competence and vice versa.

Finally, there are also demographic factors that were not considered in the current study, such as number of siblings in the home and kindergarten attendance, that need to be considered in future research as they may also affect children's levels of social competence. For instance, previous research has shown that siblings in the home promote social competence (Kitzmann, Cohen, & Lochwood, 2002) and EF (McAlister & Peterson, 2013).

## 5 | CONCLUSION

The results from the current study show that age-related development in EF contributes to the age-related increase in social competence during the preschool years. In addition, the results highlight the importance of considering the individual contributions of three EF components in the development of social competence in peer conflict. Specifically, the representational skills uniquely associated with working memory may support social competence in preschool peer conflict situations. Further understanding of the nature of the EF–social competence association can help inform the types of interventions used for children at risk for peer rejection due to social incompetence. Such interventions may seek to train specific EF abilities, such as working memory, which may be necessary during peer conflict episodes.

## ENDNOTE

<sup>1</sup>To analyse the prosocial responses on their own, we divided the number of endorsed prosocial responses by the number of prosocial and incompetent responses (i.e., passive responses were not included). Our analyses with the prosocial proportion variable revealed the same result pattern as our competent response variable: inclusion of the EF variables in the regression model produced a significant  $R^2$  change ( $R^2 = 0.427$ ,  $\Delta R^2 = 0.233$ ,  $p < 0.001$ ) and reduced age to non-significance ( $b = -0.133$ ,  $t[71] = -1.036$ ,  $p = 0.30$ ), no additional variance was explained by entering age in the final step ( $R^2 = 0.427$ ,  $\Delta R^2 = 0.009$ ,  $p = 0.30$ ), and the Visual Counting Span predicted prosocial responses above and beyond the other two EF variables ( $b = 0.571$ ,  $t[71] = 3.941$ ,  $p < 0.001$ ).

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