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Executive function and the development of social information processing during the preschool years

Jessica S. Caporaso *, Stuart Marcovitch, Janet J. Boseovski

University of North Carolina at Greensboro, United States

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ABSTRACT

The six-step social information processing (SIP) model (Crick & Dodge, 1994) describes how children respond to difficult social situations, but little is known about the underlying cognitive abilities that support the individual SIP steps. Given excu executive function's (EF) association with behavioral displays of competent and aggressive responses to provocation, the current study examined how three EF components (i.e., response inhibition, working memory, cognitive flexibility) relate to four SIP steps (i.e., encoding, interpretation, response generation, and response evaluation). In addition, the current study looked at how attributions made about the transgressor in the first two SIP steps affect processing in the later SIP steps. Seventy-two 4- to 5-year-old children completed one EF task for each component and were given a structured interview that assessed four steps of the SIP model. Working memory and age were related to encoding (fact recall and emotion attributions), response generation, and response evaluation. Cognitive flexibility was only related to response evaluation. The individual contributions of EF and age, as well as early SIP steps, differ for each step. The specific processes by which working memory may relate to each step are discussed, as well as how the encoding step provides a foundation for adequate processing in later steps. The results of the current study provide novel information about how cognitive processes contribute to the development of SIP.

1. Introduction

A major developmental milestone of social competence is the ability to resolve peer conflicts appropriately (e.g., Denham, Bouril, & Belouad, 1994; Dodge, Pettit, McClaskey, Brown, & Gottman, 1986). In fact, Rubin and Rose-Krasnor (1992) argued that interpersonal problem solving is the very definition of social competence in children. Although many young children resolve conflict with aggression (Chen, Fein, Killen, & Tam, 2001), children begin to decrease their use of aggression between 3.5 and 5 years of age (e.g., Tremblay et al., 2004). However, a minority of children continue to struggle with aggression past the preschool years (Hill, Degnan, Calkins, & Keane, 2006) and face several negative consequences because of their aggression. Children who respond aggressively to conflict are more likely to be disliked by peers (Sebanc, 2003) and have noted social (e.g., Crick, 1996; Dodge et al., 2003) and academic (Denham, Way, Kalb, Warren-Khot, & Bassett, 2013; Walker & Henderson, 2012) difficulties. Consequently, previous research has examined the factors that contribute to aggressive and competent behaviors in response to conflict.

Children's judgments of transgressors are a key factor in how they resolve peer conflict. During preschool, children begin to make increasingly complex judgments of others, including their personality traits (Boseovski, Chiu, & Marcovitch, 2013), mental states

* Corresponding author at: Department of Psychology, UNCG, Greensboro, NC, 27402, United States.
E-mail address: jlstark@uncg.edu (J.S. Caporaso).

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(Wellman, Cross, & Watson, 2001), and intentions (Cushman, Sheketoff, Wharton, & Carey, 2013). Children use these judgments to anticipate the future actions of others and to inform their future actions towards those individuals (Boseovski et al., 2013; Boseovski, Lapan, & Bosacki, 2013; Croce & Boseovski, 2020). In the context of peer conflict, children's judgments of others have implications for what response choices come to mind and their views of which responses are most appropriate for the situation. For example, if a child believes that the transgressor that caused the conflict did so out of anger (emotional state) or on purpose (intentionality), then the child may be more likely to think an aggressive action is a justified response to the conflict.

Indeed, the social information processing (SIP) model (Crick & Dodge, 1994) has highlighted the importance of children's judgments and cognitions that precede behavioral responses to social situations. In the (1) encoding step, children attend to all relevant information from the external situation, including emotional information, to construct a mental representation of the situation. During the (2) interpretation step, the intentionality of the other children involved in the social situation is determined. The hostile attribution bias, an intention attribution style characterized by a greater likelihood to attribute malintent to the transgressor (for review, see Orobio de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002), is the primary concern of this step. The target children then assess what outcomes they desire from the situation in the (3) goal clarification step and mentally construct possible response options during the (4) response generation step. During the (5) response evaluation step, children assess their level of self-efficacy to enact a response, the appropriateness of the response, and how well the response fits with their social goals. Finally, children (6) enact the decided response.

Even though the SIP steps are distinct processes, a disruption in any one step may cascade and ultimately lead to an incompetent behavioral response (Crick & Dodge, 1994; Lansford et al., 2006). Failures in encoding made at the outset of SIP may negatively impact the decisions made in later steps. For example, a child may fail to encode emotion and intentionality cues, make errant emotion or intent attributions, and consequently decide the transgression was committed intentionally during the interpretation step. The emotion and intentionality judgments that occur during the first two SIP steps are central to children's responses to the conflict situation, as these person judgments may determine if aggressive retaliation is warranted. Children who judge the transgression as intentional during the interpretation step may be more likely to generate an aggressive response and even view retaliation as the appropriate, morally justified, response option during evaluation (Orobio de Castro, Verhulp, & Runions, 2012). Two emotion attribution errors relevant to social problem solving, attributions of happiness (i.e., the happy victimizer phenomenon; Arsenio & Kramer, 1992) and anger, could stem from inaccurate encoding during the first SIP step. Both attribution errors may signal that the act was done on purpose (Malti, Gasser, & Gutzwiller-Helfenfinger, 2010; Schultz et al., 2004) and have been linked to aggressive behavior (Gasser, Malti, & Gutzwiller-Helfenfinger, 2012; Schultz, Izard, & Bear, 2004). As such, these attributions have a significant influence on later SIP steps and have long-lasting effects on children's aggressive behavior. In fact, Lansford et al. found that kindergarten children's deficits in the first two SIP steps predicted aggressive behavior in 11th grade.

The social cognitive steps of the SIP model have been shown to differentiate aggressive from non-aggressive children (Crick & Dodge, 1996; Dodge & Coie, 1987; Dodge & Price, 1994) beginning in preschool (Dodge, Bates, & Pettit, 1990; Katsurada & Sugawara, 1998; Runions & Keating, 2007; Ziv, 2013; Ziv & Sorongon, 2011). Thus, children who continue on a high-aggression trajectory past preschool may do so because they have developed maladaptive cognitions about their social environment. Indeed, preschool and kindergarten children's maladaptive SIP patterns have been linked to greater social difficulties during elementary school (Lansford, Malone, Dodge, Pettit, & Bates, 2010; Runions & Keating, 2007). In addition, children with maladaptive SIP styles that begin in preschool are rated lower on school readiness assessments (Ziv, 2013). SIP develops with age, as children become more socialized with peers and adults and experience a wider variety of responses to social problems (Crick & Dodge, 1994; Rubin & Rose-Krasnor, 1992), but less is known about specific age-related trends of SIP and the cognitive mechanisms that support this development.

Because SIP is linked to children's aggression, and a normative decrease in aggression is observed during preschool, there is reason to believe that preschool is an important time to examine age-related changes in SIP, as well as other cognitive processes that may be associated with the development of SIP. Several cognitive processes are theorized to relate to the development of adaptive SIP (e.g., Arsenio & Lemerise, 2004; Crick & Dodge, 1994; Fontaine & Dodge, 2006; Fontaine, Yang., Dodge, Pettit, & Bates, 2009; Lemerise & Arsenio, 2000), but very few have been studied empirically. Notably, executive function (EF) - the conscious control of thought, behavior, and action (Zelazo & Carlson, 2012) - undergoes a period of rapid development during preschool and has been linked to the normative decrease in aggression in preschool children (Caporaso, Boseovski, & Marcovitch, 2019). EF may contribute to the decrease in preschool aggression because it concurrently supports the development of appropriate SIP during this time. Thus, the primary goal of the current study is to examine the relations between SIP and EF in preschool children and to assess how EF relates to age-related changes in SIP development during the preschool years.

Researchers have discussed the importance of processes related to EF in the development of SIP (e.g., Crick & Dodge, 1994; Fontaine & Dodge, 2006). In a study of the response evaluation and decision (RED) model, an extension of the SIP model, Fontaine et al. (2009) found that children can increasingly differentiate between different response options from kindergarten through adolescence. Although EF was not measured in their study, they attributed this increase in differentiation to EF and suggested that the development of EF is critical for children's abilities to consider different response options and compare them to other mental representations (e.g., social goals and moral rules). Indeed, this line of reasoning is entirely consistent with theories of EF that postulate that children are better able to control their behavior because of increases in the quality and quantity of mental content (i.e., representation) that children can consciously reflect on (Marcovitch & Zelazo, 2009; Zelazo, 2004, 2015; Zelazo, Müller, Frye, & Marcovitch, 2003).

According to some theories, EF is comprised of three separate but related components: working memory, response inhibition, and cognitive flexibility (Diamond, 2013; Lehto, Juujaervi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000). It is through advances in representational and reflective abilities that children can hold and manipulate information in mind (i.e., working memory), inhibit

undesirable behaviors (i.e., response inhibition), and effectively switch between different response options (i.e., cognitive flexibility; Jacques & Marcovitch, 2010). All three EF components have been individually linked to social competence (e.g., Ciairano, Bonino, & Miceli, 2006; Denham et al., 2014; McQuade, Murray-Close, Shoulberg, & Hoza, 2013; Poland, Monks, & Tsermentseli, 2016), but working memory is the only EF component to individually predict variability in social competence development during the preschool years (Caporaso et al., 2019). Caporaso et al. assert that working memory predicts social competence above and beyond the other components because it is the EF component that is most implicated in representational and reflective mechanisms (Jacques & Marcovitch, 2010). Mental representations are held within working memory and reflection occurs as these representations are manipulated within working memory. Working memory is then the main EF component implicated in the response evaluation process described by the RED model (Fontaine et al., 2009) because it allows for the consideration of multiple response options and other mental representations simultaneously. The other two EF components, response inhibition and cognitive flexibility, stem from additional processes that rely on representations and reflective processes. Thus, working memory may be important for social competence because children's ability to refrain from aggressive responses is contingent on their ability to construct, maintain, and reflect on accurate representations of the conflict situation.

The encoding SIP step highlights the importance of mental representations in social competence. As the first step of the model, the encoding step provides a foundation for processing in the other steps. Children may respond inappropriately to a conflict solely because they encoded the situation incorrectly or missed key details entirely, including emotion information (Lemerise & Arsenio, 2000). In fact, it has been proposed that EF is related to general emotion knowledge because children with EF difficulties may miss, and therefore not encode, important emotion signals in the situation (Denham & Bassett, 2018). Previous research has found that working memory is related to how well children encode past events (Abram, Picard, Navarro, & Piolino, 2014; Earhart & Roberts, 2014; Picard, Reffuveille, Eustache, & Piolino, 2009). Working memory may be a critical EF component for the encoding step because it is a measure of representational strength. Working memory supports the binding of disparate visual and spatial details into complete representations for short-term use (Abram et al., 2014). Children additionally use reflective processes to build complex, rich representations of the situation that integrate previous knowledge (e.g., social rules, goals, and strategies) into the current representation (Davidson & Glisky, 2002; Zelazo, 2015).

Because of its proposed association with encoding, working memory is indirectly implicated in every subsequent SIP step because of the cascading nature of the SIP steps (Lansford et al., 2006). Yet each individual SIP step is a distinct process and it is unclear if working memory would be uniquely associated with all the SIP steps above the other EF components. Even for SIP steps like encoding that appear to be mostly supported by working memory, there is evidence that other EF components contribute to success at these steps. Previous research suggests that response inhibition is also an important EF component for encoding because it supports children's ability to inhibit attention to irrelevant stimuli and sustain attention to relevant stimuli is necessary to encode information efficiently and accurately (Roderer, Krebs, Scmid, & Roebers, 2010). In addition, response inhibition may be particularly important for the emotion and intent attributions associated with encoding and interpretation. Children's general emotion knowledge is associated with measures of inhibitory control, perhaps because children with better inhibition are more likely to attend to emotion cues and have positive peer interactions that promote emotion understanding (Denham & Bassett, 2018; Denham et al., 2014). Person attribution errors, such as angry or happy emotion attributions and intentionality attributions, may also be caused by quick and impulsive snap judgments (Boseovski & Marcovitch, 2012; Lapan & Boseovski, 2015). Children with better response inhibition may be better at inhibiting a snap judgment in favor of a more appropriate decision that considers the contextual factors of the situation (Choe, Lane, Grabell, & Olson, 2013; Ellis, Weiss, & Lochman, 2009). Indeed, Choe et al. suggest that the relation they found between response inhibition and intent attributions in preschool children illustrates that children with low EF are unable to inhibit an impulse toward hostile attributions in favor of more advanced social reasoning.

Judgments related to the evaluation step may follow a similar pattern. Just as errant person attributions may be the product of snap judgments, errant situation judgments may also be a result of quick, non-reflective processing. Appropriate response evaluation relies on children's moral reasoning to recognize that aggressive responses are not morally acceptable (Arsenio & Lemerise, 2004). Richardson, Mulvey, and Killen (2012) suggest that young children can rely on quick moral judgments when the situations they judge are simple and based on prior experience. Yet they argue that EF is required to help children reason about multi-faceted and complex situations. Moral reasoning about retaliation is more complicated than reasoning about unprovoked harm and appropriate retaliation judgments show a more protracted developmental path than those regarding unprovoked harm (Ball, Smetana, Caporaso, Boseovski, & Marcovitch, 2021; Gasser et al., 2012; Smetana, Campione-Barr, & Yell, 2003). The noted association between response inhibition and moral judgments (Kochanska & Knaack, 2003; Kochanska, Murray, & Coy, 1997; Stifter, Cipriano, Conway, & Kelleher, 2009) is frequently interpreted as an indication that children's abilities to practice moral solutions impact their later moral reasoning (Kochanska & Askan, 2006). Perhaps specific development in response inhibition also provides children with the ability to stop and consider all aspects of the situation before making a moral judgment.

Response inhibition is further implicated in the response generation SIP step. If an aggressive response is generated, children high in inhibitory control are better suited to inhibit that option and continue the generation process until a competent response is constructed. The switch from a generated aggressive response to a more competent option may also require cognitive flexibility. However, there has not been any empirical research that has specifically targeted the generation step to lend support to this line of reasoning. Most research on children's aggressive responses uses parent or teacher questionnaires, direct behavioral assessments, or observations that all technically assess the behavioral outcome of the full SIP model and not any individual step (e.g., Caporaso et al., 2019; Denham et al., 2014; Kochanska & Knaack, 2003; Poland et al., 2016). On these measures, high instances of aggressive responses could indicate that aggressive responses were generated more often, but there are three steps prior and two additional steps after response generation that could have influenced the actual behavioral display of aggression.

In general, empirical research on EF and SIP is sparse. No studies to date have looked at the steps, or the individual processes associated with each step, and the individual EF components. The research on other processes associated with SIP steps is also incomplete. For example, the encoding step is associated with memory processes, but the EF-memory literature does not specifically address failures in encoding emotional expressions. In addition, normative developmental trends of SIP have not been considered, nor has the contribution of age-related changes in EF to this development of SIP. Finally, no research has situated EF in the context of structured SIP interviews that specifically target the sequence of steps for a single social situation. Because the SIP steps are interrelated, it is important to examine these relations in the same context. Doing so will not only allow for direct comparisons between steps but will also allow for the examination of how early steps influence processing at later steps if this influence is above and beyond that of EF and age. This is particularly important because emotion and intent attributions that are ascribed to the transgressor during the early steps have important implications for how children reason about the situation during later steps.

1.1. The current study

The primary goal of the current study was to examine how three EF components – response inhibition, working memory, and cognitive flexibility – are related to SIP development during the preschool years, and how the EF components relate to observed age-related trends in SIP. Although SIP generally develops with age as children have increased social experience (e.g., Rubin & Rose-Krasnor, 1992), these age-related changes are likely due to the rapid development of EF during the preschool preiod (e.g., Carlson, 2005). Another goal of the current study was to examine how processing in earlier SIP steps relates to processing in later SIP steps, as the effect of emotion and intent attributions associated with these steps have been largely unexplored in relation to the other SIP steps during the preschool years.

The SIP structured interview used in the current study assessed the following SIP steps: encoding (including transgressor emotion attributions), interpretation, response generation, and response evaluation. We did not have any specific predictions about which EF component will be uniquely associated with each of the SIP steps. The sparse amount of existing research makes a case that response inhibition would uniquely relate to emotion attributions, interpretation, and response evaluation and that working memory would uniquely relate to fact encoding. However, none of the existing empirical research examined all of the EF components separately and simultaneously. If working memory is indeed the EF component through which representational and reflective mechanisms operate (Jacques & Marcovitch, 2010), it may be the case that working memory is the only component that will uniquely relate to the SIP steps. It is also unclear if only age-related changes in the EF components relate to SIP or if individual variability in EF within each age will be associated with SIP, or if the relation of age and the EF components will differ based on the individual SIP steps.

We expected that performance in the encoding and interpretation steps of the SIP model would be associated with performance in subsequent steps. On the one hand, the early SIP steps are hypothesized to be related to age and EF, so any effect they have on later processing may be due to changes in age and EF. On the other hand, the first two steps may independently relate to later performance on the SIP steps. Even though EF and age may be related to the early SIP steps, the quality of the situation representation and intentionality attributions are distinct processes from EF and age and therefore may have an independent association with later SIP steps.

2. Method

2.1. Participants

Participants for this study took part in a larger study on children's social competence and EF. The current study included 72 4- to 5-year-old children ($M = 58.9$ months, $SD = 7.0$ months). The sample size was determined by a G*Power analysis with the following parameters: effect size of .20, .05 error probability, .80 power, and 6 predictor variables. The effect size used was an estimate based on the total amount of variance explained by EF and age in similar social problem solving outcomes (e.g., Caporaso et al., 2019; Denham et al., 2014; Kochanska & Knaack, 2003). Half of the participants were girls. Of the participants with reported demographics ($n = 58$), 71 % identified as White, 17 % as African American, 8 % as Multi-Racial, 2 % as Asian, and 2 % as Hispanic. Children came from a variety of SES backgrounds; 17 % reported earning less than $40,000 a year, 50 % reported earning $40,000–$90,000 a year, and 33 % reported earning over $90,000 a year. Participants were recruited through a participant database for which parents in a midsized Southeastern city voluntarily sign-up their children for participation in research studies.

2.2. Materials and procedure

2.2.1. General procedure

All participants were given a SIP interview and three measures of EF. The order of the SIP interview and the EF task block was counterbalanced. The EF measures were presented in a randomized order.

2.2.2. Social information processing interview- preschool (Ziv & Sorongon, 2011)

The SIPI-P is a structured interview adapted from Dodge and Price (1994) that is used to measure four different steps of the SIP model: encoding, interpretation, response generation, and response evaluation. The SIPI-P consists of four gendered-matched stories: two peer provocation stories and two peer entry stories presented in a fixed order (see Table 1 for story order and description). The transgressor in each story is shown to have ambiguous intent. The stories were presented in a picture flipbook. A trained experimenter

read the gender-matched stories to each participant and pointed to the accompanying pictures. At scripted parts of the story, the experimenter asked the participants a series of questions corresponding to the steps of the SIP model. Following an adapted version of the scoring procedures presented in Ziv and Sorongon (2011) and Ziv (2013), six step-specific scores were derived from the interview and totaled across all four stories (see Table 2 for specific questions and scoring).

The answers provided by the participants during response generation were coded by the experimenter. Five codes were used: "competent", "aggressive", "inept", "other", and "don't know." Competent responses included prosocial responses, avoidant responses (e.g., "I would go somewhere else"), or telling an adult about the situation. Inept responses were either crying responses or a response that indicated that the participant would "do nothing." Aggressive responses were coded as any response that included physical harm or verbal aggression (e.g., threats). Participants whose answers did not fall neatly into the criteria outlined for these three response types were given the "other" code, which also included responses of any short-term solutions that could lead to later altercations (e.g., taking back the remote in the "Watching TV" story). Those who failed to provide an answer were given the "don't know" code. The Positive Generation score used in the current study was a composite score of competent and aggressive responses. Reliability coding was done by one independent, trained researcher for 18 (25%) randomly selected participants. Inter-rater reliability for all individual codes was assessed using intraclass correlations, which revealed 88 % reliability for aggressive responses and 94% reliability for competent responses.

2.2.3. Executive function tasks

2.2.3.1. Happy/Sad Stroop (Lagattuta, Sayfan, & Monsour, 2011). The Happy/Sad Stroop (H/S Stroop) task was used to measure response inhibition. In the H/S Stroop task, participants were instructed to say "happy" when they saw a sad face and "sad" when they saw a happy face. After the completion of four practice trials, participants were given 20 additional trials of cards to label, presented in randomized order. If participants mislabeled four cards in a row, the experimenter repeated the rule. Participants received a score based on the total number of correct trial responses, with a maximum score of 20.

2.2.3.2. Visual Counting Span (Case, Kurland, & Goldberg, 1982). The Visual Counting Span (VCS) was used to measure working memory. In the (VCS), participants were asked to count the green frogs on each card while ignoring the red ladybugs. After counting each set of cards, one card at a time, the cards were removed, and the participant was asked to recall the number of frogs on each card. Participants completed three trials each with sets of two cards, three cards, and four cards. Points were allocated based on the proportion of correct responses per trial (i.e., 3 out of 4 correct would yield a score on that trial of 0.75). Participants were given credit for each correctly recalled number regardless of the temporal position of the card, using a liberal scoring method appropriate for the age of the participants (see Marcovitch, Boseovski, Kane, & Knapp, 2010). Participants could receive a maximum of nine points.

2.2.3.3. Dimensional Change Card Sort-Borders (Zelazo, 2006). The Dimensional Change Card Sort-Borders (DCCS) task was used to measure cognitive flexibility. The DCCS includes three different trial levels: (1) pre-switch trials, (2) post-switch trials, and (3) borders trials. During the pre-switch trials, participants sorted a set of six bivalent cards (e.g., a red bunny) either by color (red and blue) or the shape (boat and bunny). Before each card was sorted, the experimenter reminded the participants of the sorting rule (e.g., "Remember, we are playing the shape game. The bunnies go here and the boats go here") and labeled each card by the dimension that was being sorted (e.g., "Here's a bunny. Where does it go?"). During the post-switch trials, the experimenter changed the sorting rule (e.g., "Now we are playing the color game. The red ones go here and the blue ones go here") and began the six post-switch trials. The rule was not repeated before each post-switch trial, but the experimenter continued to label the card by the relevant dimension (e.g., "Here's a blue one. Where does it go?").

If participants passed five out of the six post-switch trials, they moved on to the borders trials. In these trials, participants were told to sort cards with a border on them are by one dimension (e.g., color) and cards without the border by the other 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 passed (e.g., Zelazo, 2006) — 1 = passed pre-switch (5 out of 6 cards correctly sorted), 2 = passed post-switch (5 out of 6 cards correctly sorted), 3 = passed borders (10 out of 12 cards correctly sorted).

Table 1
SIPI-P Stories.

Story Order	Story Description
1 Watching TV (Peer Provocation)	The transgressor takes the remote control away from the target child and changes the channel.
2 Play Doh (Peer Entry)	The target child asks two other children if s/he can play with them but the transgressors do not answer the request and continue to play.
3 Spilled Water (Peer Provocation)	The transgressor knocks over the target child's water cup during lunch.
4 Blocks (Peer Entry)	The target child asks two other children if s/he can play blocks with them, but the transgressor says that only two children are allowed to play in the block area.

Table 2
SIPI-P Questions for each Corresponding SIP Step and Scores for Each Step.

SIP Step	Targeted Questions	Scores
Encoding	Fact Recall: "Can you tell me what happened from the beginning to the end of the story?"	Fact Recall: Total number of facts participant recalled Score range: 0 to 13
	Emotion encoding: Asked to point to the picture of the emotion that corresponds to how each character felt during the story	Anger: Total number of times the participant attributed an "angry" emotion to the transgressor Happiness: Total number of times participant attributed a "happy" emotion to the transgressor Score ranges: 0 to 4
Interpretation	"Do you think the other child was mean or not mean?"	Interpretation: Total number of times the participant answered "mean" Score range: 0 to 4
Response Generation	Participants were prompted to pretend they were in the situation and were asked an open-ended question about what they would say or do if the situation happened to them.	Positive Generation: The number of generated competent responses minus the number of generated aggressive responses Score range: -4 to 4 (-4 reflects all aggressive responses across all stories, 4 reflects all competent responses across all stories)
Response Evaluation	Participants are presented with three scenarios: one aggressive, and one competent, and are asked the following three questions: 1 "Is this a good thing or a bad thing for Michael to do?" 2 "Would the other child like you if you did this?" [Yes, No] 3 3. "If you did this, would the other child let you watch your TV show afterward?" [Yes, No]	Positive Evaluation: The total number of positive competent response evaluations and negative aggressive response evaluations Score range: 0 to 24 (4 stories x 3 questions x 2 response actions)

Note. Specific questions are for the "Watching TV" story of the SIPI-P.

3. Results

3.1. Descriptive analyses

Descriptive statistics for the EF tasks and the SIPI-P scores are presented in Table 3. SIP scores mostly reflected the general social competence of the typically developing sample (i.e., high positive generation, high positive evaluation, low anger attributions). However, none of the SIP scores were at ceiling and each had a fair amount of variability. Of note, Interpretation scores were slightly above the average for the measure based on its possible range ($M = 2.58$, $SD = 1.23$), with 90% of participants selecting at least one "mean" response. Fact Recall scores were much lower than the average for the measure ($M = 2.98$, $SD = 3.59$). There were no significant gender or task order differences for any of the SIPI-P variables (all $ps > .05$).

3.2. Primary analyses

Bivariate correlations among age (in months), the three EF tasks, and SIPI-P scores are presented in Table 4. Importantly, the VCS, our measure of working memory, was positively correlated with multiple SIP steps— Encoding-Fact Recall, Encoding-Happiness, Positive Generation, and Positive Evaluation— and negatively correlated with Encoding-Anger. All variables that correlated with the VCS, except Positive Generation, were also correlated with age in the same direction, and age and the VCS were highly correlated. H/S Stroop was significantly, positively correlated with Encoding-Fact Recall and Positive Evaluation, and the DCCS was only significantly, positively correlated with Positive Evaluation. Thus, the correlations suggest that working memory is indeed the EF

Table 3
Means, standard deviations, and observed range for the EF tasks and SIPI-P scores.

Tasks	Mean	SD	Range
EF Tasks			
H/S Stroop	14.06	2.82	10 to 19
VCS	4.98	1.82	1.91 to 7.91
DCCS	1.89	0.55	1 to 3
SIPI-P			
Encoding:			
Fact Recall	2.98	3.59	0 to 12
Anger	0.63	1.03	0 to 4
Happiness	1.44	1.23	0 to 4
Interpretation	2.58	1.23	0 to 4
Positive Generation	2.67	1.30	−2 to 4
Positive Evaluation	20.19	3.66	11 to 24

Table 4
Bivariate correlations between age, EF composite scores, and SIPI-P scores.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Age	1	–	–	–	–	–	–	–	–
2. H/S Stroop	.291**	1	–	–	–	–	–	–	–
3. VCS	.662**	.390**	1	–	–	–	–	–	–
4. DCCS	.463**	.178	.561**	1	–	–	–	–	–
5. Encoding-Fact Recall	.544**	.233*	.468**	.224^{+}	1	–	–	–	–
6. Encoding-Anger	−.365**	−.071	−.273*	−.176	−.124	1	–	–	–
7. Encoding-Happiness	.292*	.155	.347**	.210^{+}	.161	−.296*	1	–	–
8. Interpretation	.049	−.005	.198^{+}	.014	.162	.220^{+}	.091	1	–
9. Positive Generation	.103	.213^{+}	.268*	.126	.237*	−.395**	.214^{+}	−.088	1
10. Positive Evaluation	.534**	.242*	.505**	.469**	.330**	−.160	.121	.031	.191

Note: $^{+}$ $p < .10$, * $p < 0.05$, ** $p < 0.01$.

component that is most related to children's SIP.

There were also significant correlations between a few of the SIP variables, notably positive correlations between Encoding-Fact Recall and both Positive Generation and Positive Evaluation. There was a significant negative correlation between Encoding-Anger and Positive Generation. Interpretation was not significantly correlated with any other variable but had a marginal relation with the VCS and Encoding-Anger.

To examine the contributions of each EF component, age, and previous step processing further, hierarchical regression analyses using the stepwise entry method at each level were run for the SIPI-P variables that were significantly correlated with at least one EF component (our primary interest). For each SIPI-P variable, the EF components were entered in step one, followed by age in step two to determine if any variables related to age aside from EF contribute to SIP development. Finally, the variables associated with the first two SIP steps (Encoding-Fact Recall, Encoding-Anger, Encoding-Happiness, Interpretation) were entered during step three to determine if processing during early SIP steps influence processing during later SIP steps beyond the shared effects of EF or age. Note that the three encoding variables are all considered one SIP step and are presumably occurring at the same time. Therefore, associations between these steps were not included in the regression analyses.

3.2.1. Encoding

3.2.1.1. Encoding-fact recall. Encoding-Fact Recall scores were regressed on the scores from the three EF tasks (step one using stepwise regression) and age in months (step two). In step one, the VCS significantly predicted Encoding-Fact Recall scores, $\beta = .468$, $t(70) = 4.430$, $p < .001$, $R^2 = .219$. The DCCS and H/S Stroop were excluded from the model. The addition of age in step two accounted for additional variability and significantly predicted Encoding-Fact Recall above and beyond the VCS, $\beta = .418$, $t(69) = 3.144$, $p = .002$, $\Delta R^2 = .098$, and reduced the VCS to non-significance, $\beta = .191$, $t(69) = 1.442$, $p = .154$,. This pattern of results suggests that only age-related changes in working memory relate to fact recall in conflict situations and that there are additional variables associated with age aside from working memory that also relate to this SIP ability.

3.2.1.2. Encoding-Anger. Encoding-Anger scores were regressed on the scores from the three EF tasks (step one using stepwise regression) and age in months (step two). In step one, the VCS significantly predicted Encoding-Anger scores, $\beta = -.273$, $t(70) = -2.376$, $p = .020$, $R^2 = .075$. The DCCS and H/S Stroop were excluded from the model. The addition of age in step two accounted for additional variability and significantly predicted Encoding-Anger above and beyond the VCS, $\beta = -.327$, $t(69) = -2.188$, $p = .032$, $\Delta R^2 = .06$, and reduced the VCS to non-significance, $\beta = -.057$, $t(69) = -.379$, $p = .706$. Similar to Encoding-Fact Recall, this suggests that age-related processes related to working memory are associated with children's abilities to refrain from errant anger attributions and that there are additional variables associated with age that also relate to this SIP ability.

3.2.1.3. Encoding-Happiness. Encoding-Happiness scores were regressed on the scores from the three EF tasks (step one using stepwise regression) and age in months (step two). In step one, the VCS significantly predicted Encoding-Fact Recall scores, $\beta = .347$, $t(70) = 3.100$, $p = .003$, $R^2 = .121$. The DCCS and H/S Stroop were excluded from the model. The addition of age in step two did not account for additional variability, $\Delta R^2 = .007$, $p = .466$, but did reduce the VCS to marginal significance, $\beta = .275$, $t(69) = 1.829$, $p = .072$. This suggests that age-related changes in working memory, but not other variables associated with age, are associated with children's attributions of happiness to the transgressor.

3.2.2. Positive generation

Positive Generation scores were regressed on the scores from the three EF tasks (step one using stepwise regression), age in months (step two) and Encoding-Fact Recall, Encoding-Anger, Encoding-Happiness, and Interpretation (step three using stepwise regression). In step one, the VCS significantly predicted Encoding-Fact Recall scores, $\beta = .241$, $t(70) = 2.082$, $p = .041$, $R^2 = .058$. The DCCS and H/S Stroop were excluded from the model. The addition of age in step two did not account for additional variability, $\Delta R^2 = .008$, $p = .433$. In step three, Encoding-Anger accounted for additional variability and individually predicted Positive Generation scores above and beyond the VCS and age, $\beta = -.366$, $t(68) = -3.102$, $p = .003$, $\Delta R^2 = .116$. The VCS remained a significant predictor of Positive

Generation, $\beta = .302$, $t(68) = 2.061$, $p = .043$. Encoding-Free Recall, Encoding-Happiness, and Interpretation were excluded from the model. This pattern of results suggests that individual differences in working memory and the ability to refrain from anger emotion attributions both independently relate to the likelihood that children generate a competent and not an aggressive response to social problems. Despite being correlated with Positive Generation, Encoding-Fact Recall was not independently related to Positive Generation above and beyond working memory and age.

3.2.3. Positive evaluation

Positive Evaluation scores were regressed on the scores from the three EF tasks (step one using stepwise regression), age in months (step two) and Encoding-Fact Recall, Encoding-Anger, Encoding-Happiness, and Interpretation (step three using stepwise regression). In step one, the VCS significantly predicted Positive Evaluation scores, $\beta = .505$, $t(70) = 4.896$, $p < .001$, $R^2 = .255$. The DCCS accounted for additional variance and significantly predicted Positive Evaluation scores above and beyond the VCS, $\beta = .295$, $t(69) = 2.352$, $p = .022$, $\Delta R^2 = .055$. The VCS remained a significant predictor of Positive Evaluation, $\beta = .327$, $t(69) = 2.605$, $p = .011$. The addition of age produced a significant R^2 change, significantly predicted Positive Evaluation scores above and beyond the EF tasks, $\beta = .328$, $t(68) = 2.542$, $p = .013$, $\Delta R^2 = .060$, and reduced the VCS to non-significance, $\beta = .127$, $t(68) = 0.885$, $p = .380$. The DCCS continued to predict Positive Evaluation scores, $\beta = .265$, $t(68) = 2.188$, $p = .032$. None of the four early SIP steps significantly predicted Positive Evaluation scores above and beyond age and the EF variables and were consequently excluded from the model.

This pattern of results first suggests that both working memory and cognitive flexibility individually relate to children's abilities to evaluate competent responses positively and aggressive responses negatively. However, only age-related change in working memory contributes to this SIP ability while individual differences in cognitively flexibility continue to relate to children's evaluation abilities above and beyond age. There are also variables associated with age other than EF that relate to children's evaluation scores. Finally, Encoding-Fact Recall did not independently relate to children's evaluation abilities beyond what is already associated with working memory and age, despite being correlated with Positive Evaluation.

4. Discussion

Previous research has suggested the importance of cognitive control processes in the development and effectiveness of children's SIP (Crick & Dodge, 1994; Dodge et al., 1986; Fontaine & Dodge, 2006; Fontaine et al., 2009), but the current study is the first to examine the empirical associations between these processes and multiple SIP steps during a period of rapid development in EF. By doing so, the current study provides novel information regarding the developmental trends of specific SIP steps during this time. To this end, we found that encoding and response evaluation improve with age during the preschool years. We proposed that specific EF components would differentially relate to SIP and suggested that both working memory and response inhibition could be associated with individual SIP steps. Overall, we found that working memory was the only EF component related to the majority of the SIP variables. The response evaluation step was the only SIP step predicted by EF components other than working memory. In addition, the current study is the first to examine how early SIP steps relate to processing in later SIP steps in preschool children, within the context of EF and age. Two encoding variables were significantly related to later SIP steps, which suggests that the quality of children's situation representations, including their emotion attributions, influences subsequent processing of the social situation.

4.1. Working memory and SIP

Previous research has found that all EF components relate to children's social competence but working memory is uniquely associated with children's social problem solving abilities (Caporaso et al., 2019). The results of the current study show that working memory is the only EF component that is related to most of the SIP steps. The other two EF components, response inhibition and cognitive flexibility, were only correlated with Encoding-Fact Recall and response evaluation. Perhaps the discrepancy between the results of the current study and previous social competence research lies in the fact that SIP is ultimately a cognitive decision-making process prior to behavioral action (Crick & Dodge, 1994). Actual behavior may demand more support from the other two EF components, but the cognitive SIP steps may primarily depend on working memory to process and evaluate the information from the social situation. Overall, the finding lends evidence to the notion that social competence in peer conflict situations may, at least in part, be related to children's abilities to maintain, manipulate, and reflect on mental representations. Yet each SIP variable measured in the current study designates a distinct cognitive process. As such, the interpretation of the results for each variable differs, so the relation between working memory and each step will be discussed individually.

Working memory was associated with all three encoding variables: Encoding-Fact Recall, Encoding-Happiness, and Encoding-Anger. We expected that working memory would be associated with the encoding variables given that these variables indicate the quality of the situation representation that is held in consciousness for the duration of SIP. We also speculated that response inhibition could additionally relate to both the recall and emotion attribution encoding variables. Yet we found that response inhibition only related to Encoding-Fact Recall but did not independtly predict fact recall scores above and beyond working memory. There was no evidence that inhibition is related to the person judgment processes captured by the encoding variables in the current study.

The finding that working memory relates to Encoding-Fact Recall is in line with previous research on encoding and children's memories for past events (e.g., Abram et al., 2014; Earhart & Roberts, 2014; Picard et al., 2009), as well as theories of memory and EF in general (e.g., Bauer, 2007; Davidson & Glisky, 2002; Zelazo, 2004, 2015). There seems to be some overlap between the constructs of memory and the EF component of working memory, as they appear to rely on similar processes (i.e., reflection and representation), and a major component of EF is the ability to remember and use information in goal-directed activities (Jacques & Marcovitch, 2010).

However, the current results point to a dissociation between the two because age was associated with Encoding-Fact Recall independent of EF, suggesting that there are variables related to encoding that would not be accounted for by EF.

The two emotion attribution errors were also associated with age-related improvements in working memory. Errant anger attributions followed the expected pattern and had a negative relation with working memory and age, but the findings for errant happiness attributions were in the opposite direction. Nonetheless, the current study is the first to provide evidence that EF is a cognitive process that underlies errant emotion attributions related to social conflict. For anger attributions, the relation with working memory rather than response inhibition suggests that errant anger attributions are partially due to errors in encoding the emotional expression of the transgressor. Children could also struggle with considering both emotion cues and the question regarding emotion attribution so they instead rely on a more prototypic, experience-based answer (e.g., the transgressor did something mean, therefore he must have been angry; Boseovski & Marcovitch, 2012).

We also expected that the errant happiness attributions would also have a negative relation with the EF components and age. In the current study, happiness attributions to the transgressor (i.e., happy victimizer phenomenon) were considered a failure in accurately encoding the emotional expressions of the transgressor and are typically associated with failures in moral reasoning and aggression (Arsenio, 2014; Dunn & Hughes, 2001; Gasser et al., 2012; Malti et al., 2010). However, the presence of a positive association between working memory and happiness attributions could indicate that the happy victimizer phenomenon is developmentally normative, and perhaps unrelated to problematic social and moral outcomes during the preschool years (e.g., Ramos-Marcuse & Arsenio, 2001). During preschool, developmental increases in working memory abilities may allow children to encode the instrumental outcome of the situation and be able to link that outcome with the emotional state of the transgressor. As such, happy victimizer attributions during preschool may not necessarily be a failure in encoding emotional expressions or reflective thinking, but an indication that children begin to understand the links between an agent's desires, actions, and the outcomes of actions. Previous research has indeed found advances in these abilities beginning in preschool and into the early school years (Baird & Moses, 2001; Cushman et al., 2013), and EF has been linked to these advances (Zelazo, Helwig, & Lau, 1996).

Finally, individual differences in working memory were positively associated with children's abilities to generate a competent rather than an aggressive response. We speculated that response inhibition and possibly cognitive flexibility could relate to Positive Generation, such that children may have to inhibit a generated aggressive response then switch to a competent response, but there is no evidence to support this speculation. Instead, it appears that the quality of the situation representation has an impact on the response that is generated. This is not only indicated by the association with working memory but also the fact that Encoding-Free Recall was related to Positive Generation but did not explain any additional variance above and beyond working memory.

However, there was also a part of working memory that continued to relate to Positive Generation above and beyond the early SIP steps. In addition, the association between working memory and Positive Generation does not appear to be due to age-related changes in working memory but rather stable individual differences that persist across age. Perhaps this is indicative of the role working memory has in the development of a bias towards specific responses to conflict. As children begin to learn how to resolve conflict appropriately during the early preschool years, individual differences in working memory may begin to differentiate children who successfully resolve the conflict from those who continue to use aggression due to higher representative and reflective abilities (e.g., Caporaso et al., 2019). Children with better working memory subsequently have more opportunities to enact a variety of competent responses and as a result of continued use, competent responses are more accessible to them during future conflict situations. Conversely, children with continually low working memory may be biased towards aggressive responses and are unable to construct competing competent response options. Working memory improves with age, but because children's early responses to social conflict have a cascading effect, stable individual differences in working memory may have a stronger influence on children's abilities to generate competent solutions to social problems.

4.2. Response inhibition, cognitive flexibility, and SIP

Response inhibition was significantly correlated with both Encoding-Fact Recall and Positive Evaluation but did not have independent contributions to either step above and beyond the other EF tasks. For Encoding-Fact Recall, response inhibition may have contributed to the overall quality of the mental representation via attentional control but the quality of the representation was captured primarily by children's working memory capacity. For Positive Evaluation, perhaps response inhibition did not have an independent contribution because of how response evaluation was assessed in the current study. In the SIPI-P, all children are asked to evaluate each response option, one at a time, so children cannot skip this step and enact an impulsive judgment. Consequently, it is not surprising that response inhibition was not independently associated with Response Evaluation despite its implied significance in the RED model (Fontaine & Dodge, 2006).

Along with age-related changes in working memory, individual differences in cognitive flexibility were independently related to Positive Evaluation. Children are required to consider multiple pieces of information when asked to evaluate each response option and both working memory and cognitive flexibility could support this skill. Fontaine et al. (2009) proposed that EF allows children to compare response options to multiple mental representations, which in turn assists the response evaluation process. Aside from the representation of the situation, other representations implicated in the response evaluation process include children's moral understanding, emotion and intent judgments of the transgressor, social goals, expectations of each response, and self-efficacious beliefs (Arsenio & Lemerise, 2004; Crick & Dodge, 1994; Lemerise & Arsenio, 2000).

Given the amount of information that could be used during Response Evaluation, it is likely that it is the SIP step that makes the most demand on EF processes. Indeed, moral judgments of retaliation may require EF more so than judgments of other moral harms because of the complex nature of these judgments and the amount of information that needs to be considered when making such

judgments (Ball et al., 2021; Richardson et al., 2012). As working memory capacity improves with age (Carlson, 2005), children can simultaneously represent and reflect on increasing amounts of information. They may also start the evaluation process with a more accurate situation representation, as indicated by the positive correlation between Encoding-Free Recall and Positive Evaluation. Individual differences in cognitive flexibility then indicate how well children can switch between representations and bring additional representations to mind while evaluating each response option in the moment of conflict.

In addition, stable individual differences in cognitive flexibility could lead to processing biases that influence the response evaluation process over time. Children's evaluations of both competent and aggressive responses are influenced by sociomoral beliefs that are established through previous social interactions (Dahl, 2018; Kochanska & Askan, 2006; Smetana, Jambon, & Ball, 2018). Previous studies have found that EF relates to children's moral reasoning because higher EF is associated with more opportunities to practice moral rules, attend to moral information in the environment, and reflect on moral information before, during, and after conflict situations (Kochanska & Kim, 2014; Kochanska & Knaack, 2003; Smetana et al., 2012), all in service of the internalization of moral rules. Children with higher EF may be better at learning from either their own past experiences or the experiences of others in their environment that aggression is unacceptable and less likely to lead to instrumental gains and social acceptance. When faced with future instances of provocation, high EF children are then able to recognize that competent responses are the best, most moral, solutions to the conflict. All of the EF components are implicated in these abilities, but perhaps cognitive flexibility is representative of all of these skills because tasks used to assess flexibility include components of both working memory and inhibition (Carlson, 2005; Diamond, 2013).

Contrary to expectations, Interpretation was not significantly related to age, response inhibition, or any other EF component. It is important to note that this is not due to a low frequency of hostile attributions in our sample. In fact, most of the participants reported that the transgressor was mean at least one time. Therefore, we conclude that these attributions, as measured by the SIPI-P, are not related to age or EF during preschool. These null findings could be due to the age of the participants in the current study. Four-to 5-year-old children have less understanding of intentionality and do not use that information in the same way as slightly older children (i.e., young children tend to focus on situation outcomes when asked to judge the acceptability of transgressions and ignore intentionality information, Zelazo et al., 1996). Other studies have found that 4-year-old children struggle with attributing differing intentionality to individuals who complete the same actions, despite being explicitly told the different intentions for each individual (e.g., "running to be healthy" vs. "running to be home for dinner"; Baird & Moses, 2001). This suggests that preschool children have difficulty considering intentionality separate from the action. Thus, some of the participants in the current study may have selected that the transgressor was "mean" based on the outcome of the action alone and is not indicative of a hostile intent attribution. Consequently, EF and age did not systematically relate to these attributions.

Another possible reason for the intentionality results observed in the current study has to do with measurement. The question children were asked to assess the presence of a hostile attribution bias was "Do you think [the transgressor] was mean or not mean?" Despite being used in previous SIP work with older children to assess hostile attributions (e.g., Dodge & Price, 1994), the evaluation of meanness is a personality judgment rather than an intent judgment (Boseovski, Lapan et al., 2013). When asked this question, participants are not explicitly told that they should make their judgments based on the transgression alone and may consider instead what kind of person the transgressor is on a more global level. Indeed, in research with school-aged children, younger children that labeled the transgressor in ambiguous social situations as "mean" attributed less malintent when asked about the intentionality of the transgressor in the same situation (Boseovski et al., 2013; Boseovski, Lapan et al., 2013). This suggests that judgments regarding "meanness" are not the same as questions that directly require children to reason about intentionality. In this regard, the results of the current study are not entirely surprising as previous research has not found a direct association between personality judgments and EF. Previous research on children's personality judgments has found meaningful age differences, as children increasingly attribute "niceness" through middle childhood, but this age effect is typically observed in a wider age range (e.g., preschool through middle childhood) than what was included in the current study (see Boseovski, 2010, for a review).

Furthermore, the terminology used to assess hostile attribution appears to influence whether or not these attributions are significantly associated with other variables in the study. For example, Runions and Keating (2007) asked children if the transgressor committed the transgression because he "wanted to" or if it was "by accident" (p. 842) and found that hostile attributions in preschool meaningfully predicted social behavior in 1st grade. Similar questions were used by Choe et al. (2013), who found that hostile attributions were associated with inhibition in preschool. However, Ziv and Sorongon (2011) asked children if the transgressor was mean or not mean and did not find that interpretation scores were related to any variables, including age. Ziv (2013) used the same question, and although there was one correlation between interpretation and generation scores, interpretation was not related to any other meaningful outcome variables (i.e., social competence or school readiness). In addition, there is evidence to suggest that answers to forced choice hostile attribution questions provided by preschool children are not accurate, reliable, or valid because forced choice questions can be answered without a true understanding of intentionality (Schultz et al., 2018). Together, the results from these previous studies suggest that the interpretation question used in the current study assessed personality attributions rather than intent attributions, and this may be the reason why no meaningful associations between age, EF, or any other SIP variables emerged.

4.3. The influence of early SIP in the processing of later SIP steps

Both Encoding-Fact Recall and Encoding-Anger were correlated with performance on later SIP steps. Despite positive correlations with both Positive Generation and Positive Evaluation, Encoding-Fact Recall did not independently relate to these steps above and beyond working memory and age. This is likely because of the shared variance between these variables. Nonetheless, the relation between the Encoding-Fact Recall and the two later SIP steps indicates the importance of accurate situation representations for SIP

processing. Inaccurate representations of the situation may make it harder for children to construct a competent response that would adequately resolve the situation because they have fewer, and possibly incorrect, situation facts to inform their response options. It may also be easier for children to recognize that competent response options are optimal when they have more complete and accurate representations of the conflict situation because these representations may hold important cues about the moral status of the response (e.g., is retaliation justified?).

Encoding-Anger was related to Positive Generation independent of EF, age, and the other early SIP variables. Children who attribute anger to the transgressor may be biased toward aggressive response options to react in an equally angry way. Perhaps the perceived anger of the aggressor made children feel angry, which could then cue aggressive response options and make it more difficult to generate competent response options (Lemerise & Arsenio, 2000). Indeed, children's feelings of anger are associated with aggressive reactions to provocation (Orobio de Castro, 2004; Orobio de Castro et al., 2012; Runions & Keating, 2007) and the selection of aggressive responses from an array of other response options (Denham et al., 2014). Thus, the errant encoding of transgressors' emotional cues and subsequent anger attribution may be detrimental to children's abilities to generate competent response options and suggests that such person judgments are an important part of SIP.

4.4. Other age-related constructs associated with SIP

Many of the SIP steps were associated with age independent of the EF components, including Encoding-Free Recall, Encoding-Anger, and Response Evaluation. Preschool is a time marked by considerable improvement in many areas of development (Allen & Bickhard, 2018) so it is likely that other abilities additionally relate to the improvement of SIP during this time. Theory of mind, for example, is one ability that develops over the preschool period (Wellman et al., 2001) and is related to social competence (Capage & Watson, 2001; Hughes, Cutting, & Dunn, 2001; O'Toole, Monks, & Tsermentseli, 2017), as well as many processes associated with individual SIP steps. Preschool children's ability to understand the mental states of others is positively associated with emotion knowledge (Brock, Kim, Gutshall, & Grissmer, 2018) and moral reasoning (Lane, Wellman, Olson, LaBounty, & Kerr, 2010), and negatively associated with hostile attributions (Choe et al., 2013), and negative trait attributions (i.e., "mean," Lapan & Boseovski, 2015). It is also important to note that there is a robust association between theory of mind and EF (for review, see Carlson, Claxton, & Moses, 2015) and it is possible that some of the relations observed between EF and SIP in the current study could be mediated or partially mediated by theory of mind.

There are other abilities related to age that are distinct from EF that could be associated with specific SIP steps. For example, expressive language predicts fact recall above and beyond EF (Rajan, Cuevas, & Bell, 2014). Emotion knowledge also develops during the preschool years (Denham et al., 2012) and is negatively related to errant anger attributions (Garner & Lemerise, 2007), as well as moral reasoning (Lane et al., 2010). Finally, moral emotions, and particularly empathy, increase with age (Valiente et al., 2004) and are related to children's moral reasoning (Ball, Smetana, & Sturge-Apple, 2017).

4.5. Limitations and future directions

One limitation of the current study is the modest sample size and the cross-sectional design. The developmental claims drawn from the results would certainly be strengthened by a longitudinal design with an increased sample size. Another limitation is the use of a SIP structured interview as our only measure of SIP. The explicit nature of SIP interviews and the use of third-party vignettes may not fully capture the in-the-moment processing individuals go through during personal difficult social situations. Indeed, much of the processing outlined by the SIP model could be done implicitly in the moment of conflict, much outside of conscious awareness. Additionally, conflicts that happen in real-time likely elicit more emotional reaction that hearing about stories where provocation happens to other children. These emotions may change how children process information from the situation and how they ultimately respond (Lemerise & Arsenio, 2000; Orobio de Castro, 2004). However, the large amount of research that has been conducted on the SIP model using structured interviews and the associations between these measures and real-life behavior contributes to the validity of the structured interview (e.g., Andrade et al., 2012; Crick & Dodge, 1996; Dodge et al., 2003; Dodge & Price, 1994; Lansford et al., 2006; Ziv, 2013; Ziv & Sorongon, 2011). Regardless, the conclusions generated from the current study could be strengthened by future research that uses additional, ecologically valid measures.

The current study also lacks an adequate assessment of children's social competence in their everyday lives. The lack of a social competence measure limits the conclusions that can be drawn from this study regarding EF and children's behavior. Research with older children and adolescents suggests complex associations between inhibitory control factors, aspects of SIP, and aggressive behavior. For example, Fite, Goodnight, Bates, Dodge, and Pettit (2008) found that positive aggression evaluations were only related to aggressive behavior for adolescents characterized as highly impulsive. Another study found that cognitions about aggression fantasies mediated the relation between impulsivity and aggressive behavior in 9- to 11-year-old children (Musher-Eizenman et al., 2004). An important next step for this research would be to see whether other SIP steps mediate or moderate the relation between EF and social competence during preschool because that would provide a fuller picture of how EF supports children's abilities to avoid aggressive behavior in everyday peer conflict situations. Is it the case that children's EF supports SIP, which in turn supports the ability for children to respond appropriately to conflict without the use of aggression? Conversely, is it possible that as children become more adept at solving social problems with development, their SIP abilities also develop? Or perhaps is it a bi-directional relation, just as the SIP steps influence each other in a bi-directional manner (Crick & Dodge, 1994)? These will be important questions to address in future research.

Longitudinal research beginning in early childhood is also needed to explore the general developmental patterns of SIP, as well as

the factors that contribute to the continuity of adaptive and maladaptive SIP styles. Some aspects of SIP may be age-dependent, such that they improve with the maturation of cognitive abilities, while others aspects of SIP reflect stable individual differences that become solidified as children age. Although many children develop appropriate and adaptive SIP styles, a subset of children have maladaptive SIP styles that remain relatively stable from kindergarten through adolescence (Lansford et al., 2006). By examining the age-related changes in the SIP steps, the current study provides evidence that many of the SIP steps improve with age during preschool, in part because of the development of working memory. There is also evidence that some of the steps are affected by individual difference factors independent of age, and that age was not related to every step.

Finally, the results of the current study point to many important avenues for future research. The SIPI-P is comprised of both peer entry situations and peer provocation situations. Although previous research has not found a difference in SIP judgments based on this distinction in older children (e.g., Dodge & Price, 1994), it is possible that preschool children could be sensitive to this distinction and that each situation type has different EF demands. In addition, future research should examine the factors that contribute to the development of both EF and SIP. The typically developing children in the current sample had, on average, appropriate SIP and age-appropriate EF so the data likely reflects normative developmental trends. This suggests that there may be environmental factors that contribute to the concurrent development of both constructs. Parenting, for example, is one factor that could contribute to the development of maladaptive SIP as well as poor EF. Children who have parents that use coercive disciplinary tactics, characterized by reinforcement of negative child behaviors coupled with harsh punishment, are more likely to have issues with aggression (Eddy, Leve, & Fagot, 2001) and regulatory behaviors (Scaramella & Leve, 2004). Another factor could be the level of environmental enrichment provided to children. Enrichment, such as resources for play, books, and opportunities for exploration, is linked to the development of EF (Bos, Fox, Zeanah, & Nelson, 2009; Sheridan & McLaughlin, 2014). A lack of enrichment could also be characterized by a lack of adequate socialization experiences which could impact the development of SIP due to a relative lack of previous knowledge that can be used to engage in appropriate SIP (Crick & Dodge, 1994).

4.6. Conclusion

In conclusion, the results of the current study provide evidence that cognitive control abilities are related to the development of several SIP steps, including emotion attributions and situation evaluations that likely rely on these attributions. Working memory was the main EF component that was associated with several SIP steps, which suggests that representation and reflection on the current social situation is an integral part of SIP. To further support this theory, situation fact and emotion cue encoding were related to later SIP steps. Thus, the accurate and thorough encoding of the conflict situations provides an important foundation for the processing that occurs in later SIP steps. Because peer rejection and continued use of aggression past the preschool period are noted consequences of maladaptive SIP (e.g., Dodge et al., 2003; Lansford et al., 2006), the importance of studying the cognitive mechanisms that support appropriate SIP is clear. The current study provides valuable information that is necessary to address SIP issues during preschool, as well as later in development.

Declaration of Competing Interest

None of the authors were involved in the editorial process for the manuscript and appropriate steps were taken to ensure that all authors were blind to the review process.

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