

DUAL-TASK COSTS AND THE ROLE OF INHIBITORY CONTROL IN NON-
INFERENCEAL THEORY OF MIND PROCESSING

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by
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Abstract

Current methods of assessing an individual's Theory of Mind (TOM) abilities, especially the false-belief task, assess more than just TOM abilities (Bloom & German, 2000). One such ability in particular, inhibitory control (IC), is believed to be necessary for inhibiting salient and contradictory information about the reality of a situation in order to ascribe a false-belief to an individual (Carlson, Moses, & Breton, 2002; Leslie & Thaiss, 1992). The role of IC cannot be determined precisely, however, as existing tasks confound pure TOM reasoning with other processes (Apperly, Samson, & Humphreys, 2005). The current study sought to assess the role, if any, that IC plays in TOM processing aside from its possible role in making inferences about others' behavior. The non-inferential TOM task was employed (as used in Apperly, Back, Samson, & France, 2007) to more selectively assess TOM reasoning and a dual-task methodology was used to assess the role of IC. The dependent measure was processing costs, a score comprised of the participant's accuracy and reaction time. The participants completed the non-inferential TOM task concurrently with a secondary task either in non-inhibitory or inhibitory conditions. Unexpectedly, it was found that participants in the inhibitory conditions performed just as well on the non-inferential TOM task as participants in the non-inhibitory condition. This finding suggests that IC may not be involved in the representation of mental state information. Thus, the findings also suggest that the reason studies show IC to be correlated with other TOM tasks, such as the false-belief task, is because IC is related to the other processes involved in these tasks, such as making TOM inferences. Alternatively, the IC task used may not have been effective and could be the cause of the lack of a main effect for the inhibitory (experimental) condition.

Keywords: theory of mind, TOM, non-inferential, inhibitory control.

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TABLE OF CONTENTS

List of Figures	i
Foreword	ii
Introduction and Literature Review	1
Overview of the Present Study.....	8
Method	10
Results	14
Discussion	16
References	20
Appendix A	23
Appendix B	24
Appendix C	25
Figure 1	27
Figure 2	28
Figure 3	29
Vita	30

LIST OF FIGURES

Figure 1. Processing costs for each condition in the inhibitory (experimental) condition

Figure 2. Processing costs for each condition in the non-inhibitory (control) condition

Figure 3. Interaction trend between probe type and sentence position across groups

FOREWORD

This thesis is written in accordance with the style of the *Publication Manual of the American Psychological Association (6th Edition)* as required by the department of Psychology at Appalachian State University.

Dual-Task Costs and the Role of Inhibitory Control in
Non-Inferential Theory of Mind Processing

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Theory of mind (TOM) refers to an individual's ability to understand the beliefs, desires and actions of others. TOM involves separating oneself from reality, and understanding that others have beliefs, desires, and intentions that are different from one's own (Premack & Woodruff, 1978). Other functions served by TOM are empathizing, deceiving and identifying deception, and predicting others' behavior. In clinical populations, a deficit of TOM abilities is believed by some to be the basis for the social deficiencies exhibited by those with autism (i.e., Baron-Cohen, Leslie, & Frith, 1985). TOM is also heavily studied in a developmental context, as the ability to understand false-beliefs marks a clear and significant change in children's cognitive abilities (Wellman, Cross, & Watson, 2001).

The most commonly used task for assessing an individual's TOM abilities is the false-belief task. Wimmer and Perner (1983) were the first to employ the false-belief task to test children's TOM capabilities. The researchers presented children 3 to 9 years old with a story about a boy who likes chocolate. In the story, the boy places a piece of chocolate in a blue colored cabinet (a toy chocolate is placed in a cabinet that has been painted blue). The boy then goes out to play (a boy doll is removed from the scene) and his mother enters the room. The mother uses some of the chocolate and places it into a green cabinet, not back into the blue one. The mother leaves and the boy returns (the boy doll is placed back into the scene). The children were told that the boy was hungry and asked where the boy would look

for the chocolate. They found that at about 4 years old, children began answering correctly (that the boy would look in the blue cabinet) more than 50% of the time. Children younger than 4 years old were generally not able to reason that the boy will still believe the chocolate to be in the blue cabinet. This finding has been replicated many times, using various forms of the false-belief task (for a meta-analysis of studies using the false-belief task, see Wellman et al., 2001).

Obviously, in assessing the TOM abilities of adults, more cognitively demanding tasks are needed. Higher-order false-belief tasks are stories that require understanding more than one individuals' mental state. For example, participants read a story in which one character thinks about the mental state of another character. These questions often take the form of "A thinks that B thinks X" (McKinnon & Moscovitch, 2007, p. 183). Most of the other common methods of assessing TOM abilities in adults also rely on written passages. An individual may be tested on his or her ability to understand double bluffs, faux pas, or violations of social norms (for a list of commonly used TOM tasks, see Bird, Castelli, Malik, Frith, & Husain, 2004).

Unfortunately, the tasks currently used in adult populations also confound the core processes of TOM reasoning with incidental executive demands such as the need to make inferences. Thus, these false-belief tasks also engage other, more general, cognitive mechanisms. Different assessment methods are needed to more closely examine the processes involved in TOM reasoning (Apperly, Samson, & Humphreys, 2005).

Bull, Phillips, and Conway (2008) have presented evidence that current TOM tasks fail to assess the TOM mechanism independent of other processes. In their study, participants completed a "stories" version of the false-belief task, either alone or concurrently with one of

four secondary executive function tasks: an “updating” task, a “switching” task, a task of inhibitory control, and a task that required the participant’s attention but had minimal cognitive demands. The “stories” task required participants to keep track of multiple characters in a story, and was given in two within-subjects conditions. The experimental or TOM condition asked participants to make inferences about the mental states of the characters in the story, while the control condition asked participants to make inferences about physical or mechanical events occurring in the story. Participants made significantly more errors in the task when they were also completing a secondary task (all the secondary tasks caused interference in both TOM and control conditions). Critically, however, the secondary tasks interfered with participants’ ability to pass the “stories” task in both TOM and control conditions; they did not selectively interfere with their performance in the TOM condition. This finding suggests that successfully performing the “stories” task requires general executive functioning in addition to TOM processing, and, thus, the task does not isolate the core TOM mechanism. Some researchers have questioned the validity of tasks such as the “stories” task in light of evidence similar to this (i.e., Apperly et al., 2005).

Bloom and German (2000) have argued that the false-belief task is not a good test of an individual’s TOM abilities because passing false-belief tasks requires resources beyond the base products of TOM processing (as shown in Bull et al., 2008). Apperly et al., (2005) concurred and added that new tasks should be developed that isolate components of TOM processing that may be distinct from general executive functioning. Apperly, Back, Samson, and France (2007) developed a task that allows us to do this because it does not require individuals to make inferences about behavior when thinking about mental state information.

In the non-inferential TOM task, participants are directly presented with all the relevant information and asked to use this information to make a judgment (Apperly et al., 2007).

When children younger than 4-years of age are simply presented with two conflicting statements, one regarding someone's belief and the other regarding a state of reality, they are unable to override the influence of the information about reality (Wellman & Bartsch, 1988). For example, when children are told, "Sam thinks the puppy is in the garage/ the puppy is really on the porch," and then asked where Sam would look for the puppy, they answer that he will look on the porch. This shows that children without TOM abilities have difficulty with mental state information even when explicitly given the information (i.e., when no inference is necessary).

Analogous to this, Apperly et al. (2007) used a method that allowed assessment of non-inferential TOM processing in adults. They claim that the non-inferential TOM task isolates the process of thinking about mental state information and shows that it is separate from making inferences. The researchers presented normally functioning adult participants with two statements, one regarding a man's belief and the other regarding a state of reality. The statements were followed by a picture probe, and participants answered whether or not the probe accurately depicted the information presented in the statements. For example, a participant may have been presented with the following: "He thinks the ball on the chair is red," "Really the ball on the chair is yellow," and then a picture of a man with an arrow pointing from his head to a red ball on a chair.

The data from Apperly et al. (2007) suggested that when the statement about the man's belief contradicted the statement about reality (i.e., when the man's belief was false, or a false belief reality (FBR) trial type), participants had more trouble in thinking about those

statements than when the man's belief was simply unrelated to reality (an unrelated belief reality (UBR) trial type). It took them longer and it was more difficult for them to say whether the picture accurately corresponded to the information in those statements. Apperly et al. (2007) argued that these effects reflect the processing costs of false beliefs. Also, they claim that these effects are evidence that TOM functioning does have core components to which other methods of TOM assessment are not sensitive. Moreover, these findings suggest that purely thinking about the mental states of others is identified as one component process of TOM and is separate from the need to make inferences. This is because this task isolates the holding in mind of mental state information and finds processing costs in representing false beliefs.

One potential explanation for the processing costs of false beliefs comes from Leslie, Freidman, and German (2004). The researchers proposed the selection processing model, claiming that children and adults have a "true-belief default" (p. 528) and that it must be successfully inhibited if a belief with different content is to be represented. For example, in the false-belief task used in Wimmer and Perner (1983), the children who failed the task failed because they could not inhibit their knowledge that the chocolate was in the green cabinet and, thus, were not able to represent the boy's belief that the chocolate was in the blue cabinet.

Evidence for the need to inhibit salient information when representing contradictory information comes from several sources. Samson, Apperly, Kathirgamanathan, and Humphreys (2005) found neuropsychological evidence that reducing the inhibitory demands of a false-belief task improved the performance of a patient with right prefrontal and temporal damage. The patient, named WBA, completed standard false-belief tasks and a low

inhibitory requirement variation in which the actual location of the object was not known (the only information given was where the story's character thought it was). WBA was unable to pass the standard version of the false-belief task, but successfully passed the variation that had a low inhibitory requirement. The researchers concluded that when the actual location of an object is not known, this information does not need to be inhibited and, thus, only the inference has to be made. When the new location of the object was known, WBA had to inhibit this information, and she could not pass the task.

Similar to WBA, very young children do not appear to have well developed inhibitory control mechanisms. Wellman et al. (2001) conducted a meta-analysis of studies that used the false-belief task and also found that reducing the salience of the object in question (or removing it completely), and, thus, reducing what needs to be inhibited, improved children's performance. Children may perform better when the object is removed because they no longer have to inhibit the reality of where the object is in order to infer where a person believes it to be.

Older adults also show deficits in inhibitory functioning and researchers have found the same effect in their false-belief performance (Bailey & Henry, 2008; German & Hehman, 2006; McKinnon & Moscovitch, 2007). Bailey and Henry (2008) administered a battery of cognitive and TOM tasks to groups of younger and older adults. The participants completed false-belief tasks where the actual state of reality was known and where it was unknown. Older adults were especially impaired in the reality-known condition that required inhibitory control (IC), purportedly because they had to inhibit what was known about reality. The researchers claim that the cause of age-related decline in TOM functioning is age-related decline in IC.

In addition to the evidence mentioned, individual differences in IC have also been found to correlate with TOM performance in children even after controlling for other factors (Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002; Carlson, Moses, & Claxton, 2004). In Carlson and Moses (2001), for example, children were given a conflict IC task in which different stimuli were presented, and the children were told to respond in a way that conflicted with a prepotent response. For example, children were shown cards of a sun and a moon and had to say “night” when the sun card was shown and “day” when the moon card was shown. The children also completed several false belief tasks. After statistically controlling for age, verbal ability, family size, and performance on mental-state control tasks, scores on the IC task still correlated strongly ($r = .66$) with TOM performance providing evidence that IC plays a role in false-belief processing.

Most directly, Bull et al. (2008) had participants complete the “reading the mind in the eyes” task concurrently with an IC task. The “eyes” task requires identifying the mental state expressed in a picture of a set of eyes. In a control condition, participants were to identify the age and gender of the person whose eyes were depicted. Concurrently performing an IC task impaired participant’s performance in the (experimental) mental-state condition but not in the control condition. Collectively, the findings reviewed in this section suggest that IC is highly involved in TOM processing.

Overview of the Present Study

Children, adults, and clinical populations with deficits in IC all struggle with typical false-belief tasks but perform better when the inhibitory demands of the task are lowered. Also, IC ability correlates with TOM performance, and concurrently performing an IC task interferes with people’s ability to perform TOM reasoning. The studies that provide this

evidence, however, have all confounded purely thinking about the beliefs of others with other cognitive processes because the tasks used do not isolate the holding in mind of mental state information. The non-inferential TOM task used in Apperly et al. (2007), however, does isolate the holding in mind of mental state information.

The purpose of the current study was to examine the relationship between IC and the representation of mental state information, including false-beliefs. The non-inferential TOM task as used in Apperly et al. (2007) was administered in two conditions. In one condition an inhibitory control task was concurrently performed and in the other condition a matched control task was concurrently performed.

If two tasks depend on the same cognitive resources (such as IC), then interference effects will be observed when the two tasks are performed simultaneously (Klinberg & Roland, 1997). We believe it is true that salient information about reality must be inhibited in order to attribute a contradictory belief to an individual. Thus, our first hypothesis was that we would see more errors and slower reaction time in the task when the participants were simultaneously performing a task that occupies their IC than when also performing a secondary task that does not occupy their IC. Our second hypothesis was that, in addition to main effects for inhibitory condition and trial type, we should see an interaction between the two variables. Specifically, we predicted that concurrently performing the IC task would cause stronger dual-task costs in the FBR condition than it would in the UBR condition. This is expected because representing a belief and a state of reality that are unrelated to one another does not require the state of reality to be inhibited, but representing a false belief about reality does. These results would suggest that it is IC specifically that is involved in the representation of false-beliefs.

Method

Participants

Twenty eight participants (14 in the inhibitory condition and 14 in the control condition) from ASU were recruited through the Psychology Subject Pool. The pool consists of students enrolled in introductory and intermediate psychology classes who have elected to enter the Psychology Subject Pool to fulfill an experiential learning credit for the course. Unfortunately, due to a miscommunication in the lab, demographic data was not collected for the participants in this study. Institutional Review Board approval for this study was obtained on March 29, 2011 (see Appendix A).

Materials

The current study employed the same non-inferential TOM task used in Apperly et al. (2007). The task was completed on a computer in the psychology lab at Appalachian State University using E-prime experimental design software and consisted of 7 practice trials and 288 experimental trials. In each trial, two sentences were presented consecutively followed by a picture probe. See Appendix B for example items.

The sentences may have described a state of reality (e.g., “he thinks the ball on the chair is red”), or a belief of the man (e.g., “really, the ball on the table is yellow”). The picture probe depicted a man, a ball, a table, and a chair. There was a blank space next to the photograph that showed an enlarged ball on either a cartoon table or chair. The picture probe showed either a state of reality or the man’s belief. In depicting a state of reality, there was an

arrow pointing from the ball in the photograph to the enlarged ball. In depicting the man's belief, the arrow instead pointed from the man's head to the enlarged ball.

There were three variations within the experimental trials. First, the sentences may have described a false-belief (FBR trial) on the part of the man (e.g., the man thinks the ball on the chair is red; really the ball of the chair is blue) or the man's belief may have been unrelated to reality (UBR trial; e.g., the man thinks the ball on the chair is red; really the ball on the table is yellow).

Second, the probe may have depicted a state of reality or a belief of the man. In the picture probe there may have been an arrow pointing from the man's head to the enlarged object, signifying his belief, or there may have been an arrow pointing from the table or chair to the enlarged object, signifying reality. This variation was included in order to explore whether mental state information is processed differently when making judgments about beliefs than when making judgments about reality.

Third, because the probe only presented information from one of the sentences and not both, only one of the sentences was directly relevant to the participant's response. The position of the relevant sentence also varied, meaning that sometimes the sentence which directly corresponded to the picture probe was presented first and sometimes it was presented second. This manipulation was included because the sentence presented first must be held in mind while reading and thinking about the second sentence. As stated previously, processing the picture probe may have been different depending on whether the probe corresponded to the information presented in the first sentence or the second sentence.

The secondary task was designed to tax the participants' IC in the experimental condition or not tax their IC in the control condition. In this task tones of two different

frequencies were randomly presented via headphones. The tones were presented at a rate of one tone every 5 seconds.

Procedure

After reading and signing informed consent forms (see Appendix C), the participants had the opportunity to ask questions about the study. After any questions were answered, the non-inferential TOM task was explained to the participants and a set of practice trials was completed. The participants then completed the non-inferential TOM task concurrently with the secondary task either in the non-inhibitory condition or inhibitory condition. The instructions were to respond yes or no, by left or right-clicking a computer mouse, as to whether the picture probe correctly depicted the information presented in the sentences. The presentation of the sentences and picture probe was self-timed. Participants controlled the presentation of the first sentence, the second sentence, and the picture probes by pressing the space bar.

In the non-inhibitory condition of the secondary task, the instructions were to respond via keyboard every time a tone was heard. In the inhibitory condition, the instructions were to only respond to the tone of higher frequency and not to the tone of lower frequency. The secondary task ran continuously and concurrently with the primary task. As in Apperly et al. (2007), participants were instructed to complete the tasks as quickly and efficiently as possible. The instructions for both tasks did not emphasize speed over accuracy or vice versa.

Design

There were four independent variables and the current study utilized a 2 x 2 x 2 x 2 mixed design. The within-subjects variables were trial type (FBR, UBR), probe type (reality, belief), and sentence position (first, second). The between-subjects variable was task type

(non-inhibitory, inhibitory). The task also included three types of filler trials to insure against the creation of a superficial strategy for completing the trials. These filler trials included two beliefs of the man, two descriptions of reality, or a belief on the part of the man that is consistent with reality. The dependent variable was the processing cost (mean correct reaction time divided by percentage of correct responses) incurred by participants in assessing the correctness of the picture probe. As in Apperly et al. (2007), the reaction time was the time between the presentation of the picture probe and the participant's mouse response.

Results

Apperly et al. (2007) reasoned that their hypothesis about the processing costs of false beliefs concerned overall processing cost and not speed or accuracy individually. Thus, in order to compute one score to represent processing costs, the mean reaction time of each condition (RT) was divided by the proportion correct for that condition (% correct), as done in Apperly et al. (2007). Average reaction times across conditions ranged from 1839 milliseconds (ms) to 2003 ms. For the initial analyses, alpha was set to .05 and both effect size (partial eta squared) and observed power were computed. Because of the small sample size, the power to detect an effect was low for several analyses. In instances where the effect size was larger than .1 and the p -value was less than .10, I reported these effects as trends (see Figure 1 and Figure 2 for mean processing costs for each within-subjects condition in the inhibitory and non-inhibitory conditions, respectively). Apperly et al. (2007) reported an average processing cost of 1665 for FBR trials and 1407 for UBR trials; the current study found an average processing cost of 2691 for FBR trials and 2197 for UBR trials.

Two participants were removed from the analysis. Participant 10 was removed because the average proportion of trials in which the participant answered correctly was significantly below chance in each condition. Apperly et al. (2007) reported error rates of 4% to 20% across the different conditions. With participant 10 removed, error rates in our study ranged from 6% to 20% across the different conditions. Participant 20 was also removed because there appeared to be an error in the processing of the participant's data. Some of the

participant's data were lost in the transfer between E-prime and Excel on campus in Boone, North Carolina.

A four-way mixed-design ANOVA was conducted using trial type (FBR, UBR), probe type (belief, reality) and relevant sentence position (first, second) as the within-subjects independent variables and task condition (non-inhibitory, inhibitory) as the between-subjects variable. There was a trend for a main effect of trial type, $F(1, 28) = 3.10, p = .09, MSE = 4535096.48, \eta_p^2 = .11$. This trend showed that participants had more difficulty with FBR trials than UBR trials. A significant main effect of probe type was found, $F(1, 28) = 5.66, p = .03, MSE = 856962.15, \eta_p^2 = .18$. Participants had more difficulty when the probe was a belief on the part of the man ($M = 2585.66, SD = 15.24$) than when the probe was one of reality ($M = 2277.90, SD = 13.74$). The between-subjects main effect of task condition was not significant, $F(1, 28) = .20, p = .66, MSE = 8453679.25, \eta_p^2 = .01$. The expected interaction between task condition and trial type was also not significant, $F(1, 28) = .42, p = .52, MSE = 1906980.88, \eta_p^2 = .02$. There was a trend for the interaction between probe type and sentence position, $F(1, 28) = 3.67, p = .07, MSE = 6054689.15, \eta_p^2 = .12$, as shown in Figure 3. In trials with reality probes, participants had more difficulty when the probes corresponded to the information presented first. However, in trials with belief probes, participants had more difficulty when the probes corresponded to the information presented second.

Discussion

The non-inferential TOM task has been presented as an alternative to existing TOM tasks because it requires participants to think about TOM information but does not require them to make inferences about that information. This is important because it allows one to isolate the representation of TOM information from potentially separate processes involved in inferring that information (Apperly et al., 2007). The main objective of the current study was to investigate what role inhibitory control plays in TOM reasoning aside from its role in making TOM inferences.

Contrary to expectations, there was no main effect or trend for the between-subjects independent variable of secondary task condition (inhibitory and non-inhibitory). Participants who simultaneously completed the task designed to tax their IC performed no worse on the non-inferential TOM task than participants who simultaneously completed the control task. Although unexpected, these findings may potentially inform the developmental and aging literature about the relationship between IC and TOM abilities. This study was not able to detect a relationship between IC and pure TOM reasoning and therefore it is possible that IC and TOM reasoning do not rely on the same cognitive mechanism. Yet, in the literature, there is still evidence that a relationship exists between IC and TOM performance in children and older adults (Bailey & Henry, 2008; Carlson & Moses, 2001; Wellman et al., 2001). The results of the current study suggest that IC abilities may rely on the same cognitive

mechanisms as other processes which are part of TOM tasks, such as making TOM inferences, and not pure TOM thinking.

Alternatively, it is also possible that the task of IC used in the current study was poorly designed or ineffective. While the task required some of the participants' attention, it may not have engaged their IC significantly more than the control task. In the inhibitory condition, the participants were instructed to respond to tones of a lower frequency while ignoring tones of a higher frequency. In the control condition, participants responded to every tone that was presented. It may have been that the control condition also required inhibition, and interfered with performance on the non-inferential TOM task just as much as the inhibitory condition, which did not require participants to respond to every tone.

Apperly et al. (2007) found one significant effect that was replicated in the current study as a trend; FBR trials were more difficult to process than UBR trials. They found that when a situation involved a false belief (a belief and a state of reality which contradict one another), it was more difficult for the participants to process than a situation in which there was no contradiction between a belief and the state of reality. From this finding, Apperly et al. (2007) concluded that mentally representing false beliefs requires "resisting interference" (p. 1106) between the belief and the state of reality and that doing so is part of an individual's executive functioning.

One effect emerged in the current study which differed from an Apperly et al. (2007) finding. They reported that reality probes were associated with higher processing costs than belief probes. In the current study, however, participants had significantly more difficulty processing trials where the probe depicted a belief on the part of the man than those where the probe depicted a state of reality. The effect found in the current study is more consistent

with the literature on children's TOM performance because children exhibit more difficulty when making judgments about beliefs than when making judgments about reality.

Researchers have explained this in terms of the cognitive bias called the "curse of knowledge" (Birch & Bloom, 2007, p. 25) or the "reality bias" (Mitchell & Taylor, 1999, p. 168). These two cognitive biases hold that children fail non-inferential TOM tasks because they do not have the necessary executive functions to override information about reality as they process information about a person's belief. The results of the current study are more consistent with those ideas than are the findings from Apperly et al. (2007) despite the fact that both studies used undergraduate students as participants. Apperly et al. (2007), which utilized a single-task condition only, did not comment on this issue. It is possible that the secondary task used in the current study caused this effect by making the reality probes harder to process and causing the participants' performance to be closer to how children process such information.

The involvement of executive resources, such as IC in non-inferential TOM processing, remains an important issue to investigate because a large number of studies find that IC and TOM abilities are strongly linked (Bailey & Henry, 2008; Carlson & Moses, 2001; Wellman et al., 2001). The non-inferential TOM task separates thinking about TOM information from making an inference about that information and should be considered a primary task for investigating this link.

Further research could corroborate these findings by considering individual differences in executive functioning. If it is true that IC is not involved in TOM thinking per se, and the non-inferential TOM task isolates TOM thinking per se, then individuals with strong IC should perform the non-inferential TOM task at the same level as individuals with

weak IC. Additionally, data on the participants' secondary task performance could be collected as well in order to see how they distributed their attention between the two tasks.

The findings of the current study may also be relevant clinically, as some believe that individuals with autism exhibit social deficiencies due to a lack of TOM abilities (Baron-Cohen et al., 1985). Since the current findings suggest that pure TOM reasoning may not involve IC, failure on the non-inferential TOM task might actually represent a failure to hold mental state information in mind rather than a failure of executive functioning. Thus, if the current findings are not a result of low power or other methodological issues such as a poor task of IC, it could be hypothesized that those with autism who were to perform poorly on the non-inferential TOM task would indeed lack the ability to mentally represent TOM information instead of having a more general cognitive dysfunction.

Further research should attempt to replicate the findings of the current study with more participants while using a different task of IC. If a different IC task also caused no interference on non-inferential TOM performance, this would be strong evidence that IC plays little to no role in simply representing TOM information.

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Appendix A

RB <irb@appstate.edu> Tue, Mar 29, 2011 at 12:37 PM

To: schmengerk@email.appstate.edu

Cc: waringda@appstate.edu

To: Kurt Schmenger

Psychology

CAMPUS MAIL

From: Dr. Timothy Ludwig, Institutional Review Board

Date: 3/29/2011

RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)

Study #: 11-0250

Study Title: Dual-task costs and the role of inhibitory control in non-inferential theory of mind processing.

Submission Type: Initial

Expedited Category: (7) Research on Group Characteristics or Behavior, or Surveys, Interviews, etc.

Approval Date: 3/29/2011

Expiration Date of Approval: 3/27/2012

This submission has been approved by the Institutional Review Board for the period indicated. It has been determined that the risk involved in this research is no more than minimal.

Investigator's Responsibilities:




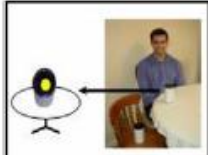
Federal regulations require that all research be reviewed at least annually. It is the Principal Investigator's responsibility to submit for renewal and obtain approval before the expiration date. You may not continue any research activity beyond the expiration date without IRB approval. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.

You are required to obtain IRB approval for any changes to any aspect of this study before they can be implemented. Should any adverse event or unanticipated problem involving risks to subjects occur it must be reported immediately to the IRB. Best wishes with your research!

CC:

Douglas Waring, Psychology

Appendix B
 Sample items from the non-inferential TOM task.

	SENTENCE 1 →	SENTENCE 2 →	PICTURE PROBE
(a)	“He thinks the ball on the chair is red”	“Really the ball on the chair is yellow”	
(b)	“He thinks the ball on the chair is red”	“Really the ball on the chair is yellow”	
(c)	“He thinks the ball on the chair is red”	“Really the ball on the table is yellow”	
(d)	“He thinks the ball on the chair is red”	“Really the ball on the table is yellow”	

Appendix C
APPALACHIAN STATE UNIVERSITY

Informed Consent for Participants in Research Projects Involving Human Subjects

Title of Project:

Dual-Task Costs and the Role of Inhibitory Control in Non-Inferential Theory of Mind Processing

Investigator(s): Kurt Schmenger, Dr. Doug Waring

I. Purpose of this Research/Project

The purpose of the study in which you are being asked to participate is to determine if a particular executive function- inhibitory control- is needed in the representation of false-beliefs. This type of study is important because it will help researchers to better understand how people represent others' thoughts, feelings, and behaviors more generally.

II. Procedures

In today's session, you will be asked to complete a computer-based activity. You will complete a number of items in which you are presented with two sentences and a picture. Your instructions are to assess whether or not the picture accurately depicts the information presented in the sentences. Your involvement will only be necessary on this one occasion. This session should take no longer than 1 hour and will take place in a room within the psychology building.

III. Risks

There are no anticipated physical or psychological risks associated with participating in this study.

IV. Benefits

By participating in this study, you will learn more about the research process in psychology. Your participation will help to increase knowledge that could benefit others in the future.

V. Extent of Anonymity and Confidentiality

Please be assured that confidentiality is a priority with the data obtained in this study. The identity of participants will only be provided on this informed consent statement. After this each participant will be assigned a number which will be used to connect all other information obtained in this study. This number will be the same for all aspects of the information you provide, but will not be included on this informed consent statement. Therefore, it will be impossible for anyone to identify a participant by the responses that he or she gives. At no time will the researchers release participants' raw data to anyone other

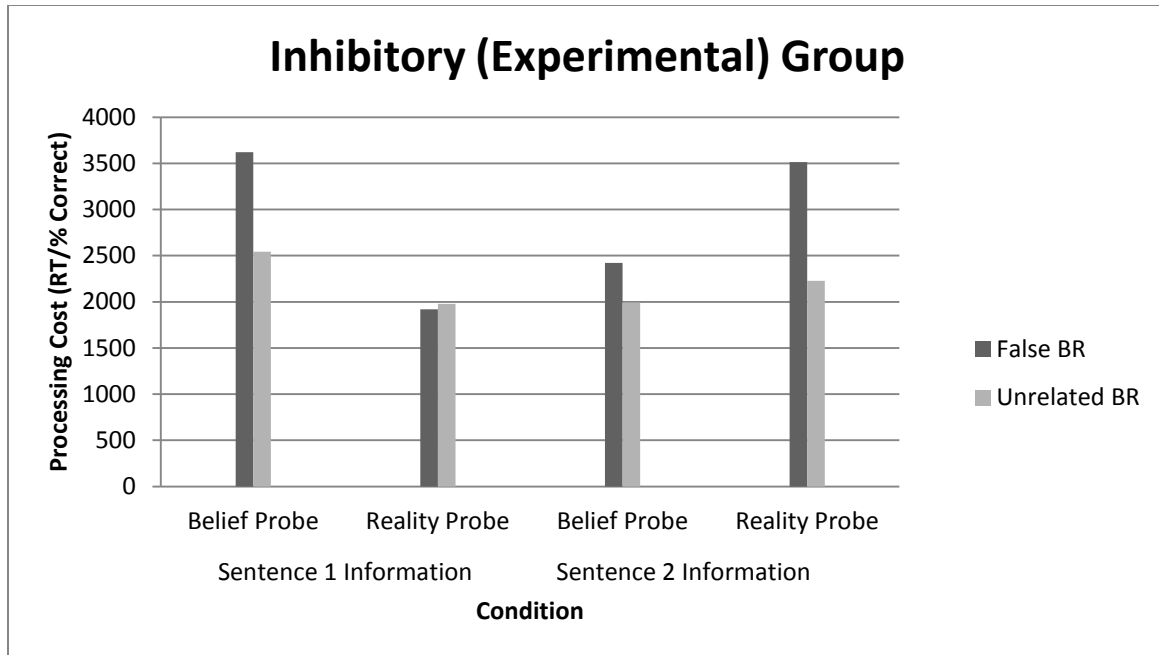


Figure 1. Processing costs (RT/% correct) for each condition in the inhibitory (experimental) group

Note. BR = belief-reality pair, RT = reaction time, % correct = mean proportion of items correct

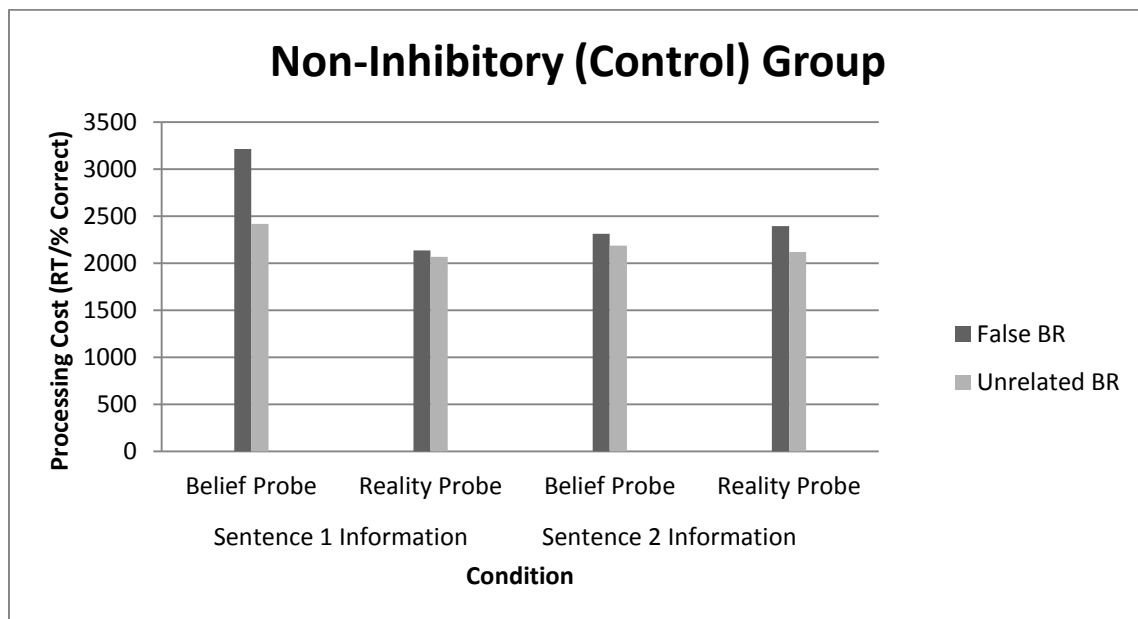


Figure 2. Processing costs (RT/% correct) for each condition in the non-inhibitory (control) group

Note. BR = belief-reality pair, RT = reaction time, % correct = mean proportion of items correct

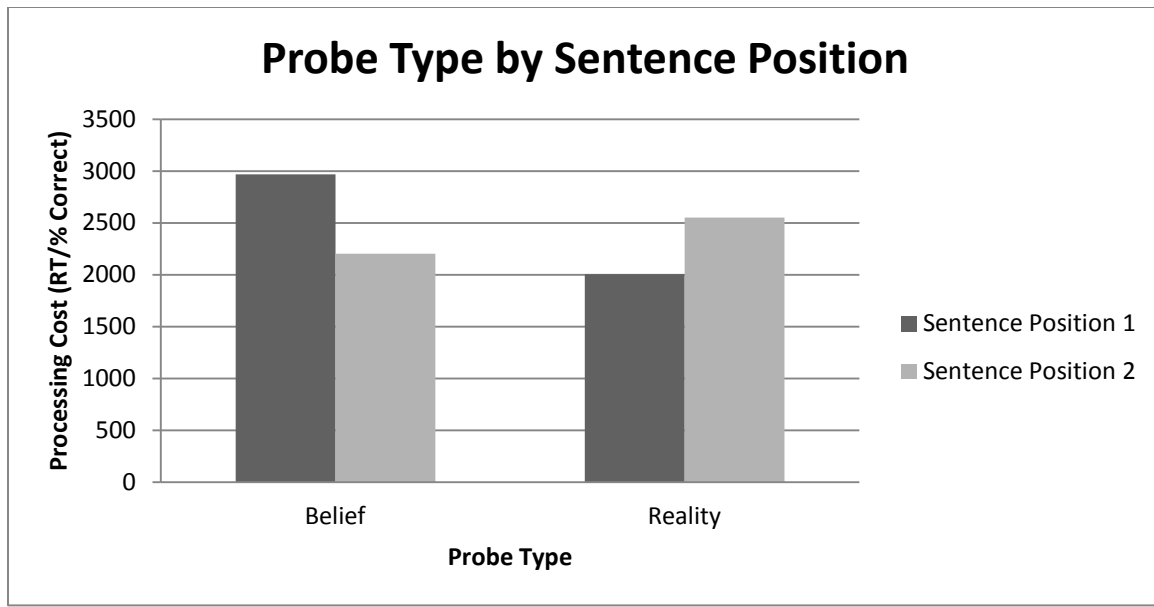


Figure 3. Interaction trend between probe type and sentence position across groups

Note. RT = reaction time, % correct = mean proportion of items correct

VITA

Kurt Schmenger was raised in West Deptford, New Jersey and earned his Bachelor of Arts Degree with a major in Psychology from Lehigh University in 2008. After graduating, Kurt spent a year living in Madrid, Spain and working as an English teacher. He enrolled at Appalachian State University in 2009 and earned his Master's degree in Experimental Psychology from Appalachian State University in 2012.