PRESCHOOLERS' CO-REPRESENTATION OF THEIR PARTNER'S ROLE IN A JOINT SIMON TASK

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ABSTRACT

PRESCHOOLERS' CO-REPRESENTATION OF THEIR PARTNER'S ROLE IN A JOINT SIMON TASK

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The aim of this thesis was to investigate whether preschoolers co-represent their partner's role while performing a joint action. The tasks used in this research were standard Simon, joint Simon and go/no-go tasks. By counterbalancing the sequence of these tasks, this thesis tested the reliability of Saby et al.'s (2014) study in which these experiments were conducted in a fixed order as go/no-go, standard Simon and joint Simon task. Additionally, a preliminary test (elevator task) was used to determine the differences in children's motivation towards collaboration. This test was conducted both before and after the experimental tasks to investigate whether this motivational difference correlated with the size of the joint Simon effect. However, no such correlation was found. The response time analysis of Simon tasks yielded a strong Simon effect in the standard Simon which was absent in the go/no-go task, in line with the existing literature. A Simon effect was also observed in the joint Simon task, but it was significantly smaller than the effect found in the SST. There were no sequence effects. These results support the referential coding account which can explain the joint Simon effect as well as the modulation of the effect with regard to social factors related to the perceived similarity of the co-actor. The difference between the Simon effects suggests that preschoolers might have perceived their adult co-actor as rather dissimilar from themselves.

Keywords: cognitive development, joint action, task co-representation, Simon Effect, joint Simon task

ÖZ

ORTAK SİMON DENEYİNDE OKUL ÖNCESİ ÇOCUKLARIN PARTNERLERİNİN ROLÜNÜ ORTAK SİMGELEMELERİ

Katırcıoğlu Terzi, Esragül
Yüksek Lisans, Bilişsel Bilimler Bölümü
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Bu tezin amacı ortak eylemlerde okul öncesi çocukların partnerlerinin rollerini de simgeleyip simgelemediklerini araştırmaktır. Bu araştırmayı yürütmek için standart Simon, ortak Simon ve yap/yapma deneyleri kullanılmıştır. Deneylerin sıraları denkleştirilerek Saby ve diğerleri (2014) tarafından deneylerin belirli bir sıra (yap/yapma, standart Simon ve ortak Simon) ile gerçekleştirildiği çalışmanın güvenilirliği test edilmiştir. Ek olarak, katılımcıların işbirliğine yönelik motivasyonlarını ölçerek bu ölçümün, ortak Simon deneyindeki Simon etkisi ile ilişkili olup olmadığını incelemek için deneylerden önce ve sonra ön test (asansör testi) gerçekleştirilmiştir. Çocukların asansör testindeki davranışları ile ortak Simon etkisi boyutları arasında istatistiksel bir ilişki bulunmamıştır. Cevap süreleri analizleri, alandaki mevcut çalışmalarla uyumlu olarak standart Simon deneyinde güçlü bir Simon etkisi bulunmuş, yap/yapma testinde ise Simon etkisi bulunmamıştır. Ortak Simon testinde de Simon etkisi bulunmuştur, fakat bu etki standart Simon testinde bulunan etkiden istatiksel olarak daha düşüktür. Sonuçlar, ortak Simon etkisini ve eylemin yapıldığı paydaşın kişiye algılanan benzerliğinin Simon etkisinin boyutunu etkilemesini de açıklayan referanslı kodlama yorumunu desteklemektedir. Standart ve ortak Simon deneylerinde gözlenen Simon etkisindeki fark, okul öncesi çocukların ortak Simon testini birlikte gerçekleştirdikleri yetişkin araştırmacıyı bir şekilde kendilerinden farklı gördükleri izlenimini uyandırmaktadır.

Anahtar Sözcükler: bilişsel gelişim, ortak hareket, ortak simgeleme, Simon etkisi, ortak Simon deneyi

To all woman’s rights activists & my beloved Ata’m…

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LIST OF ABBREVIATIONS

A, B & D	Clustered data set of sequences A, B, D (See **Table 2**)
BCa	Bias corrected accelerated
C, E & F	Clustered data set of sequences C, E ,F (See **Table 2**)
Comp	Compatible Trials
FE	Female experimenter
Incomp	Incompatible Trials
JST	Joint Simon task
JSE	Simon effect observed in the joint Simon task
ME	Male experimenter
MT	Movement Time
GNG	Go/no-go
RT	Response Time; reaction time
SE	Simon Effect
S-R	Stimulus response
SSE	Simon effect observed in the standard Simon task
SST	Standard Simon task
TEC	Theory Event Coding
ToM	Theory of Mind

CHAPTER 1

INTRODUCTION

As social animals, most humans live in a society where almost everyone has a role with respect to their abilities and need to communicate with each other for the continuity and well-being of the society as well as for themselves. This system is not the mere summation of individual actions of people, but rather their synchronized behavior leads to enhanced capabilities that go much beyond what any single individual could perform on their own. Sebanz & Knoblich (2009) underline this aspect by stating that human beings as a species would not be able to survive if we were not able to act jointly. Thus, the capability of coordinating one's own actions with others significantly expands the potential products of actions and their efficiency (Clark, 1996). The lives of humans as well as the lives of many species which live collectively are very much intertwined with each other. Studies conducted with our closest primate relatives, chimpanzees, however, showed no similar tendency for joint action. From these findings, it was concluded that only human beings are "adapted for some special types of cooperative interactions, namely, cooperative interactions with the special structure referred to as shared intentionality" (Warneken et al., 2006, p. 660). Understanding how this unique capability is achieved is thus an important aspect in seeking to understand the proficiencies of the human mind. One might wonder why our closest primate relatives, chimpanzees, who live in large groups, are not capable of joint action: the underlying difference between the actions of these animals and humans is the way joint actions are performed. It becomes evident from various research (Tomasello & Carpenter, 2007) that although these animals can perform actions with each other and (sometimes) humans, their actions lack certain features of truly joint actions which are seen even in human infants already. Basic features to differentiate coordinated individual actions and joint actions are skills and motives towards shared intentionality which is considered to be the set of psychological states shared by the actors of the action using lower level mechanism such as joint attention (Tomasello & Carpenter, 2007).

Although studying social interactions has been a research field for a very long time, the fact that it requires a process-oriented perspective has been recognized rather recently. In other words, researchers rather recently started to converge on reasoning that, studying joint action only using social stimuli may not be sufficient, but real-time interactions among individuals should be studied in social context (Sebanz et al., 2006). One of the methods used is converting known interference paradigms to joint paradigms such that researchers can investigate how the insertion of a co-actor or an observer affects the performance of the participant. These paradigms include tasks such as the Simon task (Simon, 1990), the Bear Dragon task (Kochanska et al., 1996) and the picture-word task

(MacLeod, 1991). The Simon task is a two “choice-reaction task (CRT)” in which the irrelevant location features of the stimulus may or may not overlap with the relevant location feature of the response. It is thus a “spatial compatibility task”. In “compatible” trials they overlap, facilitating the response, whereas in “incompatible” trials they do not overlap, hampering the response. The difference in response time between compatible and incompatible trials is called “Simon effect” (Hommel, 2011). In the pioneering study by Sebanz et al. (2003), a joint version of the standard Simon task (SST) was conducted along with go/no-go (GNG) and standard versions. Their results showed that the performance of the participants was affected when sharing the task with the co-actor. They claimed that actors automatically included the co-actor’s task share into their own action plan, that is, they co-represented their co-actors’ task. However, different studies with the joint Simon task (JST) yielded results that the co-representation account seems to fall short in explaining (Guagnano, 2010; Dolk et al., 2011, 2014). Thus, investigating the developmental foundation of co-representation in children promises to be very informative for resolving this current hotly-debated subject in the literature.

Milward and Apperly (2014) studied co-representation of a task in children with a modified versions of a classic inhibition test named “Bear and Dragon” task (Kochanska et al., 1996). It was noted that that the Bear and Dragon task was similar to the Simon task in terms of the existing tendency to act upon a stimulus. In the study, it was found that the children responded faster when they responded to the same puppet/stimuli rather than responding to different ones. This behavior was observed only in older children (4-5 years-old) but not in young children (2-3 years-old). Consequently, they suggested that the co-representation mechanism developed during early childhood, around 4 years of age. Another study which aimed to investigate co-representation developmentally was Saby et al. (2014). In this study, the JST was used to investigate the presence of co-representation in preschool children. A significant difference was observed between compatible and incompatible trials in the standard Simon and the JSTs, but not in the GNGtask. The fact that the order of the experiments was not counterbalanced, however, raises doubts on the reliability of the experimental design and the validity of the conclusions drawn. Alternatively, the finding of a joint Simon effect (JSE) might be due to a transfer effect of S-R mapping rules from the preceding SST. Such “set effects” have also been observed in adults before (Ansorge & Wühr, 2004, 2009).

Given the inconclusive results of Saby et al.’s (2014) study, this thesis aimed to replicate the same spatial compatibility experiments while overcoming their shortcomings. Therefore, the order of the tasks was counterbalanced to investigate the true existence of a Simon effect in the JST in preschoolers. If a Simon effect could be found in a JST that has not been preceded by a SST, this ould be the evidence for the existence of co-representation of their partner’s task in children of age 5. With regard to studies that aim to find social factors modulating or eliminating the JSE, we also addressed the issue whether children’s differences in their motivation towards collaboration would be correlated with their performance in the JST. Saby et al. (2014) also used a collaborative task before the spatial compatibility tasks to seek whether the performance of children who collaborated with a partner would show differences in the extent of the JSE in comparison with the others that conducted a similar task alone. They also compared whether the JSE size was different when performed with the previously collaborating experimenter versus a second experimenter. These results showed no significant difference. Therefore, we did not use the collaborative task used in Saby et al.'s (2014) study but another task, namely the "elevator task" (Warneken et al., 2006). The elevator task was also performed after the spatial compatibility tasks to find out if the motivation to collaborate would change after the spatial compatibility tasks and if this change or their behavior in the post elevator task would be correlated with the extent of the exhibited JSE. Thus, we wanted to know whether there was any bidirectional correlation between the elevator task and the experimental tasks.

In the remainder of this thesis, Chapter 2 provides a review of studies investigating the JSE and of accounts both from an adult and from a developmental perspective. Chapters 3 and 4 present the methodology and the results of the experiments (Phase-1: pre-elevator task; Phase-2: go/no-go, standard Simon, JSTs; Phase-3: post-elevator task), respectively. Chapter 5 comprises a general discussion of the findings. Finally, in Chapter 6, the main conclusions of the study are summarized and suggestions for future studies are made along with the limitations of the current study.

CHAPTER 2

LITERATURE REVIEW

Joint action manifests itself in complex behaviors such as playing basketball, dancing tango and in simple everyday activities like having a conversation with someone or lifting an object together (Allport, 1924). Also considering language as a joint tool used to manifest coordinated action, the percentage of time we do not exhibit joint action becomes very limited (Clark, 1996). Although it is a vast part of our lives and we perform joint actions numerous times throughout a day, understanding its underlying mechanisms thoroughly are yet to be achieved. A definition on joint action which was put forward by Sebanz et al. defines joint action as “two or more individuals coordinate their actions in space and time to bring about a change in the environment” (2006, p.70). However, Carpenter (2009) suggests that a major aspect is lacking from this definition, which is shared goals amongst participants of joint action, differentiating it from coordinated action in group activities of some animals. Thus, researches who think shared representation should be in the definition of joint action seem to adopt the definition by Bratman (1992) which emphasizes that in order for the action to be considered joint, all parties involved must have the knowledge that they have the intention to perform that action together and they will plan their actions accordingly. Additional characteristics of joint action that Bratman (1992) points out is understanding the mutual commitments and helping each other when necessary. From this definition, the question arises whether the joint activities children and even infants seem to engage in develop before their Theory of Mind (ToM).

In the review by Carpenter (2009), studies investigating infants’ motivation and skills show that on some basic and limited scale children upon the age of 1 fulfill most of the crucial requirements of joint action, such as an understanding of the goal and intention of others, common knowledge with them and obligations of joint action. Hence their ToM may be more robust than previously considered. ToM ability is central to joint action since it is essential for forming shared intentions which is vital for genuine joint action. In fact, infants might be overgeneralizing attribution of intention, such that agents need not be human. In the study by Surian et al. (2007) it is observed that 13-months-old infants significantly gazed more at the caterpillar when it moved toward the food location where the caterpillar falsely “thought” it was although its location had been changed. These experiments with nonverbal infants analyzing whether children looked significantly longer when the actors acted in an unexpected way, i.e., when infants’ expectation was violated. Additionally, in a study by Behne et al. (2005) it was observed that 9-month-olds reacted differently – they waited more patiently – when the adult was unable to give a toy to them as compared to when she was unwilling, thus showing they understood the goaldirectedness of the adult's action. Although these studies show tendencies and capabilities of infants towards joint action, this is not to say that they have developed all the skills that adults have. The normative dimension of joint action seems to develop later than these basic skills, as it was shown that children at the age of 3.5 years continued the collaborative activity with a peer even when they received the reward but not their partner, whereas 2.5-year-olds did not (Hamann et al., 2012). Also, the explicit dimension of ToM develops later in childhood, around 4 years of age, thus children below this age are unable to take into account the false-belief of the actor but they may show their expectations through spontaneous response such as looking longer to an unexpected behavior of the actor (Baron-Cohen, 1985). Also, one of the main differences between adults and children with respect to joint actions is that adults' joint actions are automatic, whereas young children rely on scaffolding by an adult. In such interactions, they do well mostly in ritualized conditions, however, a novel entity deteriorates their interactions (Brownell, 2011). In the longitudinal study by Bakeman & Adamson (1984), they observed that around 12 to15 months infants became more actively engaged in coordinated joint actions rather than only following the guidance of the adult.

With the vast amount of behavioral data that shows that even infants can perform joint action to some extent, there needs to be more research to understand the underlying mechanisms that enable these joint actions. By comparing them with the adult studies these developmental studies would enhance our knowledge on the foundations of joint action. The two lines of research that attempt to explain how social context, in other words, the presence of others, can affect individual performance are notably social facilitation and ideomotor approaches.

Social facilitation is concerned with the performance change of individuals in the presence of some audience. The term "facilitation" was due to the early findings which showed that performance was enhanced when there were others, however later studies showed more specifically that performance was facilitated only in simple tasks whereas it was degraded in difficult tasks (Aiello & Douthitt, 2001). There were different interpretation attempts to explain these findings. Zajonc (1965) suggested that the presence of others increased the drive of the actors and this drive facilitated the dominant response and worsened the subordinate response. The dominant responses, which are the learned behaviors from previous experiences, are usually the correct ones in simple tasks but the wrong ones in difficult tasks. Later, in 1968 Cottrell, Wack, Sekerak and Rittle claimed that performance would only be affected if the actors thought that others were evaluating them. Further on, Baron (1986) suggested that the presence of others leads to distraction which results in an attentional conflict. This conflict modulates the attentional focus of actors which turns out beneficial for performance up to a certain point where demands of the task is not high but degrades performance otherwise. The essential aspect of studies on social facilitation relevant to our study is that its focus is how the company of social agents affects an actor's performance.

On the other hand, the ideomotor approach on joint action accounts for the way others' actions affect the agent's actions. Ideomotor theory, which is a framework for action control, states that action and perceptions are highly linked with each other such that actions are represented by their perceptual outcomes and these links are established "on the fly" as individuals experience the sensory outcomes of her actions (Hommel, 2013, p. 120; Hommel, Brown, & Nattkemper, 2016; Prinz, 2013). Due to this close link, an action representation might be activated when it is intended, imagined or someone else is seen performing that action. In the TEC (Theory of Event Coding), that is a theory based on ideomotor theory, actions are represented by their perceptual outcomes and they can be activated bidirectionally (Hommel, 2009; Hommel, Müsseler, Aschersleben, & Prinz, 2011). Important for our research is the fact that TEC posits that task sets consist of event codes that are organized in a certain way with respect to the task demands and their interaction history (Prinz, 2015). Event codes are placeholders for events which are outside the representing system and are made up of semantic feature compounds, whose weights are changed off-line with respect to the task (Prinz, 2015; Memelink & Hommel, 2013). The features of event codes can be shared or none intersecting and this could facilitate or degrade the task performance depending on whether the codes will be activated cooperatively or will be in competition.

One of the mechanisms of joint action is thought to be task-sharing which is still under debate, but the JST is one of the most preferred experimental paradigms to understand it. Below the studies on the JSE are summarized starting from their origin, the (standard) Simon task.

Standard Simon task (SST)

The SST is a two-choice spatial discrimination task where the irrelevant spatial feature of the stimulus activates a corresponding response due to the overlap of spatial features between S-R. In the most preferred experimental set-up for SST, the participants are seated in front of a monitor and are instructed to press one button when they see one of the two stimuli and press the other button when they see the other stimulus (see Figure 1: Standard Simon Task Set-up (Figure taken from Ruissen & Bruijn, 2016, p. 4 (A))). In compatible trials, the stimuli (may be visual or aural) is presented in the same location with the response defined by a rule. Whereas in incompatible trials the response associated to the stimulus by the rules is in the reverse location as the stimulus. The incompatible trials have significantly larger reaction times than the compatible trials. This phenomenon is called the Simon effect and it is a consequence of the activation of two difference responses in incompatible trials due to the automatic tendency to respond on the same side of the stimulus and the response defined by the rules (Simon, 1969).

The SST is an experimental tool that is widely referred to when studying perception, action and their interference (Hommel, 2011). According to Hommel (2011), the main reasons for the high preference of the Simon task in these research areas lies in the fact that the Simon task enables complete control over the cognitive representations; and, therefore, the results obtained by using the Simon task are apprehensible and easily related to the theoretical literature. The Simon effect was observed in 1969 by Simon and Small for the first time as the difference in reaction times of the participants between compatible

S-R pairs and incompatible ones, where stimuli were high and low tones presented to participants on the left and right ear and left and right key presses were requested as responses according to a S-R rule relating the height of the tone (relevant stimulus dimension) to a response on one or the other side, respectively. In the following years, visual (rather than auditory) stimuli have been used more often in the Simon task, e.g., red and blue squares appearing on the right or left side of a computer, which have to be responded to by left and right key-presses, respectively. The Simon effect has been replicated numerous times with different modalities and different alignments (Special Issue on the Simon Task in *Acta Psychologica*, 2011; Dolk et al., 2014). The commonly accepted view on the occurrence of the SE is that the irrelevant spatial stimulus feature codes automatically activate the matching spatial response code, resulting in facilitation of the compatible responses and in a conflict in response selection in the incompatible trials. Developmental studies also showed that standard Simon effect could be observed in children as young as 2-year-olds (Davidson et al., 2006; Gerardi-Caulton, 2000; Saby et al., 2014).

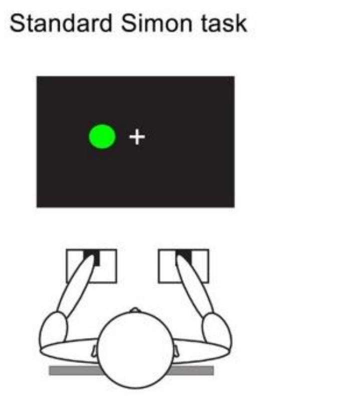


Figure 1: Standard Simon Task Set-up (Figure taken from Ruissen & Bruijn, 2016, p. 4 (A))

Go/no-go (GNG) task

The GNG task is a task where an individual respond to a single stimulus only, hence, no conflict at the stage of response selection occurs and, consequently, the results of GNG tasks do not yield a Simon effect (Hommel, 1996). The task setting can be seen in Figure 2: Setting in the individual GNG task (b) from the study of Sebanz et al. . Participants are seated on one of the response sides when experimenters also want to conduct another joint experiment with the same participant (and a co-actor) and compare its results with the GNG task. In this case, they do not want to add a source of artifact by changing the location of the participant between experiments. Thus, the participants are seated to the same side as they are seated in the following tasks (Sebanz et al., 2003; Ansorge & Wühr, 2004).

Figure 2: Setting in the individual GNG task (b) from the study of Sebanz et al. (2003, p. 14)

However, a Simon effect was found in some studies that manipulated some aspects of the experiment. In the studies by Ansorge and Wühr (2004, 2009), a Simon effect is observed in a GNG task when it follows a SST. They argue that the stimulus-response rule along with the response locations of the SST was preserved in the WM of participants and transferred to the latter task, resulting in a“set effect”. In another study by Porcu, Bölling, Lappe and Liepelt (2016) a Simon effect was observed in a GNG task even when no SST preceded the GNG task but they changed the usual response, pushing a button, to pointing responses. They claimed that due to the dynamics of the pointing to a fixed response, participants had to shift their spatial attention from the location of the stimulus to the location of the response which was on opposite sides in the incompatible trials.

Joint Simon task (JST)

The JST, a modified version of the SST, has a similar setup as the SST and GNG task, thus it is sometimes referred to as “social Simon task” or “joint GNG task”. The JST is in fact a GNG task only conducted with two participants side by side (See Figure 3). From the point of view of task responsibilities per participant, the GNG task and the JST do not differ. Due to this relation between the GNG task and the JST, the Simon effect would not be expected in the JST either. However, experimental studies did show a Simon Effect in JSTs in adults (Sebanz et al., 2003; Hommel et al., 2009). The authors claimed that the Simon effect was present because the individuals were (automatically) co-representing the co-performer’s task (share) in their own action plans and thus creating an action representation which was actually detrimental to their own performance. Hence, the JST has been used in a variety of studies to observe the interaction of an individual with another person and the extent to which the other’s actions and the joint tasks affect the individual’s own behavior (Dolk et al., 2014; Sellaro, 2013). Nevertheless, some experiments showed that a Simon effect could be observed in GNG tasks with minor manipulations even without a partner (Dolk et al., 2013; Vlainic et al., 2010; Porcu et al., 2016). An exemplary study by Dolk et al. (2013) showed a Simon effect when the “co-actor” was a Japanese waving cat and metronome positioned at the other side of the table.

There are also other studies that determined the effect of social factors on the Simon effect such as Hommel, Colzato and van den Wildenberg (2009) and Müller et al. (2011). In these studies, the Simon effect was found to be decreased or eliminated when the coperformers were intimidating (Hommel et al., 2009), competitive in the prior task (Ruissen & Bruijn, 2016) or were dissimilar out-group members (Müller et al., 2011; McClung, Jentzsch, Reicher, 2013)). The fact that the partner's presence and, moreover, their similarity increases the Simon effect indicates that the existence of a partner makes a difference in the agent (Dolk et al., 2014). It was shown by Ford and Aberdein (2015) that self-reported empathy was positively correlated with the extent of the joint Simon effect (JSE) when the task was conducted with a friend. In addition, Colzato (2012) investigated the difference in the JSE between religious (Buddhists) and non-religious people. The JSE was found to be stronger in religious people rather than non-religious people even though the groups' Simon effects found in the SST were comparable. The results were claimed to be due to the practices in Buddhism that increase self-other integration which leads to a decreased discrimination between the action of others and self-generated actions. This consequently leads to a more pronounced spatial discrimination in religious people with respect to people with more individualistic beliefs. Spatial discrimination which underlies the Simon effect is thought to be more pronounced when other features possibly discriminating between the response alternatives are too similar. Since in a joint Simon task, the response features (left, right response) are instantiated by the two partners (sitting left, right) the more similar these two are the stronger the weight of the sole feature that remains to discriminate among them – the spatial feature – will become. Another factor that modulates the JSE is attention. In the study by Liepelt (2014) they manipulated the position of the hands thus changing their spatial saliency. The results showed that in the high saliency conditions (hands on the sides of the monitor) the SE was higher than in the low condition trials (hands on the knees) when both the participant's hand was in the high salient position. Moreover, the authors observed the same hand position effect on spatial compatibility even when the co-actor was removed and a rubber-hand was inserted to the set-up.

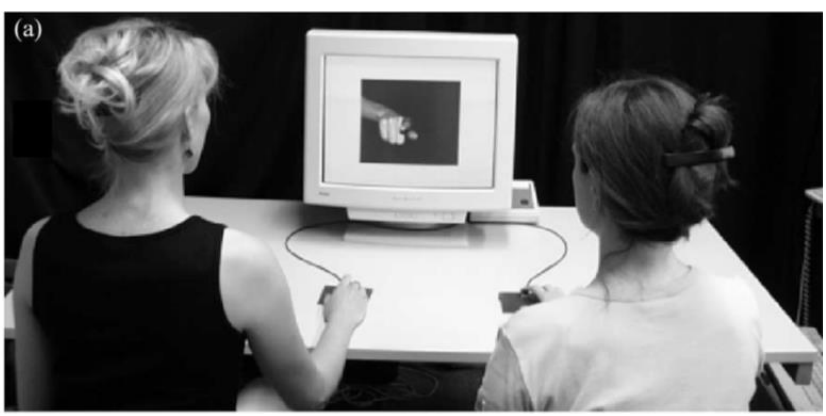


Figure 3: Setting in the joint GNG task (a) from the study of Sebanz et al. (2003, p. 14)

The underlying mechanisms for the JSE are still under debate. Currently, there are several approaches for the explanation of the JSE, as summarized below:

a) The **co-actor task representation** (also called **co-representation**) account (Sebanz et al., 2006), states that the actors automatically co-represent the co-actors task (rules that define when they will respond with respect to which stimuli) hence the representations of both actors taken together result in representing the full task. In their study (Sebanz et al., 2003), a JSE was not present when a co-actor was present but did not act, whereas it was present when the co-actor was instructed to respond to the complementary stimulus without any feedback of the action. These observations were claimed to result from the automatic representation of the co-actor's share of the task at the onset of the instruction and knowledge of this sharing is sufficient to induce the JSE.

b) The **spatial response coding** account (Guagnano et al., 2010) eliminates the social effect of a co-actor and claims that the co-actor only serves as a mean that provide a spatial reference frame. By showing that the effect is eliminated when the co-actor is positioned out of the actor's peripheral space, it is claimed that the existence of a co-actor only functions as a reference leading to the spatial coding of the actor's own action. The JSE is claimed to be the result of facilitation of responses in compatible trials, unlike the other accounts which attribute it to an interference effect due to a conflict in response selection.

c) The **referential coding** account (Dolk et al., 2014), which is based on TEC, assumes that actions are represented by their perceptual features and outcomes, and a profound link exists between them. Thus, actions can be activated not only by anticipations of the outcomes but also by the environment if it contains the perceived effects. Consequently, any salient event in the environment could lead to the activation of the alternative response and emphasizing on the discriminative spatial feature of the response. Due the different functional difference between SSE and JSE, and the similarity of responses between the GNG and the JSTs Dolk and Prinz (2016) refer to JST as "joint Go/NoGo" task and claim JSE to be resultant of a different interference effect than SST, produced by the task instructions or environment in a GNG task.

The referential coding account which was recently proposed by Dolk et al. (2014) claims to satisfy all the results of various JSTs. The authors state that some study results could not be explained with the 'a' and 'b' accounts, mentioned above. Accounts 'a' was claimed to be inadequate to explain results where a Simon effect could be observed in tasks when co-actors were not intentional agents, such as the Japanese waving cat. Account 'b' was found to be contradictory with the experimental results showing the presence of a Simon effect or its intensity is being affected by social factors such as an intimidating co-actor (Hommel et al., 2009) or an outgroup member (Müller et al., 2011; McClung, Jentzsch, Reicher, 2013). Only account 'c' is consistent with all the existing JST results in the literature. This claim accounts for the SEs found in manipulated GNG set-ups as it dissociates the SE from the presence of a co-actor. Both actor co-representation account and referential coding account are based on ideomotor theory as they rely on the assumption that actions are represented in terms of perceptual outcomes and explain the JSE because of conflicting concurrent representation of more than one action representation. These accounts also rely on the assumption that one's own actions and the observed actions of another are represented in the same way. The difference between these accounts are how they claim alternative action is represented by the actors even though it was not assigned to him (Sellaro, 2013). In the co-actor representation account, the action alternative is thought to result from the knowledge of the co-actor's task share and representing it. As for the referential coding account representation, the source of activation is not related to a specific situation but rather "what matters for response conflict is the number of concurrently active action representations but not the source of activation" (Dolk et al., 2014, p. 6).

Besides studying shared intentionality, co-representation and action in adults and social animals, studying their developmental origins opens a further and complementary approach. Developmental studies on joint action can give information about the level of cognitive processes required to perform respective levels of coordination (Milward, Kita, & Apperly, 2014). The development of joint action has been shown to follow a particular trajectory (Hamann et al., 2012). Around 18- to 24-months infants start establishing simple collaborative activities, becoming more skilled as the end of this period approaches (Eckerman & Peterman, 2012). Children manage to coordinate their actions in more complex situations when they are 3 years old (Ashley & Tomasello, 1998). The question whether the joint actions of children are truly joint in nature or just coordinated actions to reach their own goals is, however, ambiguous in some conditions (Milward & Apperly, 2014). The age at which any of these abilities – coordinated action and truly joint actions – are found to develop will provide insights into the underlying mechanisms. Brownell (2011) also highlights this view by claiming that, although many studies on joint action capabilities of children have been carried out, but not many have studied the mechanisms that underlie these abilities.

One mechanism used to distinguish joint coordinated actions from individual actions that are coordinated in adults, is the phenomenon of co-representation (Milward & Apperly, 2014). Co-representation also gained interest in recent studies with children, aiming to elucidate its developmental course (Milward & Apperly, 2014; Saby, Bouqet, & Marshall, 2014). In the study by Milward and Apperly (2014), children were seated side by side at a table with a screen in the middle. Children were thus aware of each other's presence. Two puppets were introduced to both children and – depending on their group condition – they either performed the instruction given by the same puppet or by different puppets. It was found that children made more mistakes when they were beside a partner performing a different task as compared to the condition when both were performing the same task. However, in Experiment-2, after applying the initial tasks conditions (same or different) first, the puppets to be attended were switched (e.g. if the task had been same then children started responding to the other puppet's instructions). As a result, the error rate increased in the group which had to do the same task initially as compared to the group that had the different task condition initially. It was stated that this change in error was due to the representation of the co-actors' task initially which led to a smaller number of errors after the switch occurred in the different task condition. A similar but simpler experiment to explore the co-representation phenomenon at an earlier age was also conducted. The age of the participants at which they were found to show co-representation was 45-69 months (approximately 4-5 years); whereas similar results could not be found in the younger age group of 29-45 months (2-3 years). The authors claimed this to be the first evidence of the co-representation phenomenon in 4-5 year-old-children.

Another study that addressed co-representation in children was conducted by Saby et al (2014). To explore the occurrence of joint task representation in 5-year-old children the authors used the JST as experimental paradigm. Further questions were if there would be a difference in the SE between participants who engaged in a prior collaborative task and those who did not; and whether the intensity of the SE would differ if the co-actor had been the collaborative partner or an observer. Three tasks were used in that study: a GNG task, a SST and a JST. The JST was conducted twice to test for the impact of the status of the partner: whether she was the collaborative partner from the preceding task versus the observer. Importantly, these were applied in a fixed order to all participants with the JST always following the SST. Results indicated no effect from the collaborative task on the size of the JSE but indicated the presence of co-representation in children: a SE was observed in the first JST and the SST, but not in the GNG task and the second JST. The authors claimed that the absence of the JSE in the second JST could be explained by the ability of children to suppress the irrelevant spatial information after performing the consecutive trials of the SST and the first JST. Thus, the findings of a JSE in the first JST was taken to constitute evidence for task co-representation of children of age 5. However, their study has a crucial methodological shortcoming: the authors did not take into consideration the possible transfer effect of the S-R rule from the SST to the JST, as indicated in previous studies with adults (Ansorge & Wühr, 2004, 2009). The study of Ansorge & Wühr (2009) showed that a Simon effect was observed in GNG tasks when a two-choice response task (SST) preceded the GNG task thus transferring the S-R rule from the former to the latter. These findings were consistent with Ansorge & Wühr's "response discrimination account" which holds that participants would show a SE if they used the (irrelevant) spatial features of the stimuli (appearing on the left or right of the screen) in order to discriminate their motor responses (pressing left or right). Furthermore, the "response discrimination account" holds that these S-R mappings would be held in working memory not only for the time of the task but also possibly carry over to a subsequent task. This effect is called "set effect" (Ansorge & Wühr, 2004, p. 366f). Returning to the study of Saby et al. (2014), it could well be that the Simon effect they found in the JST resulted from such a "set effect" rather than from co-representation. Consequently, the results of Saby et al. (2014) are inconclusive at this point.

To sum up, this study aimed to answer the following questions: (1) Whether the JSE observed in adults is also observed with children at the age of five when the JST does not follow the SST; (2) If the presence (and the strength) of the JSE is correlated with the cooperativity index of children assigned through the elevator task; (3) If the spatial compatibility tasks would affect and predict the elevator task following them. The expected results were to observe differences among the JSE results with respect to the sequences: if there is a JSE only in sequences where the JST follows the SST, this could still be interpreted in terms of Ansorge & Wühr's (2004, 2009) "set effect". If, however, there is also a JSE in sequences where the JST precedes the SST, this would constitute stronger evidence for co-representation of the partner's task. However, even if a JSE is observed, this does not automatically mean that children co-represent their partner's task. Since there are varying explanations in the adult literature on the joint Simon effect as pointed out above, a careful interpretation of the results is called for.

CHAPTER 3

METHODS

In this section the experiment procedure, the setup used and the distribution of participants in the various sequences are described in detail. In the experiments, the dependent variable are the responses of participants accordingly to the experiments whereas the type and conditions under which the stimulus was presented to the participant was the independent variable (Hommel, 2013).

3.1. Participants

Sixty-three Turkish children and five children from other nationalities (mean age 64.6 months, SD=6.8 months; 36 girls) participated in this study. They were from four different preschools in Ankara. Two of the preschools had international students who were not Turkish, those students were also included in the study. The experiments were carried out in the preschool's classrooms assigned for our study. The number of participants joining elevator task was fifty-eight; because of the limited time we had at one of the preschool we were not able to perform phase two tests on five of the participants.

Table 1 refers to the distribution of subjects to the sequences the participants are assigned to, which is the order of the spatial discrimination tasks they are undergoing. These tasks are the standard Simon (SST), the joint Simon (JST) and the go/no-go (GNG) tasks. To examine the effect of order of tasks on the occurrence of the Simon effect, all possible orders of the three tasks were taken into account. The number of participants in each condition is shown in column '# of subjects'. Within each group every subject was given role A or B in the elevator task. The number of subjects assigned to role A or role B are given in the columns 'role A' and 'role B'. In the spatial compatibility tasks children were to respond to one stimulus in the joint Simon and GNG tasks, the number of children assigned to each stimulus are given in the column 'butterfly' and column 'caterpillar' which were the two stimuli (see Figure 7).

Table 1: Distribution of Participants to Sequences, Roles, Stimuli and Gender

Sequences	#of subjects	Role A	Role B	Butterfly	Cater-pillar	Male	Female
A	10	6	3	6	4	4	6
B	10	5	5	3	7	5	5
C	11	4	5	6	5	5	6
D	11	6	3	6	5	5	6

Table 1 (cont.)

Sequences	#of subjects	Role A	Role B	Butterfly	Cater-pillar	Male	Female
E	11	5	6	6	5	4	7
F	10	5	5	5	5	4	6
Total	63	31	27	32	31	27	36

3.2.Setups & Procedures

The experiment consisted of three phases as shown in Figure 4: Flow of the Phases. The first and third phases, which were the elevator task, were one and the same within one subject. The second phase consisted of one standard Simon task (SST), one go/no-go (GNG) task and one joint Simon task (JST).

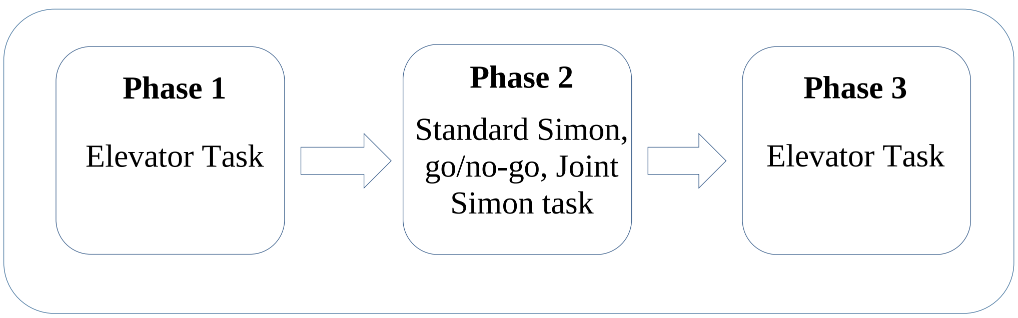


Figure 4: Flow of the Phases

The order of the tasks in phase-two had six possibilities as shown in Table 2. Children were assigned to one of the six sequences beforehand and the tasks were conducted with respect to that sequence.

Table 2: Sequences conducted in Phase 2

No	Sequence Name	Sequence
1	Sequence A	Joint Simon task → Go/no-go task → Standard Simon task
2	Sequence B	Joint Simon task → Standard Simon task → Go/no-go task
3	Sequence C	Go/no-go task → Standard Simon task → Joint Simon task

Table 2 (cont.)

No	Sequence Name	Sequence
4	Sequence D	Go/no-go task → Joint Simon task → Standard Simon task
5	Sequence E	Standard Simon task → Go/no-go task → Joint Simon task
6	Sequence F	Standard Simon task → Joint Simon task → Go/no-go task

Phase 1: The First Elevator Task

The elevator task, conducted before the SST, JST, GNG task aimed to determine the children's motivation for cooperation. The JSE observed in adults was found to be affected by social factors such that the effect was decreased or eliminated when co-actors were intimidating (Hommel et al., 2009). Thus, in our study we wanted to investigate if the (extent of the) JSE observed in children could be correlated with a prior collaboration task. Each phase was analyzed and coded separately.

The elevator task was designed by Warneken et al. (2006) as a problem-solving task involving two people with complementary roles. In their study, children of 18 and 24 months of age were taken as participants. The aim was to find the children's skill of coordinating their actions with an adult partner in four tasks requiring cooperation. An interruption period where the adult partner stopped collaborating was inserted to the experiments to observe the child's reaction and assess shared intentionality. It was stated by the authors that the response given in the interruption period would provide information about the motivation of each children toward cooperation (Warneken et al., 2006). In the present study, we wanted to assess the motivation to collaborate of each child to investigate if this motivation would be correlated with the degree of the JSE.

Complementary roles are defined by the different actions needed to be performed by the participant and the experimenter in order to achieve the common goal. The goal of this task was to grab the toy inside a vertically movable cylinder that is inside a platform in a box by performing complementary actions. In order to retrieve the toy two people had to stand on opposite sides of the box, one had to push the cylinder upwards (role B, see Figure 11: Instance during elevator task when child is in role B pushing the cylinder upwards and ME is in role A grasping the object) so that the other could reach and take the toy from the opening of the cylinder (role A, see Figure 6: Instance during the elevator task when child is in role A gathering the target and ME in role B pushing up the cylinder.). One person could not succeed doing this task alone because for the agent in role B, there was a transparent screen that disabled reaching the toy after pushing the cylinder up and for the agent in role A pushing the cylinder up was not possible. The toys used as targets were approximately 4 x 4 cm sized animals, characters, cakes etc. The apparatus and target toys are shown in Figure 5: Elevator Task Apparatus (duck as an example target toy). The complete task consisted of four trials of retrieving the targets. Trials 1+2 were the same and ended when the target was retrieved. Trials 3+4 were the same but included pauses when the male experimenter (ME) interrupted his role after the participant had become engaged. The data that was used were behavioral codes the behavior of the child during the interruption phase.

Figure 5: Elevator Task Apparatus (duck as an example target toy)

Children were taken from their classrooms one by one and met with the experimenters. A male experimenter (ME) acted as play partner and a female experimenter (FE) helped with time keeping and recording during demonstration and interruption periods. Children were first introduced to the apparatus by moving around it and being shown the transparent screen along with the holes where the hands could reach through. Secondly, the two experimenters demonstrated how to play with the shown apparatus, three times. The role assigned to the participants was predefined and FE stood on the side on which the children were going to play. When the demonstration was over, FE moved aside and the children were invited to play in her place with a nonverbal invitation by alternating gaze to the apparatus and to the child and with nodding to her. If the children did not understand this nonverbal invitation or if they acted shy, then some verbal motivation was given such as ‘Would you like to play?’, ‘Come play instead of me’, etc. With the participation of the children, trial 1 began. When the participant was in role A, ME pushed the cylinder up and waited for her to grab the toy. When the participant was in role B, ME started to perform his role and tried to reach the toy until she lifted the cylinder up. If the child could not perform the role after the demonstration, assisting verbal cues were given by ME. The majority of children succeeded performing the role. After completing trial 1 successfully, trial 2 began, which was similar to trial 1. After completing trial 2 successfully, trial 3 was initiated. When the child became engaged ME quit his role deliberately. ME continued the interruption for 10s then resumed his role just as at the beginning of the trial. In role A ME stopped reaching for the target when the child pushed the cylinder up; in role B, he dropped the cylinder when the child started to reach for the object. When ME resumed his role, most children continued their role also and if the child had disengaged in the interruption verbal cues were given. The same procedures were applied in trial 4.

The behaviour of the participants in the interruption periods of trials 3+4 was classified with respect to the categories shown in Table 3**:** Coding Schema for Overall Behavior During Interruption Periods (Warneken et al., 2006, p.647). The interruption periods were videotaped by FE, and then categorized. The interruption period of each trial was coded separately and the most dominant attitude was taken as the final record of the participant. It was also noted whether the child had at least one eye contact with ME.

Table 3: Coding Schema for Overall Behavior During Interruption Periods (Warneken et al., 2006, p.647)

Category	Definition
Disengagement	Child leaves apparatus or plays on apparatus without pursuing the goal of the task by banging on the apparatus, climbing on it, etc.
Individual attempt	Child attempts to retrieve the object individually in problem-solving tasks or attempts to continue the game alone in play tasks (e.g., in the elevator task, the child would come over to the side of the experimenter and push the cylinder up herself while reaching for the object; in the tube-with-handles task, the child tries to hold both handles or peel it open on one side).
Waiting	Child remains on correct side of the apparatus and is ready to perform her role.
Reengagement	Child is ready to perform her role and in addition tries to reengage E1, for example, by pushing the cylinder of the elevator up, pointing at the object, and vocalizing while looking at the partner.

Note. The 15-s interruption period served as the unit of analysis. For each interruption period, one of the scores was given.

Phase 1 and 3 were identical. Before all of the phases verbal consent was obtained from each child. Possibly due to the fact that some children felt frustrated in the interruption period they did not want to participate in the elevator task again in Phase 3. These cases were coded separately.

Figure 6: Instance during the elevator task when child is in role A gathering the target and ME in role B pushing up the cylinder.

The categorical data were mapped as ordinal variables as in Table 4: Mapping of categories of the elevator task to ordinal values for statistical analysis. 25% of the video records of the pre-elevator and post-elevator tasks were also viewed and categorized by the male experimenter for measuring interrater reliability. He was only given the coding schema in Table 3: Coding Schema for Overall Behavior During Interruption Periods (Warneken et al., 2006, p.647) (Warneken et al., 2006, p.647). The interrater reliability for raters for the pre-elevator task was found to be $\kappa = .88$ (95% CI, .77 to .99), $p < .001$. Since $\kappa > .81$, this agreement can be classified as "almost perfect" (Landis & Koch, 1977, p. 165). The interrater reliability for the raters for the post-elevator was found to be $\kappa = .80$ (95% CI, .66 to .94), $p < .001$. The strength of this agreement could be classified as "substantial" since $\kappa > .61$ (Landis & Koch, 1977, p. 165).

Table 4: Mapping of categories of the elevator task to ordinal values for statistical analysis

Behavior Categories	**Ordinal Values**
Not participated (in the post-elevator task)	0
Disengagement	1
Individual attempt	2
Waiting	3
Reangagement	4

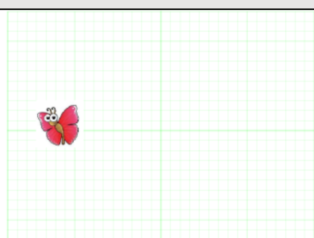
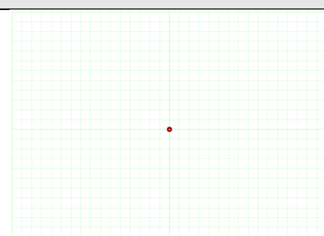
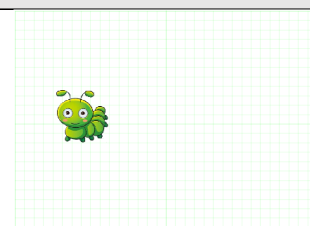
Phase 2: Standard Simon, joint Simon, go/no-go tasks

The test setups and design of stimuli in phase two were prepared similar to Saby et al.'s (2014) study. The children were seated approximately 40 cm away from the screen. Two button boxes were used to collect the responses (see Figure 7: Response Buttons). Children were asked to press the buttons with their palms. Children began to push the buttons in the practice trials. The laptop was positioned in the middle of the table and the buttons were positioned 25cm to the right and left with respect to the middle of the laptop, with the red button on the left and green button on the right. Each task consisted of four practice trials followed by twenty experimental trials. The practice trials consisted of the four possible stimulus combinations, that is, both stimuli were presented once in compatible and once in incompatible locations with respect to the associated response buttons. The children were informed that the first ones were practice trials and that the 'real game' was beginning after passing to the experimental trials. The visual stimuli used were a butterfly and a caterpillar (see Figure 7: Response Buttons) and the responses were given by pushing the left button upon seeing the butterfly and pushing the right upon seeing the caterpillar (with respect to the rules of the tasks).

Figure 7: Response Buttons (left) & Visual Stimuli (right)

The two stimuli were counterbalanced (see Table 1). The stimuli assigned to children in the GNG task and JST were always identical, that is the child always sat on the same side and responded to the same stimuli during these tasks. The experiment was run on OpenSesame (Mathot et al., 2012) software on a HP laptop with 19.5 x 30.5 cm (HxW) screen. OpenSesame was used both to run the experiment and collect the data from the response buttons. The collected data was the response times of participants pushing the buttons after seeing the stimuli and accuracy of the given responses. Stimuli appeared on the screen one after the other with fixation was presented between each trial. Trials were classified as compatible if the butterfly appeared on the left (because the rule requested to press left upon seeing a butterfly) and the caterpillar on the right (because the rule requested to press right upon seeing a caterpillar); incompatible when otherwise.

Table 5**:** The timing of the trials and example stimuli

Compatible Stimulus (max 2000ms)		Fixation (1000ms)		Incompatible Stimulus (max 2000ms)
				

The children were seated according to the tasks and were instructed about the rules. Before starting the experimental trials, the children were expected to answer three out of four of the practice trials correctly. Before each stimulus a fixation point was shown for 1000 ms. The stimulus was then shown for 2000 ms. In Table 5**:** The timing of the trials and example stimuli the sequence and duration of the fixation versus stimuli can be seen. The order of the stimuli was randomized by the software OpenSesame. Both butterfly and caterpillar stimuli had ten experimental trials each. Children had to press the right button when they saw the caterpillar and the left button when they saw the butterfly. Children were told to catch the butterfly/caterpillar by pressing the buttons with their palms.

Go/no-go Task

The child was seated at a table in front of one of the buttons which was 25cm away from the middle of the laptop screen (see Figure 8: Instances from the Go/no-go Task). The side was predetermined by the stimuli assigned to the child; left if it was the butterfly or right if it was the caterpillar. In the instruction which was given in line with the study by Saby et al. (2014), the children were told to catch one of the types (e.g. the caterpillar) as soon as they saw it on the screen by pressing the respective button (e.g. right for the caterpillar) and let the other type (e.g. butterfly) go by doing nothing and not pressing the button. The children were told to press the button with their left hand if they were seated on the left and right hand if they were seated on the right.

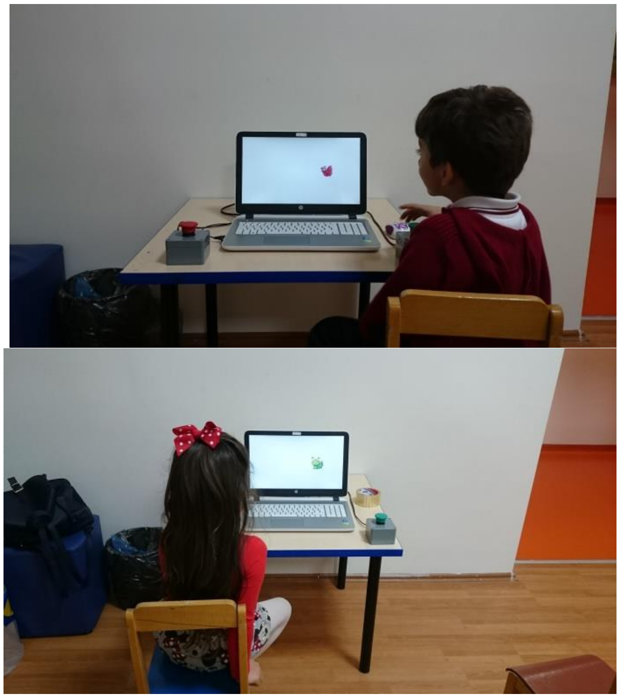


Figure 8: Instances from the Go/no-go Task

Joint Simon Task

The child was seated at a table in front of one of the buttons which was 25 cm away from the middle of the laptop screen (see Figure 9: An instance from a Joint Simon task). The side was predetermined by the stimuli assigned to the child; left if it was the butterfly or right if it was the caterpillar. The experimenter sat in front of the other button. In the instruction which was given in line with the study by Saby et al. (2014), the children were told to catch one of the types (e.g. the butterfly) as soon as they saw it on the screen by pressing the respective button and that the experimenter was going to catch the other type by pressing the other button. The children were told to press the button with their left hand if they were seated on the left and right hand if they were seated on the right. The experimenter also followed the same rule and pressed the button with the hand on the outer side, similar to previous studies (McClung, Jentzsch & Reicher, 2013).

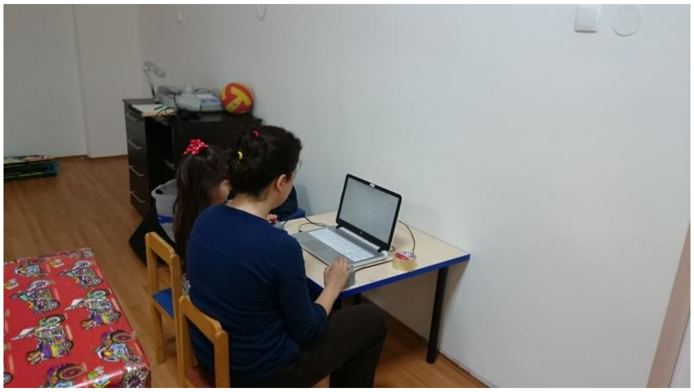


Figure 9: An instance from a Joint Simon task

Standard Simon Task

The child was seated at a table in the middle of the laptop screen; the two buttons were 25 cm left and right away from the middle of the screen (see Figure 10: An instance from a standard Simon task). In the instruction which was given in line with Saby et al. (2014), the children were told in order to catch the butterflies to press the left button and in order to catch the caterpillars they should press the right button.

Figure 10: An instance from a standard Simon task

Phase-3: Second Elevator

The procedure of Phase-3 was the same as in Phase-1; therefore, only a brief summary of the procedure is given below:

i. Participant's consent was taken to participate in the game again.

ii. Participant is re-introduced to the apparatus.

iii. ME and FE made demonstrations and gathered the toy three times while the FE was in the place of the child.

iv. FE stepped aside; the child was invited by nonverbal gestures while ME started acting in his role and awaited the child's engagement.

v. If the child did not attend to the task, verbal guidance was given.

vi. In trial 1, the target was gathered from the cylinder by performing complementary roles by ME and the child.

vii. Trial 2 was the same as trial 1.

viii. In trials 3 after the child engaged in the activity, ME remained in his place but stopped participating for ten seconds. The child's responses in the Interruption period were recorded.

ix. At the end of ten seconds, ME continued performing his role. If the child had disengaged, then he acted as in the beginning of the experiment (step 5).

x. Trial 4 was the same as trial 3.

Figure 11: Instance during elevator task when child is in role B pushing the cylinder upwards and ME is in role A grasping the object

CHAPTER 4

RESULTS

4.1. Preprocessing the Data of Phase Two

The data were preprocessed before being entered to SPSS. The preprocessing was done using Matlab software (2011). The processes that were applied are given below:

i. Correct variables were filtered from OpenSesame results.

ii. Practice trial results were deleted.

iii. Error trials were recorded, then deleted.

iv. Trials that have RTs smaller than 200 ms were also deleted, as they were considered as anticipations.

v. The trials not responded to were deleted and added to errors if they were supposed to be responded to.

vi. Mean and standard deviation (SD) of response times of each task was calculated.

vii. For JST, only the results of the children were calculated, the results of the experimenter were not included. The trials that were responded to but were no-go stimuli were counted as error.

viii. Trials which had RTs bigger than 'mean + 3SD' or smaller than 'mean – 3SD' were deleted.

ix. The means, error rates and SDs of compatible and incompatible trials were separately calculated.

x. A final data set was formed by combining all the processed data of each task so that each participant's results were represented in a row.

4.2. Results of Phase- Two

The results of the sequences were combined to form larger groups to see whether there was a Simon Effect in the JST in sequences where SST preceded JST but no SE in those sequences where JST preceded SST. The first group thus comprised the sequences A, B & D where JST precedes SST; the second group comprised the sequences C, E & F where SST precedes JST. This sequencing of SST and JST with respect to each other is shown with the ">" sign, which indicates that the task on the left hand side preceded the task on the right hand side (for example, SST>JST refers to JST following SST). Note that in both of the groups, there is a GNG task, which may intervene between the SST and the JST or the JST and the SST. In A, B & D this order is A; in C, E & F this order is E. In the group where JST>SST, A is included because the aim of the analysis of this group is to seek for the presence of the SE in JST when it does not follow SST. In the group where SST>JST E is included, likewise.

This combination of sequences was applied in order to increase the power of the analysis rather than looking at each group separately.

In the following statistical analysis, Levene's Test regarding homogeneity of variances was not taken into account since this test is claimed to be important when the group sizes are vastly different and in our study the group sizes were almost equal (Field, 2013).

Descriptive statistics and summary tables of ANOVA analyses are provided in the Appendix.

4.2.1 Combined Data Sets 1 (JST>SST) and 2 (SST>JST): Statistical Results and Discussion

One set of A, B, D was formed because in these sequences the JST preceded the SST as can be seen in Table 2 . This group is referred to as Set 1 (JST>SST). The remaining sequences C, E, F in Table 2 were combined respectively to form a united data set where the SST preceded the JST. This group is referred to as Set 2 (SST>JST).

Mean Response Time Analysis

Data were analyzed using a mixed-design ANOVA with two within-subjects factors of Task type (JST, GNG, SST) and Compatibility (compatible, incompatible) and a between-subject factor of Set (set 1 (JST>SST), set 2 (SST>JST)). Mauchly's test indicated that the assumption of sphericity had not been violated for the Task type factor, $X^2(2) = .310$, $p > .05$.

The main effects of Task type ($F(2, 122) = 101.81$, $p < .001$, $\eta_p^2 = .63$) and Compatibility ($F(1, 61) = 24.9$, $p < .001$, $\eta_p^2 = .29$) were found to have a significant effect on response time. The interaction between Task type and Compatibility was also significant ($F(2, 122) = 18.36$, $p < .001$, $\eta_p^2 = .23$). The three-way interaction between Task type, Compatibility and Set was not significant ($F(2, 122) = 1.25$, $p = .29$, $\eta_p^2 = .02$). The remaining interactions were also insignificant.

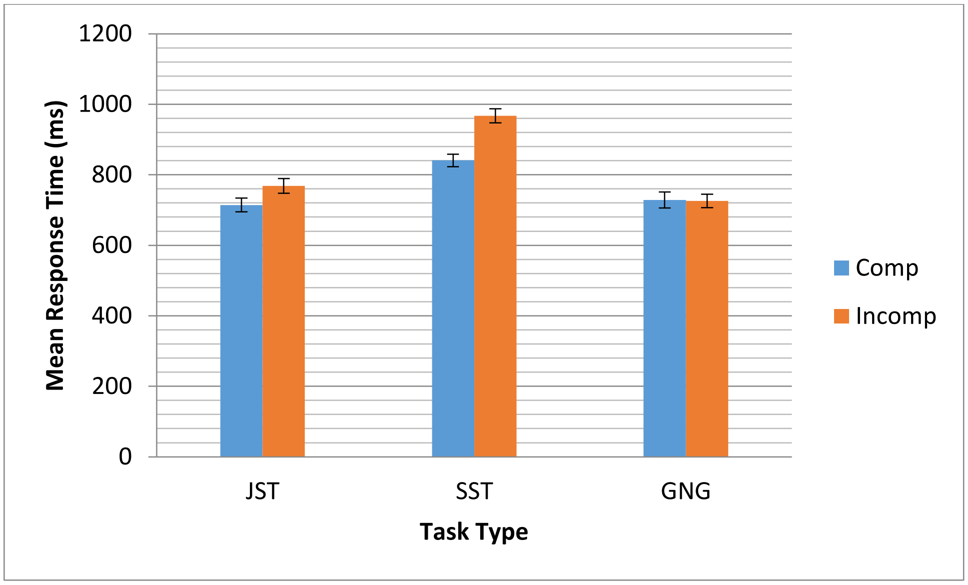


Figure 12: Bar graph of the interaction between Task Type and Compatibility. Error Bars represent Standard Error (*SE*)

The significant main effect Task type reveals the difference in response time between the three tasks. According to its effect size Task type had a high effect on response time. Planned comparisons (simple contrasts) were conducted with the GNG task taken as control condition, thus comparing JST and SST with GNG task. Simple contrasts showed that GNG task differed significantly from SST ($F(1, 61) = 177.52$, $p < .001$, $\eta_p^2 = .74$) but not from JST ($F(1,61) = 1.05$, $p = .31$, $\eta_p^2 = .017$). Alternatively, a Helmert contrast was carried out, comparing (1) GNG vs JST & SST and (2) JST vs SST. The first contrast was significant (test statistics) indicating that both Simon task conditions taken together differed from the GNG condition ($F(1,61) = 67.34$, $p < .001$, $\eta_p^2 = .53$). Importantly, the second Helmert contrast showed a significant difference between the JST and SST as well ($F(1,61) = 133.23$, $p < .001$, $\eta_p^2 = .67$). Mean response times in the SST were the highest (904.06 ms, *SE* = 17.21) followed by JST (741.35 ms, *SE* = 17.68) and GNG task (727.05 ms, *SE* = 19.25) eventually. The main effect of Compatibility showed that overall there was a significant difference between compatible and incompatible trials, such that compatible trials (761.19 ms, *SE* = 16.91) were responded faster than incompatible trials (820.45 ms, *SE* = 17.63). The interaction between Task type and Compatibility showed that the difference between compatible and incompatible response times (the Simon effect) differed significantly among tasks ($F(2,122) = 18.36$, $p < .001$, $\eta_p^2 = .23$) as can be observed from Figure 12: it was highest in the standard Simon (126.82 ms) task, considerably smaller in the JST (53.88 ms) and in the GNG task practically inexistent (-2.92 ms). Simple contrasts of this interaction among tasks yielded a significant difference among both tasks with respect to the GNG task (JST vs GNG, $F(1,61) = 5.90$, $p < .05$, $\eta_p^2 = .09$; SST vs GNG, $F(1,61) = 49.75$, $p < .001$, $\eta_p^2 = .45$). Alternatively, a Helmert contrast was carried out, comparing (1) GNG vs JST & SST and (2) JST vs SST. The first contrast was significant (test statistics) indicating that the Simon effect in both Simon task conditions taken together differed significantly from the GNG condition which showed no Simon effect ($F(1,61) = 27.32$, $p < .001$, $\eta_p^2 = .31$). Importantly, the second Helmert contrast showed a significant difference between the JSE and SSE as well ($F(1,61) = 10.70$, $p < .005$, $\eta_p^2 = .15$). The different size of the SE in the GNG task as compared to the two Simon tasks and, most importantly, between SST and JST suggests that participants behaved differently in these tasks. The three-way interaction Task type*Compatibility*Set, revealed that there was no significant difference between response time in compatible versus incompatible trials of task types among Set 1 and Set 2. It can be observed from Figure 13 that the difference between incompatible and compatible trials of JST was larger in Set 2 with respect to Set 1 (65.49 ms vs 42.28 ms), however this difference was statistically insignificant. Thus, the hypothesized sequence effect was not observed. The between-subjects factor Set was not significant either, thus overall participants in both Sets responded similarly, in terms of response times.

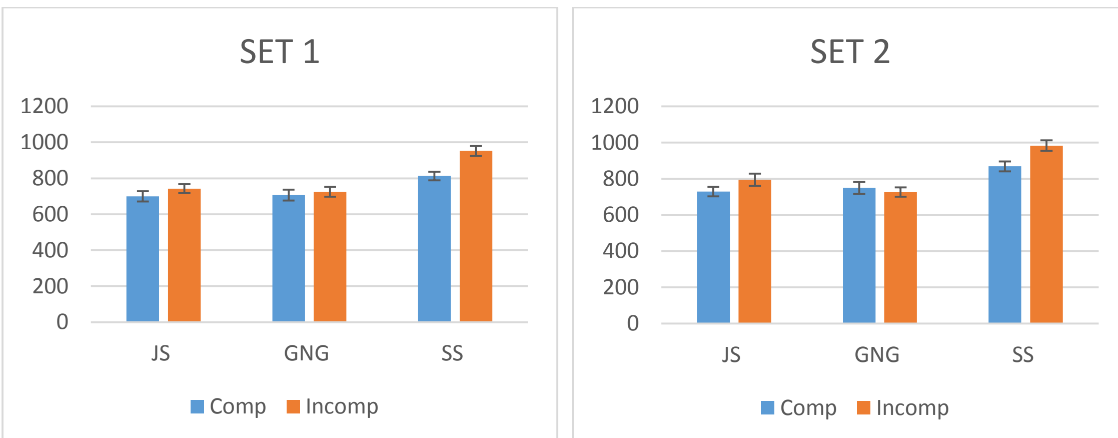
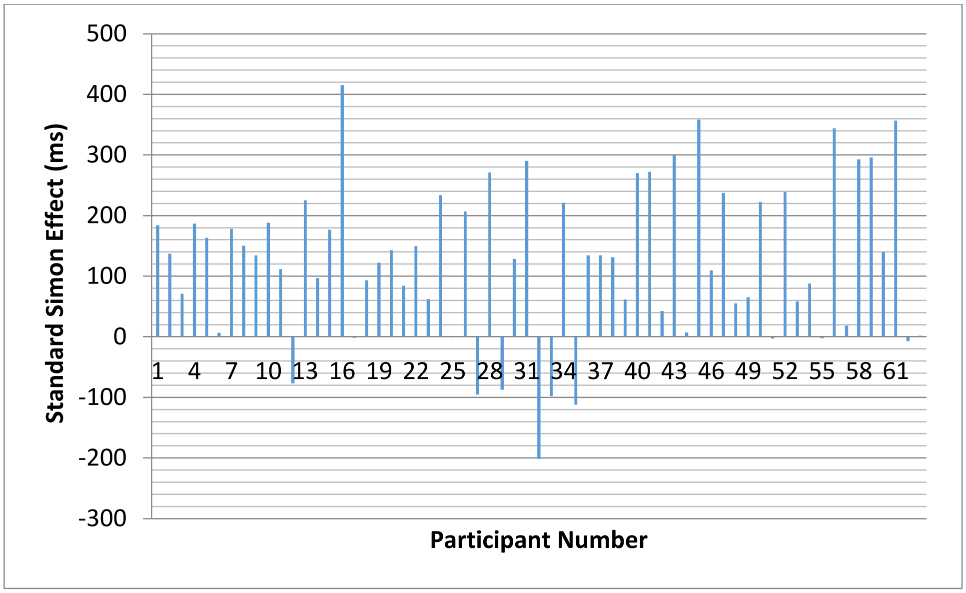


Figure 13 : Bar graph of Mean RT of the trials of combined data sets, Set 1 (JST>SST) and Set 2 (SST>JST). Error Bars represent Standard Error (*SE*)

In Figure 14: Bar graph of participants' SSE (top) and JSE (bottom) sizes, the differences in RTs between incompatible and compatible results (SE) in individual children are shown. It can be observed that although the JSE of some children was bigger than the JSE shown by other children, the significant difference between SSE and JSE was not due to inter-individual differences among children but rather an overall difference in response between the tasks.



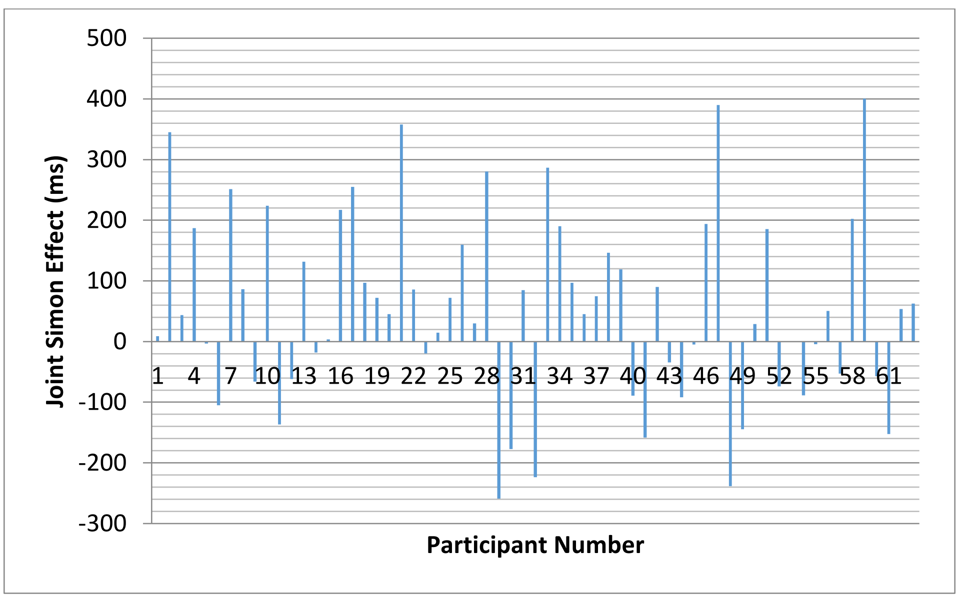


Figure 14: Bar graph of participants' SSE (top) and JSE (bottom) sizes in RTs

Error Rate Analysis

Data were analyzed using a mixed-design ANOVA with the within-subjects factors of Task type (JST, GNG, SST) and compatibility (compatible, incompatible) and the between-subject factor Set (set 1 (JST>SST), set 2 (SST>JST)). Mauchly's test indicated that the assumption of sphericity was violated for Task type, $\chi^2(2) = 34.44$, $p < .001$ and for the interaction of Task and Compatibility χ^2 (2) = 14.29, $p < .01$. Therefore, Greenhouse-Geisser corrected degrees of freedom (*df*s) are reported in the *F*-statistic.

The main effect of Task type ($F(1.39,84.92)= 27.94$, $p < .001$, $\eta_p^2 = .31$) and Compatibility ($F(1,61)= 22,14$, $p < .001$, $\eta_p^2 = .27$) were found to be significant. Also, the interaction of Task type and Compatibility was significant ($F(1.65,100.66)=23.81$, $p < .001$, $\eta_p^2 = .28$). The three-way interaction between Task type, Compatibility and Set was insignificant ($F(1.65,100.66)=2.04$, $p = .14$, $\eta_p^2 = .03$), along with the remaining interactions. The between-subjects effect of Set also did not have a significant impact on errors when taken into consideration alone ($F(1,61)=2.81$, $p = .099$, $\eta_p^2 = .044$).

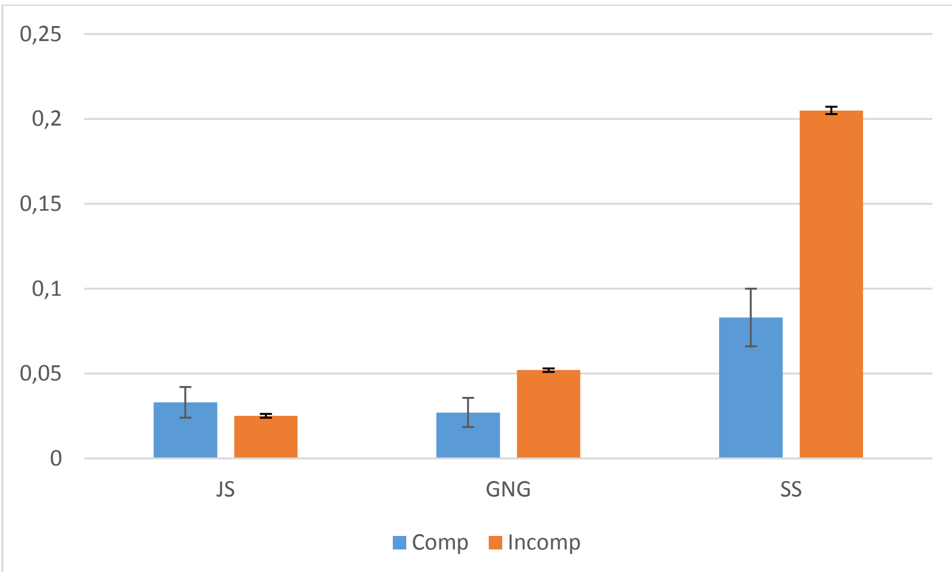


Figure 15: Bar graph of the interaction between Task Type and Compatibility. Error Bars represent Standard Error (*SE*)

The significant main effect Task type reveals the difference in error rates between the three tasks and according to its effect size it had a high influence on error rates. Planned comparisons (simple contrasts) were conducted with the GNG task taken as control condition, thus comparing JST and SST with GNG task. Simple contrasts showed that GNG differed significantly from SST ($F(1, 61) = 27.16$, $p <.001$, $\eta_p^2 = .31$) but not from JST ($F(1,61) = 1.11$, $p = .30$, $\eta_p^2 = .018$). Alternatively, a Helmert contrast was carried out, comparing (1) GNG vs JST & SST and (2) JST vs SST. The first contrast was significant indicating that overall error rates in both Simon task conditions taken together differed significantly from the GNG condition ($F(1,61) = 13.90$, $p < .001$, $\eta_p^2 = .18$). Importantly, the second Helmert contrast showed significant difference between the JST and SST as well ($F(1,61) = 36.5$, $p < .001$, $\eta_p^2 = .37$). Error rates in the SST were the highest (.14, *SE* = .008) followed by GNG (.04, *SE* =.008) and JST (.03, *SE* = .006) eventually. The main effect of Compatibility showed that overall there was a significant difference between compatible and incompatible trials, such that compatible trials (.09, *SE* =.01) were responded more accurately than incompatible trials (.05, *SE* = .007). The interaction between Task type and Compatibility, which can be seen in Figure 15, showed that the error rate between compatible and incompatible response times differed among tasks: it was highest in the standard Simon (.12) task, smaller in the GNG task (.025) and in the JST practically inexistent (-.01). Simple contrasts of this interaction among tasks were significant (JST vs GNG, $F(1,61) = 5.19$, $p < .05$, $\eta_p^2 = .08$; SST vs GNG, $F(1,61) = 18.23$, $p < .001$, $\eta_p^2 = .23$). Alternatively, a Helmert contrast was carried out, comparing (1) GNG vs JST & SST and (2) JST vs SST. The first contrast was not significant ($F(1,61) = 3.88$, $p = .053$, $\eta_p^2 = .06$) indicating that overall the difference in error rates between compatible and incompatible trials in both Simon task conditions taken together did not differ significantly from that of the GNG condition. Importantly, the second Helmert contrast showed a significant difference between the JST and SST also ($F(1,61) = 40.05$, $p < .001$, $\eta_p^{2} = .40$). The insignificant three-way interaction Task type*Compatibility*Set, revealed that there was no significant difference between error rates in compatible versus incompatible trials of task types among Set 1 and Set 2. It can be observed from Figure 16: Bar graph of Error Rates of the trials of combined data sets 1 (JST>SST) and 2 (SST>JST). Error Bars represent Standard Error (*SE*). that the error rate between incompatible and compatible trials of JST was larger in Set 2 with respect to Set 1 (.04 vs .02), however this difference was statistically insignificant. Thus, the hypothesized sequence effect was not observed. The between-subjects factor Set was not significant either, thus overall participants in both Sets responded similarly, in terms of error rates.

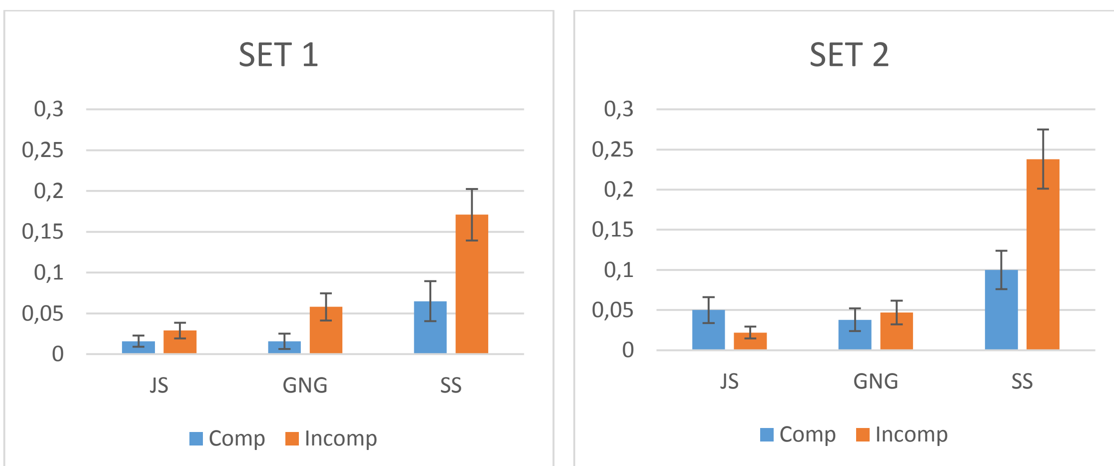


Figure 16: Bar graph of Error Rates of the trials of combined data sets 1 (JST>SST) and 2 (SST>JST). Error Bars represent Standard Error (*SE*).

4.2.2 School-wise Comparison using Response Time Measurement

In order to investigate whether there was difference between the performance of participants from different preschools, response time data were analyzed using a mixed-design ANOVA with the within-subjects factors Task type (JST, GNG, SST), Compatibility (compatible, incompatible) and the between-subject factor of School (1, 2, 3, 4) since the experiments were conducted in four different preschools. Mauchly's test indicated that the assumption of sphericity was not violated for the main effect of Task type, $\chi^2(2) = .07$, $p > .05$ but it was violated for the interaction of Task type and Compatibility, $\chi^2(2) = 7.25$, $p < .05$, therefore, Greenhouse-Geisser corrected degrees of freedom (*df*s) are reported in the *F*-statistic.

The main effects of Task type ($F(2, 118)= 58.24$, $p < .001$, $\eta_p^2 = .50$) and Compatibility ($F(1, 59)= 7.08$, $p < .05$, $\eta_p^2 = .11$) were found to have a significant effect on response time. The interaction between Task type and Compatibility was also significant ($F(1.79, 105.59)= 9.78$, $p < .001$, $\eta_p^2 = .14$). The interaction of Compatibility and School was significant ($F(3, 59)= 2.80$, $p < .05$, $\eta_p^2 = .12$), meaning that the response time differences between compatible and incompatible trials (Simon effects) differed with respect to schools (in descending order): school-2 (87.639 ms), school-1 (68.364 ms), school-4 (2.052 ms) and school-3 (-7.344). The "no effect" found in school-3 and school-4 must be noted since it shows that the response times in compatible trials vs the incompatible trials were indistinguishable, which was not expected (see Figure 17). The interaction between Task type, Compatibility and School was not significant ($F(5.37,105.59)= 1.07$, $p = .38$, $\eta_p^2 = .05$). The remaining interactions were also not significant. The between-subjects factor School also did not show any significant effect ($F(3,59)= .95$, $p = .42$, $\eta_p^2 = .05$).

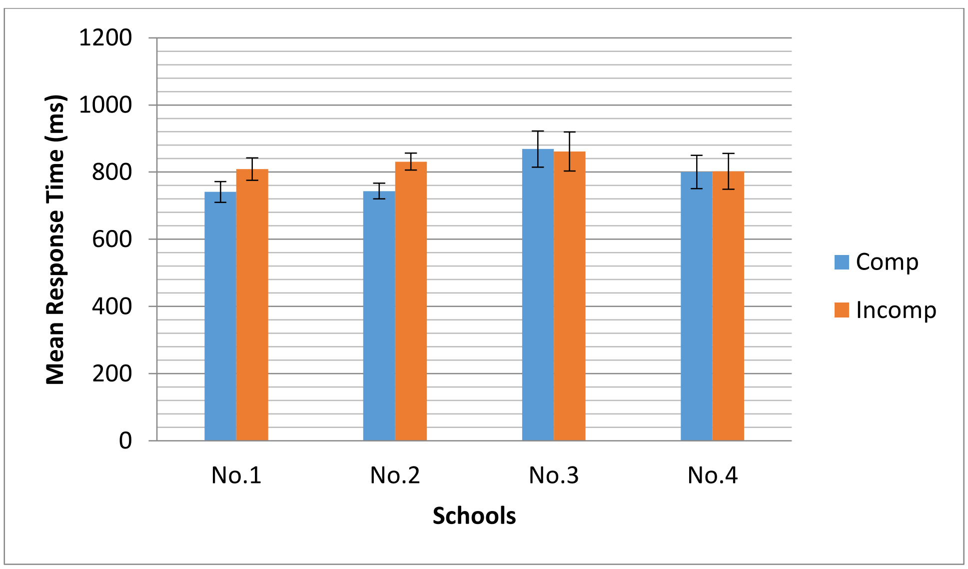


Figure 17: Bar graph of the interaction of the factors Compatibility and School. Error Bars represent Standard Error (*SE*).

4.2.3 Stimuli-wise (Hand-wise) analysis

Mean Response Time Analysis

In the joint Simon and GNG tasks the children were told the push the response buttons with their outer hands (i.e. when the assigned stimulus was "butterfly" they pushed the button with their left hand and when it was "caterpillar" they pushed it with their right hand because the butterfly response button was on the left and the caterpillar button was on the right). A mixed ANOVA was conducted to investigate whether there was a statistical difference in response times of children who responded with their left or right hands in the joint Simon and GNG tasks. In particular, the interaction between Hand and Compatibility is crucial, since this interaction would show whether the presence of Simon effect was dependent on the hand used or not. The within-subjects factors were Compatibility (compatible, incompatible), Task type (JST, GNG) and the between subjects factor was the hand (left, right) used in JST and GNG tasks. Since both hands were used during the SST, this task was not analyzed.

The interaction between Task type and Compatibility was significant ($F(1, 61)= 5.82$, $p < .05$, $\eta_p^2 = .09$). The interaction of Task type and Hand was significant ($F(1, 61)= 5.54$, $p < .05$, $\eta_p^2 = .08$). This indicates that response times given by the left/right hand differed with respect to task type. In the JST, right hand responses were faster (721.83 vs 760.90 ms) whereas in the GNG task left had responses (715.39 vs 739.44 ms) were faster (see Figure 18). The interaction between Task type, Compatibility and Hand was not significant ($F(1,61)= .00$, $p = .10$, $\eta_p^2 = .00$). The remaining interactions were also not significant, most notably the Hand and Compatibility interaction ($F(1, 61)= .34$, $p = .56$, $\eta_p^2 = .01$). This insignificant interaction Hand*Compatibility shows that the difference between compatible and incompatible responses was not dependent on whether the participants responded with the right or left hand. The between-subjects factor Hand also did not show significant effect overall ($F(1, 61)= .05$, $p = .83$, $\eta_p^2 = .001$).

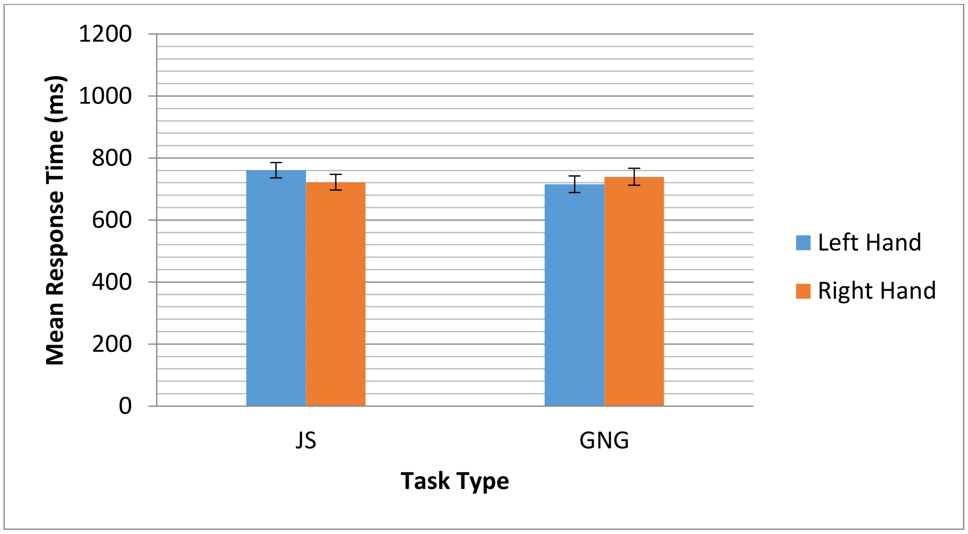


Figure 18: Bar graph of the interaction of the factors Task type and Hand. Error Bars represent Standard Error (*SE*).

Error Rate Analysis

A mixed ANOVA was conducted to investigate whether there was a statistical difference in accuracy of children who responded with their left or right hands in the joint Simon and

GNG tasks. The within-subjects factors were Compatibility (compatible, incompatible), Task type (JST, GNG) and the between-subjects factor was Hand (left, right) used in JST and GNG task.

The interaction between Task type and Compatibility was significant ($F(1, 61)= 5.201$, $p < .05$, $\eta_p^2 = .079$). The interaction of Task type and Hand was also significant ($F(1, 61)= 4.236$, $p < .05$, $\eta_p^2 = .065$). This indicates that the number of incorrect responses given by the left/right hand differed with respect to task type. In both tasks, the left-handed responses had higher error rates as compared to the right-handed responses (JST: .031 vs .027; GNG: .061 vs .018), however the difference was larger in the GNG task (see Figure 19). The interaction between Task type, Compatibility and Hand was not significant ($F(1,61)= .005$, $p = .942$, $\eta_p^2 = .000$). The remaining interactions, most importantly, the interaction between Hand and Compatibility, were also not significant. The between-subjects factor Hand also showed a significant effect ($F(1, 61)= 6.912$, $p < .05$, $\eta_p^2 = .102$). This suggests that even when other variables are disregarded only the change in hand used for the response yields a significant effect on error rates. Left-handed responses had significantly higher error rates (.046, *SE*= .006) than right-handed responses (.023, *SE*= .006).

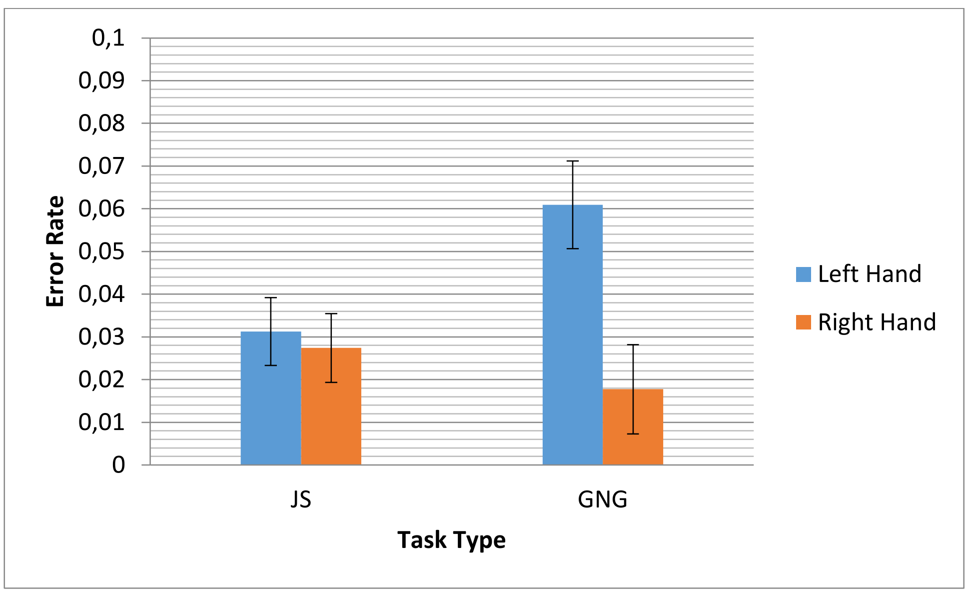


Figure 19: Bar graph of Error Rates of the interaction between Task type and Hand. Error Bars represent Standard Error (*SE*).

4.3. Results of Phase – One and Three Elevator Tasks

To search for a relationship between the behaviors observed in the elevator tasks conducted before and after Phase-two and the JSE, Spearman correlations were calculated. The variables entered to the Spearman's test were as follows: JSE (the difference in response time between incompatible and compatible trials), pre- elevator score (the score given to the elevator task conducted before Phase-two), post-elevator score (the score given to the elevator task conducted after Phase-two), role (role of the participant; A or B), and change in score (if there was a change in behavior between pre-elevator and post-elevator task; 1 if there was a change in behavior, otherwise 0).

Table 6: Descriptive Statistics of Elevator Task

		n	%
Pre_elevator_score	1	4	6.9
	2	2	3.4
	3	26	44.8
	4	26	44.8
Post_elevator_score	0	9	15.5
	1	2	3.4
	2	3	5.2
	3	26	44.8
	4	18	31.0
Role	A	31	53.4
	B	27	46.6
Change_in_Score	Different	35	60.3
	Same	23	39.7

Table 7: Spearman's Correlations Results of Elevator Task. BCa bootstrap 95% CIs reported in brackets.

	Pre-elevator_ Score	**JSE Size**	**Post-elevator Score**	**Role**	**Change in Score**
Pre-elevator Score	1	.12 [-.17 .36]	.37** [.06 .63]	-.28* [-.550 .025]	.14 [-.12 .41]
JSE Size	.386	1	.00 [-.27 .26]	.114 [-.15 .36]	-.09 [-.35 .18]
Post-elevator Score	.005	.981	1	-.31* [-.56 -.06]	-.38** [-.61 -.12]
Role	.036	. 396	.020	1	.12 [-.13 .36]
Change in Score	.296	.504	.004	.37	1

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

The behavioral scores of the children in the elevator tasks can be seen in Table 6: Descriptive Statistics of Elevator Task. It can be observed that the distribution of scores is not scattered evenly, but rather clustered in some categories, thus the behavioral variance was low. The statistical analysis yielded the results shown in Table 7: Spearman's Correlations Results of Elevator Task. BCa bootstrap 95% CIs reported in brackets. where above the diagonal the correlation coefficients with symbols indicating different levels of significance and bias corrected and accelerated bootstrap confidence intervals in square brackets are given. Below the diagonal the exact values *p*-values are given. Pre-elevator task behavior was significantly related with post-elevator behavior, r_s= .366, 95% BCa CI [.062 .634], p= .005, and the role given to the participant r_s = -.276, 95% BCa CI [-.550 .025], p= .036. The post-elevator task behavior was also significantly related with the change of behavior after Phase-two, r_s = -.377, 95% BCa CI [-.608 -.123], p= .004 and the role given to the participant r_s = -.305, 95% BCa CI [-.5466 -.064], p= .020. One of the main research questions of the current study was whether the JSE found in Phase-two would be related to children's pre-elevator task behavior. It was found insignificant, r_s = .116, 95% BCa CI [-.166 .360], p= .386. The research questions regarding Phase-three were as follow: firstly, would the JSE be related with the behavior exhibited in the post-elevator task? This relation was found to be insignificant, r_s = -.003, 95% BCa CI [-.273 .255], p= .981 as well. Secondly, would the SE of participants whose behavior changed in the post-elevator with respect to the pre-elevator task be related to this change? This and all other relations were also insignificant.

CHAPTER 5

GENERAL DISCUSSION

The JST is one of the prominently used spatial compatibility task in adults, to seek the existence of co-representation of a co-actor's task/action and the factors that modulate this effect. There are social (task co-representation, (Sebanz et al., 2006)), non-social (response coding, (Guagnano et al., 2010)) and heterogeneous (referential coding, Dolk et al., 2013) accounts that aim to explain the nature of the wide range of findings from the studies conducted. In order to comprehend the origins and mechanisms underlying joint action entirely, investigating its mechanisms in children and their development is a necessary yet not thoroughly probed subject. An investigation of co-representation using the JST in 5-year-olds was first undertaken by Saby et al. (2014). They found a SE in the JST and claimed that co-representation was already fully developed in 5-year-olds. However, in their study the JST was always preceded by a SST. Results of a "set effect" in adult studies with the Simon task and the GNG task paradigm is well known (Ansorge & Wühr, 2004, 2009). Due to this lack of counterbalancing among tasks the occurrence of a SE in the JST in Saby et al.'s study may have resulted from this transfer of spatial coding of responses from the SST to the JST. However, a JSE might not be found in tasks where the JST does not follow a SST. Thus, Saby et al.'s methodological procedure precluded any precise conclusions. The primary aim of this thesis was to examine the true occurrence of the JSE in children – after counterbalancing the experiments in Saby et al. (2014). A second aim of the thesis was whether this effect was correlated with the motivation of participants towards cooperation.

The experiments in Phase 2 (the Simon tasks and the GNG task) were conducted to investigate the true occurrence of a JSE in 5-year-olds and whether the results would be in line with the action co-representation account (Sebanz et al., 2003, 2006). Participants performed a SST, a JST and a GNG version of the Simon tasks in a counterbalanced order. That is, they were responsible for both stimuli in the SST, whereas they shared the S-R responsibility with the experimenter in the JST and in the GNG task they only responded to one stimulus. The logic behind these experiments was the following: If 5-year-olds can already co-represent a co-actor's task then a SE should be observed in all JSTs regardless of following a SST or not and the size of the SE of participants should be the same among JST and SST. Also, these two tasks should be different from the control condition, that is, the GNG task results. However, if the SE in the JST was due to a set effect, it should not be observed in participants who did the JST prior to the SST.

The response time analysis showed a significant difference among tasks which is similar to previous child and adult studies (Sebanz et al., 2006; Saby et al., 2014). This effect was due to the increased response times in the SST with respect to the JST and GNG tasks, which is a result of cognitively higher task demands in the SST. In the current literature, RTs of JST are generally smaller than RTs in the GNG task although this was not the case in our study. However, the difference is insignificant among the RTs of these tasks which is in line with adult studies (Dolk & Prinz, 2016). This similarity is considered to be an evidence that shows that JSE and SSE are resultant of different interference effects and SST and JST are not functionally equivalent (Dolk & Prinz, 2016). A SE was found in all SSTs, as expected according to previous studies conducted with young children (Davidson et al., 2006; Saby et al., 2014). A SE was also found in the JST regardless of its sequencing with respect to the SST. This clearly rules out our alternative hypothesis, namely that the SSE found by Saby et al. (2014) was due to a "set effect". However, the size of the SE found in SST and JST differed significantly, suggesting that acting alone and taking care of two stimuli was different in nature from taking turns and sharing the S-R responsibility with a co-actor. This difference was not due to inter-individual differences of children, but an overall difference in responses to respective tasks (see Figure 14). As for the error analysis, the results showed that error rates were significantly different between compatible and incompatible trials of SST and GNG task, but not for the JST. Hence, the significant functional difference between SST and JST was also observable in the error analysis. The increase in errors when cognitive load is increased, in this case in the SST, was expected with respect to previous studies with children (Davidson et al., 2006; **S**aby et al., 2014). The error rates in GNG task being larger than JST is similar to the study by Saby et al. (2014).

In summary, both the RT and error rate dependent variables showed that the SST differs from both the GNG task and the JST and the differences between the GNG task and the JST are statistically insignificant. Thus, only for SST both variables clearly point to a conflict at the response selection level (i.e. the classical SE). As expected there was no effect in the GNG task in RTs, but there was a difference between compatible and incompatible trials in the error rates. For the JST, there was a significantly smaller SE in RTs with respect to SSE and no effect was observed in the error rates. Error rates should always be consulted in developmental studies differing from adult studies because children make more errors, whereas adults increase the RT when the task demand is increased to avoid making errors (Davidson et al., 2006). Thus, error rate is a crucial dependent variable which actually carries important supporting or divergent information besides the RT data in studies with children. Combining the response times and error analysis, the difference in generality and magnitude between the SSE and JSE, the functional difference between the SST and the JST is apparent. The task co-representation account claims that the full task is represented in the representation schema of both participants hence fails to explain this functional difference (Sebanz et al., 2003). The spatial coding account explains this difference by claiming that the underlying reason of the JSE is the result of facilitation of compatible responses rather than an interference effect occurring in the incompatible trials (Guagnano et al., 2010). However, this account fails to explain the similarities between the GNG task and the JST and also the modulation of the JSE with respect to social factors in the adult literature. Hence, our results are interpreted as supporting the referential coding account which views the JST as a “joint Go/NoGo task” thus accounting for the similarities between the JST and GNG task on the one hand and the differences between the JST and SST on the other hand. In addition, referential coding also explains how this interference effect caused by the conflict in response selection in incompatible trials can be modulated by social factors which affect the degree of self-other integration when the labor is divided with a co-actor. The referential coding account as instantiated in the TEC claims that actions are coded with respect to their perceived features and perceived outcomes. Who the agents of these actions are is also an inherent feature in these codes (Hommel, 2009; Prinz, 2015). Fully representing the task of the co-actor is not necessary, yet the presence of the other may shape and enhance one’s own representations (Prinz, 2015). Consequently, the actions conducted by two actors in the JST are very similar in perceptual nature, thus are coded by exactly the same codes except the performing agents and their location features. Hence, when both actions are activated (with any salient event in the case of JST), the actor should weight the distinctive features in order to separate between the alternative actions and give the correct response. This scenario leads to a SE when an event occurs that activates the alternative action via social (a co-actor) or non-social events (Japanese waving cat; Dolk et al., 2013). The similarity in features between the actor and the co-actor can modulate the extent of the SE effect. Consequently, as the actor perceives the co-actor more similar to her/himself, self-other integration is facilitated and the number of shared features among event codes is increased. This high similarity among actor and co-actor leads to a relative emphasis on the location feature (left, right) in the response code as the only feature that remains to discriminate between the two actions (pressing left or right) or agents (e.g., actor sitting left; co-actor sitting right), respectively. Importantly, spatial response features (left or right) and agent features (actor or co-actor) are systematically confounded in the JST (Prinz, 2015) since the actor is sitting at one side (e.g., left) and the co-actor is sitting on the other side (e.g., right). As a consequence, the JSE is increased (Dolk et al., 2014; Ruissen, & de Bruijn, 2016; Hommel et al., 2009; Memelink & Hommel, 2013). Thus, the account suggests that the SE is not a binary effect but a continuous one that could be modulated with social factors that affect how the participant perceives the co-actor (or any salient event) and attends to that other actor or event (Japanese waving cat at the opposite location). The spatial features of the alternative action may be emphasized less as the difference between codes get larger and thus the weight of spatial feature are decreased leading to an absence or attenuation of the SE in a JST (Dolk et al., 2014; Hommel et al., 2009; Ruissen & de Bruijn, 2016).

On the other hand, the doubt on the occurrence of the JSE in Saby et al. (2014) being due to a “set effect” (Ansorge & Wühr, 2004, 2009) was not supported by our results. In addition to the lack of such a sequence effect found for the JST, the GNG task performance was not affected either when preceded by the SST. That is, no SE was observed in the GNG tasks neither when it preceded the SST nor when it followed it. A SE in a GNG task when it follows a SST has been observed in adults (Ansorge & Wühr, 2004, 2009), however it was not found in the present study with children. This result suggests that unlike adults, children did not transfer the S-R rules formed in the SST to the GNG task.

This result is consistent with the findings in the study of Davidson et al. (2006) which showed that adults change their default response when the same type of inhibition was presented throughout the block (incompatible single-task block) whereas young children did not exhibit this behavior, thus showed a SE among single-task blocks also. Thus, adults may be changing and ‘keeping’ in mind the rules of tasks aiming to enhance their performance, which in some cases could lead to decreasing it.

The analysis whether the hand used affected the Simon effect (in terms of RTs and error rates) showed negative results, making the results of this study more reliable and in line with adult studies (Seibold et al., 2016). Different from adults’ results a general advantage of RT was not observed for the dominant hand (assuming for a majority of the children it is the right hand), however, an advantage was observed in terms of error rates. Children made less mistakes with the right hand as compared with the left hand. The results may be due to the differences of experience of adult’s vs children. Children who have not yet used their dominant hand as much as adults may not yet have fully formed a bias towards the dominant hand. Also, the interaction of task (GNG task, JST) was observed for both dependent variables (RTs and error rates), where the right hand RTs were faster in JST whereas left hand responses were faster in the GNG task. As for the error rates, left handed responses always yielded more errors but this was more pronounced in the GNG task. This interaction was not expected and is not addressed in the literature, thus more studies should be conducted in order to explain it. A handedness comparison should also be done in SST in future studies, since it would also provide more insight into the pattern observed in the JST and GNG tasks.

The school analysis showed a difference in spatial compatibility performance of schools which was unexpected. The difference was due to the lack of a SE in two of the four schools. There was no observable difference between the schools or the students that would account for the observed difference in SE. In a recent study by Milward et al. (2017), showed that the ability to avoid interference effect could be predicted by the individual differences in ToM and inhibitory control. Also, the number of students from these schools were relatively small, hence the results may not be representative and further research must be conducted if these results are correlated with any aspect of the schools.

The studies conducted in Phase 1 aimed to find out whether a cooperativeness index, in the Elevator tasks (Warneken et al., 2006) would show any correlation with the SE found in the JST. Children’s behavior in the interruption period was taken as an indicator of their motivation to cooperate. It was hypothesis that if the JSE was a result of social representations, then this indicator could be correlated with the extent of JSE. The elevator task was also performed after the spatial compatibility tasks for a second time (Phase 3) to find out whether both the cooperation index and the change in the cooperation index after the JST was correlated to the JSE of Phase 2. The results showed no correlation, however, neither between the cooperation indexes prior nor after the Simon tasks and the JSE in Phase 2. Neither was there any correlation between the JSE and children who changed their behavior in Phase 3 with respect to Phase 1. The hypothesis in these experiments was based on the underlying assumption that the individual differences in children’s motivation to cooperate could be reflected through their behavior in the interruption period of the elevator task. In the studies by Warneken et al. (2006; 2012) which contained such interruption periods, 18-, 24-, 21- and 27-month-old children produced reengagement attempts almost equally often. The difference in behavior did not change with respect to age, but changed only when the co-actor was unable to continue to cooperate instead of being unwilling. Therefore, the lack of correlation may be because children at the age of 5-years had already attained a “high ‘baseline’ level of joint action readiness” (Saby et al., 2014) and thus this experimental paradigm might be insensitive to address individual differences of older children’s motivation to cooperate.

CHAPTER 6

CONCLUSION

In this thesis, we investigated whether the occurrence of a SE in a JST in children, as found in the study of Saby et al. (2014), was valid even when the JST did not follow the SST. Moreover, various studies showed that the JSE was dependent on social factors. Similarly, in this study, we also explored whether individual motivational differences to collaborate among children was correlated with the size of the JSE. However, no such relation was found, suggesting that the mechanisms operating in the JST in children were not completely social in nature or, alternatively, that the collaboration task was not suitable for the age range of the children in this study.

The results of the compatibility tasks showed a Simon effect in the SSTs in any sequence, as expected. Also, in accordance with our expectations no Simon effect was found in the GNG tasks. However, a Simon effect which was smaller than the Simon effect of the SST was found in the JST regardless of sequence (SST>JST or JST>SST). This result was consistent with the study of Saby et al. (2014). Consequently, our results supported the results of their study (Saby et al., 2014) that is, even when the methodological confound in their study was taken care of, the JSE continued to exist. However, our findings point to important qualifications of this general result, in terms of the extent and generality of the JSE. The JSE was significantly smaller than the SSE in terms of response times and it was literally absent in terms of error rates while it was clearly visible in the standard ST. In terms of theoretical accounts, our results were interpreted from a different perspective as compared to Saby et al. (2014). Their interpretation assumed the co-representation account of the JSE in adults and claimed that co-representation was fully developed in preschoolers as well. Nevertheless, we did not take this explanation for granted due to various studies conducted with adults in the meantime which both the co-representation and the spatial coding accounts fail to explain. Thus, we interpreted out results in accordance with the referential coding account. The advantage of the referential coding account is that (1) it allows for the explanation of the functional difference observed between standard and JSTs found in our study and (2) explains how the JSE could be modulated by social factors in addition, e.g., the perceived similarity between actor and co-actor.

The second aim of the study was to investigate a possible correlation between children's motivation towards cooperation and the size of the JSE they exhibited. No significant correlation was found between these results, though. This result is consistent with the referential coding account for the JST since this result suggests that the Simon effect might not necessarily be modulated by the motivation towards cooperation. Another possible explanation could be that the elevator task used was not sufficient to determine the individual differences of children's motivation to cooperate in this age range. A prior collaborative task had also been performed before the compatibility tasks in the study by Saby et al. (2014), yet, they also did not find a difference in the extent of the JSE of children who collaborated with a partner and those who did not. More studies should be conducted to understand the factors that modulate the JST in children. As referential coding suggests differences in the extent of Simon effect could be observed when participant's self-co-actor integration are modulated. Thus, it might be predicted that two children performing the task together might enhance the joint SE, as compared to one child and one adult collaborator, as in the present study. Consequently, studies aiming to test these assumptions from a developmental aspect would be beneficial in understanding the nature of referential coding, more generally put, event codes, in children.

To conclude, this study is the first study to conduct JSTs, SSTs and GNG tasks in a counterbalanced manner with preschoolers. The results follow the current literature and add a developmental study to the set of adult studies supporting the referential coding account. Since the current study is one of the first studies to investigate the JSE in children, determining its developmental pattern may require even further studies. Also, more studies with children using JSTs need to be conducted to judge more precisely the role of social factors that have been shown to modulate the JSE in adults. These results would then enhance the trend in developmental research to use the JST as an indicator showing that similarity among agents and events modulate the degree of self-other integration in social context (Dolk et al., 2014).

Limitations of the Study

One main limitation of this study concerns the inefficiency of the cooperation task to yield any correlations with the JST. Specifically, children's experiences in the interruption period of the elevator task might have hindered any correlation to emerge. The interruption periods during which children's cooperation index was determined, caused frustration in some of the children. A total of nine participants did not want to 'play' the elevator task again after phase 2. Although the experimenter involved in the elevator task and in the JST was different, both experimenters were in the room during the interruption period when the child was confused and tried to make sense for the disengagement of ME (experimenter involved in elevator task). Almost all the children looked at ME's eyes at least once (95%) awaiting an explanation for his behavior and some of them also looked at FE (experimenter involved in the JST). However, the cooperative behavior of the children after Phase 2, although decreased, was still high, hence this effect was probably not significant enough to affect JSE.

Another limitation could be the different environments provided by each school for the experimenters. Although all schools allocated a room that was available and quite for the experiments, it was not possible to control all the conditions (the level of noise, available space) which were varying between them.

Also, the number of participants in the sequences alone was not enough to make a grand analysis with all of the six sequences as a between-subject factor. This was the main reason for combining three sequences into one, depending only on whether JST>SST or SST>JST, in order to achieve a stronger statistical analysis.

Lastly, increasing the number of trials in the compatibility tasks would be beneficial. In this study, we chose these numbers and setups same as the study of Saby et al. (2014) so that the results would be easily comparable. However, due to the low number of trials error rates were also low. If the trials were higher error rates would be higher and their analysis would be more reliable.

Future Studies

Due to the mentioned limitations, further studies could search for a correlation of the extent of JSE with children's motivation to cooperate with a different task that could be better in seeking this individual aspect more precisely and it would be beneficial if this task does not create frustration or such negative emotions in the children. For example, a task that measures the enthusiasm to start collaborating rather than doing the task alone could be evaluated and used similarly in this procedure in place of the elevator task.

In our study, the children performed the JST with the adult experimenter and the Simon effect was smaller than the effect found in the SST, similar to the literature. However, the difference might be caused by the fact that the adult experimenter was considered rather dissimilar from themselves also. Hence, future studies could also have the children perform the JST with another child. These studies would enlighten the underlying reasons of the difference of SEs in standard vs joint tasks. This study could also involve preliminary tasks where children are separated in groups and performing jointly or competitively. Then instructing them to perform JST with in-group and out-group members and seek whether there would be a difference.

Another interesting study could be to conduct the same experiments including the JST in different countries with children of different nationalities. Considering that the extent of the JSE is modulated by the degree of self-other integration this could give us insight on the cultural differences on creating self-other integration.

Additionally, since there are vast number of studies conducted with adults, adult studies could be performed as a control group in future studies, to verify the experimental setups.

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APPENDIX

STATISTICAL ANALYSIS RESULTS

Table 8: Descriptive statistics of response times with respect to tasks, compatibility and combined data sets 1&2

	SET	*Mean*	*Std. Deviation*	*N*
JST_rt_compatible	Set 1	699.74	155.50	31
	Set 2	729.07	148.70	32
	Total	714.64	151.57	63
JST_rt_incompatible	Set 1	742.02	140.40	31
	Set 2	794.56	190.30	32
	Total	768.71	168.37	63
GNG_rt_compatible	Set 1	706.74	169.91	31
	Set 2	750.28	185.07	32
	Total	728.85	177.70	63
GNG_rt_incompatible	Set 1	724.96	156.06	31
	Set 2	726.21	144.88	32
	Total	725.60	149.26	63
SST_rt_compatible	Set 1	812.70	132.62	31
	Set 2	868.60	153.75	32
	Total	841.10	145.34	63
SST_rt_incompatible	Set 1	952.00	153.36	31
	Set 2	982.94	162.84	32
	Total	967.71	157.74	63

Table 9: Results of Within-Subjects Effects of mixed ANOVA results on RTs of combined data sets 1&2

Source	*df*	*F*	*p*	*Partial Eta Squared*
task	2	101.806	.000	.625
task * SET	2	.348	.707	.006
compatibility	1	24.900	.000	.290
compatibility *SET	1	.382	.539	.006
task * compatibility	2	18.355	.000	.231
task * compatibility * SET	2	1.249	.290	.020

Table 10: Results of Between-Subjects Effects of mixed ANOVA results on RTs of combined data sets 1&2

Source	***df***	***F***	***p***	***Partial Eta Squared***
Intercept	1	2377.318	0.000	0.975
SET	1	1.203	0.277	0.019

Table 11: Descriptive Statistics of Error Percentage of combined data sets 1&2

SET		***Mean***	***Std. Deviation***	***N***
JST_ err _compatible	Set 1	.016	.0374	31
	Set 2	.050	.0916	32
	Total	.033	.0718	63
JST_ err _incompatible	Set 1	.029	.0529	31
	Set 2	.022	.0420	32
	Total	.025	.0474	63
GNG_ err _compatible	Set 1	.016	.0523	31
	Set 2	.038	.0793	32
	Total	.027	.0677	63
GNG_ err _incompatible	Set 1	.058	.0923	31
	Set 2	.047	.0842	32
	Total	.052	.0877	63
SST_ err _compatible	Set 1	.065	.1355	31
	Set 2	.100	.1344	32
	Total	.083	.1351	63
SST_ err _incompatible	Set 1	.171	.1755	31
	Set 2	.238	.2091	32
	Total	.205	.1946	63

Table 12: Within-subjects Effects of Error Rate

Source	***df***	***F***	***p***	***Partial Eta Squared***
task	1.392	27.937	.000	.314
task * SET	1.392	1.053	.331	.017
compatibility	1	22.140	.000	.266
compatibility *SET	1	.511	.477	.008
task * compatibility	1.650	23.810	.000	.281
task * compatibility * SET	1.650	2.040	.144	.032

Table 13: Between-subjects Effects

Source	*df*	*F*	*p*	*Partial Eta Squared*
Intercept	1	104.869	.000	.632
SET	1	2.810	.099	.044

Table 14: Descriptive Statistics of Four Schools

	School	***Mean***	***Std. Deviation***	***N***
JST Comp	1	697.258	157.505	32
	2	665.495	95.096	18
	3	823.657	165.259	7
	4	827.611	158.048	6
	Total	714.642	151.575	63
JST Incomp	1	761.834	197.595	32
	2	753.578	110.958	18
	3	823.364	185.002	7
	4	787.000	144.206	6
	Total	768.709	168.367	63
SST Comp	1	811.411	147.810	32
	2	856.096	124.175	18
	3	963.370	125.044	7
	4	811.764	163.907	6
	Total	841.096	145.337	63
SST Incomp	1	967.188	173.803	32
	2	979.163	113.751	18
	3	983.337	187.890	7
	4	917.999	176.355	6
	Total	967.719	157.738	63
GNG Comp	1	714.013	221.019	32
	2	709.156	102.140	18
	3	818.914	113.952	7
	4	762.033	148.780	6
	Total	728.854	177.695	63
GNG Incomp	1	698.752	164.757	32
	2	760.922	116.526	18
	3	777.207	164.784	7
	4	702.566	125.511	6
	Total	725.595	149.265	63

Table 15: Within-subject Effect Analysis Results

Source	***df***	***F***	***p***	***Partial Eta Squared***
task	2	58.24	.000	.50
task * SCHOOL	6	1.67	.134	.08
compatibility	1	7.08	.010	.11
compatibility * SCHOOL	3	2.80	.048	.12
task * compatibility	1.79	9.78	.000	.14
task * compatibility * SCHOOL	5.37	1.07	.383	.05

Table 16: Between-subjects Effects Results Schools

Source	df	F	p	Partial Eta Squared
Intercept	1	1578.39	.000	.96
SCHOOL	3	.95	.424	.05

Table 17: Response Time Descriptive Statistics RTs Hand

	Hand	***Mean***	***Std. Deviation***	***N***
JST Comp	L	737.65	162.63	32
	R	690.89	137.85	31
	Total	714.64	151.58	63
JST Incomp	L	784.15	171.12	32
	R	752.77	166.76	31
	Total	768.71	168.37	63
GNG Comp	L	720.77	192.38	32
	R	737.20	163.93	31
	Total	728.85	177.70	63
GNG Incomp	L	710.02	154.23	32
	R	741.68	144.70	31
	Total	725.60	149.27	63

Table 18: Within-Subjects Effects of Hand

Source	***df***	***F***	***p***	***Partial Eta Squared***
task	1	1.08	.302	.02
task * HAND	1	5.54	.022	.08
compatibility	1	3.80	.056	.06
compatibility * HAND	1	.34	.561	.01
task * compatibility	1	5.82	.019	.09
task * compatibility * HAND	1	.00	.998	.00

Table 19: Between-Subjects Effects of Hand

Source	***df***	***F***	***p***	***Partial Eta Squared***
Intercept	1	1818.05	.000	.97
HAND	1	.05	.828	.00

Table 20: Error Rate Descriptive Statistics of Hand

	Hand	**Mean**	**Std. Deviation**	**N**
JST Comp	1	.03	.06	32
	3	.03	.08	31
	Total	.03	.07	63
JST Incomp	1	.03	.05	32
	3	.02	.04	31
	Total	.03	.05	63
GNG Comp	1	.05	.09	32
	3	.01	.03	31
	Total	.03	.07	63
GNG Incomp	1	.08	.10	32
	3	.03	.06	31
	Total	.05	.09	63

Table 21: Within-Subjects Effects Hand Error Rate

Source	*df*	*F*	*p*	*Partial Eta Squared*
task	1	1.09	.300	.02
task * HAND	1	4.24	.044	.07
compatibility	1	.98	.327	.02
compatibility * HAND	1	.65	.800	.00
task * compatibility	1	5.20	.026	.08
task * compatibility * HAND	1	.01	.942	.00

Table 22: Between-Subjects Effects Hand Error Rate

Source	*df*	*F*	*p*	*Partial Eta Squared*
Intercept	1	58.96	.000	.49
HAND	1	6.91	.011	.10