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The influence of prosocial priming on visual perspective taking and automatic imitation

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Abstract

Imitation and perspective taking are core features of non-verbal social interactions. We imitate one another to signal a desire to affiliate and consider other's points of view so as to better understand their position. Research from social psychology suggests that there exists a bi-directional relationship between imitation and prosocial behaviour. A handful of cognitive studies have supported these findings by showing that priming prosocial behaviours increases imitative tendencies in a subsequent reaction time task. The relationships perspective taking has with imitation and prosociality have, however, received less attention. Using a visuo-motor automatic imitation task as a measure of imitation, the current study replicated prosocial priming designs and extended them to include a measure of visual perspective taking. Contrary to previous studies, we found no effect of prosocial priming on imitation. Further, we were unable to investigate the effects of priming on visual perspective taking, as a ceiling effect on accuracy was ubiquitous across all experimental groups. To better understand our unexpected results, we performed a meta-analysis for the effects of prosocial priming on imitation and calculated a weighted average accuracy for published scores on the visual perspective taking task. The result indicates that if a relationship does exist between prosocial priming and automatic imitation, it is likely small and variable. Findings from the visual perspective taking task lead us to conclude that it is not a robust or reliable measure for assessing perspective taking abilities in typical adults. Further work is required to determine whether perspective taking skills can be modulated using priming techniques. When contemplating the effects of experimental manipulations on behaviour, our work demonstrates the utility of replication and meta-analyses.

Introduction

Successful social interactions require the deployment of a number of cognitive processes and behaviours, including imitation and perspective taking. Whilst both of these social skills have been studied extensively in isolation, the relationship between imitation and perspective taking has received less attention. Much work investigating the effects of imitation on social behaviour has been performed, however, few studies have considered the effects of social attitude on imitation (Leighton, Bird, Orsini & Heyes, 2010). In addition, although social context modulates imitation (Chartrand & Lakin, 2013; Heyes, 2011; van Baaren, Janssen, Chartrand & Dijksterhuis, 2009), much less is known regarding how social context influences perspective taking. The current study investigates the relationship between imitation and perspective taking by testing the extent to which these socio-cognitive behaviours are similarly modulated by prosocial priming.

Involving the unconscious copying of others' actions and gestures, imitation is not only a common occurrence during social encounters, it is also an automatic process that can be hard to suppress (Dimberg, Thunberg & Elmehed, 2000; Chartrand & Bargh, 1999). Arising at a young age, imitation signals group membership together with a desire to affiliate and build rapport with others (Over & Carpenter, 2013; Chartrand & Bargh, 1999; Bourgeois & Hess, 2008) and has been referred to as the "social glue" that binds us together (Lakin, Jefferis, Cheng & Chartrand, 2003). Indeed, it appears to do so as people who are imitated are bigger tippers (van Baaren, Holland, Steenaert & van Knippenberg, 2003), donate more to charity (van Baaren, Holland, Kawakami & van Knippenberg, 2004), engage in prosocial behaviours (van Baaren et al., 2004; Carpenter, Uebel & Tomassello, 2013; Macrae & Johnston, 1998), even when there is a cost to themselves (Muller, Maaskant, van Baaren & Dijksterhuis, 2012) and indicate liking the person who imitated them more than those who do not (van Baaren et al.,2003). Clearly, then, imitation can play an important role in a social world. To clarify the role imitation can play across different social contexts, recent research has started to identify antecedents to imitation (Chartrand & Lakin, 2013; Heyes, 2011). For example, priming a desire to affiliate can increase imitative behaviour (Lakin et al., 2003). Thus, there exists a bi-directional relationship between imitation and prosociality; those who are imitated behave more prosocially and those who are prosocially primed imitate more (Lakin et al., 2003). These social psychology studies have all employed observational techniques to study imitation, whereby imitation is measured by the frequency of actions copied. In a controlled setting, cognitive studies have employed a different method to capture imitation (van Baaren et al. 2009).

While unconscious imitation can signal affiliation, “automatic imitation” refers to situations where observed actions are unintentionally copied and can lead to impaired performance of one’s own action plan (Heyes, 2011). Working from the position that observing an action can influence one’s own motor system (Prinz, 1997; Brass, Bekkering & Prinz, 2001), researchers devised a task that, based on reaction time measurements, indexes automatic imitation (Brass, Bekkering, Wohlschlager, & Prinz, 2000). A task where individuals have to inhibit a tendency to imitate, thus taking advantage of the fact that people find it difficult to suppress imitation. The automatic imitation task commonly used (Brass et al., 2000) is an example of a stimulus-response-compatibility (SRC) paradigm that exploits the fact that people cannot help but be affected by the presence of a compatible, yet irrelevant, stimulus (Boyer, Longo & Bertenthal, 2012; Prinz, 1997; Heyes, 2011). This irrelevant stimulus can either facilitate of interfere with a person’s own actions (Brass et al., 2000). In automatic imitation tasks, when individuals are given an instruction to move a finger following the presentation of a target number, their response time is facilitated by observing another’s finger (an irrelevant stimulus) performing the same action, but hindered when that finger makes a different movement (Brass et al., 2000). This interference, measured by an increase in reaction time, is thought to signify the cost of inhibiting the imitative response (Brass & Heyes, 2005; Heyes, 2011). This ‘imitation effect’ is measured as the difference between congruent reaction times (when the target and the irrelevant stimulus match) and incongruent reaction times (when the target and the irrelevant stimulus differ), hereafter referred to as the congruency effect. A larger congruency effect indicates a reduced ability to inhibit the other finger (i.e. a larger imitation effect).

A handful of studies have explored the effects of prosocial priming on imitation using this reaction time measure of imitation (Wang & Hamilton, 2013; Leighton et al., 2010; Cook & Bird, 2011). Priming is thought to operate by subtly triggering a goal that unconsciously guides behaviour (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). The explanation for the expected effect of prosocial primes on imitation being that the prime would activate a goal to affiliate and that this goal would be achieved through increasing the tendency to imitate (Wang & Hamilton, 2013). As predicted, each study reported a greater congruency effect for those prosocially primed than controls. More specifically, the prosocial priming had to be self-related (e.g. ‘I am prosocial’). When using third person priming (e.g.

'Alex is prosocial') the congruency effect did not differ from controls (Wang & Hamilton, 2013). Such results suggest that social orientations can modulate automatic imitation, consequently drawing links between two distinct components of social cognition.

Like imitation, accurate representation of another's perspective is inherently intertwined with social interactions. Perspective taking has been shown to correlate with social competence (Davis, 1983) and successful communication requires both an ability to understand someone else's point of view and separate our own knowledge or beliefs from that point of view (Leslie, 1994). Visual perspective taking refers to situations where someone else may not see *what* we see or may not see something *how* we see it (Flavell, Omanson & Latham, 1978). Individuals typically adopt an egocentric bias during social interactions, such that their own view is prioritised relative to others' viewpoints (Birch & Bloom, 2004; Epley & Caruso, 2008; Leslie, 1994; Gillespie & Richardson, 2011). Dubbed the 'curse of knowledge' (Birch & Bloom, 2004), this egocentrism also interferes with judgments of others' visual perspectives (Birch & Bloom, 2007; Keysar, Linn & Barr, 2003; Keysar, Barr, Balin & Brauner, 2000; Surtees & Apperly, 2012). For example, Keysar and colleagues (2000; 2003) created a task called the Director's Task, which involved participants following the instructions of a "Director". The participant stood on one side of a set of shelves, housing a number of everyday objects, and a director stood on the other side. The Director instructed participants to select specific items. Crucially, the participant could see every object on all shelves, whereas some objects were occluded from the Director's viewpoint. The Director would then instruct the participant to move an object. On critical trials, there was more than one of the selected object and always one which the Director could not see. To successfully complete the trial, the participant had to determine and select the object the Director had intended based on *his* perspective and ignore the alternative object, hidden from the Director's view, that they knew better matched the item described (see Figure 1 for an example). The task indexes visual perspective taking by measuring the number of errors participants make on trials where there is conflict between the participant's and the Director's perspective. Surprisingly, even when it was made explicitly clear that the Director could not see the same objects as the participant, egocentric errors were still made (Keysar et al., 2000; 2003). Participants were unable to suppress their egocentric bias and adopt the Director's perspective. This suggests that whilst we may be capable of seeing things from another's point of view, we do not always do so, with people often presuming another's perspective is the same as their own (Gillespie & Richardson, 2011; Epley & Caruso, 2008). As Gillespie and Richardson (2011) put it; "although perspective taking is central to social life, people are not particularly good at it". Identifying ways of improving its application should, therefore, enhance social interactions.

How visual perspective taking is influenced by social context and how it relates to other measures of social cognition, such as automatic imitation, have not been investigated. Further, there is reason to suggest that automatic imitation and visual perspective taking may both require a mechanism that distinguishes self from other (Shaw, Czekoova & Porubanova, 2016; Steinbeis, 2015). To succeed in automatic imitation tasks, a person must *suppress* the other's action and promote their own. Conversely, for visual perspective taking, a person must suppress their own knowledge or belief and *enhance* the other's perspective. Success at both tasks, then, requires a person to be able to quickly and flexibly distinguish between themselves and another. Social interactions require us to understand actions and feelings represented by the other as we simultaneously experience our own thoughts and intentions. This ability is referred to as a 'self-other distinction' (Steinbeis, 2015) and it is often studied using the automatic imitation task (Shaw et al., 2016). Given the requirement to balance one's own with another's belief regarding an object, the Director's Task is also an example of a self-other distinction task (Shaw et al., 2016). One study has directly addressed whether automatic imitation and visual perspective taking are both driven by the self-other distinction. Santiesteban and colleagues (2012) found that people trained to inhibit imitation (enhance the self-other distinction) performed better on the Director's Task than those trained in imitation (remove the distinction) or pure inhibition (absence of 'other'). Beyond showing that imitation-inhibition training effects transferred to a task requiring a self-other distinction process, the researchers also found that this training did not translate to better performance in a mentalising task, devoid of a self-other emphasis (although this result is confounded by a possible ceiling effect in the mentalising task). It is thought that creating a self-other conflict in the imitation-inhibition training enhanced the self-other distinction, which allowed for the flexible processing of another's perspective (Santiesteban et al., 2012). Worth noting is the fact that a control group was not included in this study. While it is unlikely that any of the training methods might have impaired performance on the Director's Task, it is not known how the imitation-inhibition group's performance (c.75% accuracy) differed from baseline performance on the task. Other studies report accuracy rates (for adults) on the Director's task ranging anywhere from 54% (Santiesteban, Shah, White, Bird & Heyes, 2015) to 88% (Dumontheil, Kuster, Apperly & Blakemore, 2010), suggesting a somewhat variable baseline measurement. Nevertheless, this finding indicates that, due to a self-other distinction, there may be an inverse relationship between automatic imitation and visual perspective taking; low imitation translates to high perspective taking. A more recent study, however, suggests that automatic imitation and visual perspective taking may be positively related, whereby higher imitative tendencies were associated with higher perspective taking abilities (Shaw et al., 2016). It is not, therefore, clear whether general socio-cognitive skills drive a person's automatic imitation and visual perspective taking performance or whether the flexibility of the self-other distinction determines behaviour.

Although automatic imitation and visual perspective taking may both operate through the process of a self-other distinction, it is not known whether they can be modulated in a similar manner. If self-related, prosocial priming does result in a person attending more to the other (as indexed by greater congruency effects), then it could also result in a person better attending to another person's perspective. This would speak to the findings of Shaw and colleagues (2016). Here, then, it would be the prosocial nature of the stimuli, and not a self-other distinction, that drives the effect. Indeed, following the findings of Santiesteban and colleagues (2012), priming a self-other distinction should *reduce* the congruency effect, whereas prosocial priming studies show an *increase* in the congruency effect (Wang & Hamilton, 2013; Leighton et al., 2010; Cook & Bird, 2011). It is likely then that self-relatedness cues may not activate the self-other distinction per se, but they may affect two self-other distinction tasks in the same way. To complicate the matter, the egocentric bias associated with visual perspective taking may itself create a barrier to modulatory effects. It is possible that while enhancing the self-other distinction may improve performance on the Director's Task (Santiesteban et al., 2012), prosocial priming may not be sufficient to positively affect visual perspective taking skills. By investigating the effects of prosocial priming on automatic imitation and visual perspective taking, we hope to go some way to resolve these queries.

The current study has two primary aims. First, drawing from studies exploring the effects of prosocial priming on automatic imitation, we will investigate the effects of prosocial priming on visual perspective taking. Does activating a goal to affiliate enhance one's ability to readily adopt another's visual perspective? Second, we aim to provide a conceptual replication of previous studies' results showing that first person, prosocial priming increases automatic imitation (Wang & Hamilton, 2013; Leighton et al, 2010; Cook & Bird, 2011). Does activating a goal to affiliate robustly increase automatic imitation in a subsequent RT task? Finally, standardized questionnaires will be administered to explore potential relationships (within the unprimed, control group only) between visual perspective taking and personality traits. These will include measures of self-esteem (Rosenberg, 1965), autistic traits (Allison, Auyeung & Baron-Cohen, 2012) and empathy (Davis, 1983). There is reason to believe that those with high self-esteem may suffer from a stronger egocentric bias (Zuckerman, Kernis, Guarnera, Murphy & Rappaport, 1983) and, therefore, perform worse on the visual perspective taking task. Indicating reduced social orienting, high autistic traits may be associated with worse performance on the Director's Task. The empathy questionnaire includes questions on perspective taking (Davis, 1983) and it is of interest whether those who claim to take others' perspectives actually do so in practice.

In line with previous findings, we predict that first person, prosocial priming will produce a larger congruency effect than both third person and control conditions (Wang & Hamilton, 2013). Further, we predict that, feeling helpful, prosocially primed groups will achieve higher accuracy on the Director's Task as compared to controls. We remain, however, agnostic as to whether the prime needs to be self-related to modulate visual perspective taking skills in a similar manner to automatic imitation. Visual perspective taking, an inherently prosocial process, may not require such a specific prime. Together, these results will verify the extent to which social attitudes influence automatic imitation and visual perspective taking, which will provide insight into the extent to which these core social abilities engage a shared, cognitive mechanism.

Method

Participants

Data from 153 individuals (111 female, Mean age = 20.9, SD = 3.8, range 18-41) were collected in return for course credit; with 52 in the first person, prosocial (PS-1st) group, 52 in third person, prosocial (PS-3rd) and 49 controls. Ages ranged from 18 to 41 with average ages of 21.58 (SD 5.2) for PS-1st, 20.42 (SD 3.0) for PS-3rd and 20.71 (SD 2.4) for the control group. Ethical approval was granted by the Research Ethics and Governance Committee of the School of Psychology at Bangor University. All participants gave their explicit informed consent and were free to withdraw from the study at any time.

Sample Size & Power Calculation

A power calculation was centred on the difference in CE between 1st person prosocial and control, as that was the main effect that was being replicated from prior studies. Previous studies found medium to large effects (Cohen's d>0.5) of PS-1st priming on AI, irrespective of whether they were within-subjects (Wang & Hamilton, 2013) or between-subjects (Cook & Bird, 2011; Leighton et al., 2010) designs (Table 3). A between-subjects design was adopted in this study because the Director's Task should only be performed once, lest the participant benefit from practice effects on subsequent presentations. We performed a sensitivity analysis in G*Power based on a mean difference between two independent groups (PS-1st and control), to calculate the power we had to detect a medium effect size (Cohen's d=0.5). This determined that a one-tailed test, with an alpha of .05 and 50 participants per group had 80% power to detect an effect size of 0.5. We, therefore, aimed to test 150 participants (50 per group).

Procedure and Stimuli

Prior to testing, participants were told they were taking part in a study investigating the relationship between accuracy and reaction times (RT) across various tasks. Testing lasted around 45 minutes and the order of tasks was held constant for all participants. Upon arrival, participants were randomly assigned to a group; first person prosocial (PS-1ST), third person prosocial (PS-3RD) or control. The order of tasks was kept the same for all participants; first they completed the demographics information sheets and the questionnaires, next they completed the priming task, immediately after priming they performed the perspective taking task and finally they completed the automatic imitation task. As our primary task of interest was the perspective taking task, we did not counterbalance the Director's Task with the automatic imitation task as we did want any effects on imitation to confound any effects on perspective taking.

1. Demographics & Questionnaires

Prior to priming, each participant completed a brief demographics information sheet (age, gender, handedness and first language) together with three previously validated questionnaires; the Short Autism Spectrum Quotient (AQ-10 Adult) questionnaire (Allison et al., 2012), a self-esteem questionnaire (Rosenberg, 1965) and the interpersonal reactivity inventory (IRI) (Davis, 1983), which measures empathy across four vectors, including perspective taking.

2. Pro-social Priming Stimuli

Prosocial priming was implemented using a scrambled sentences task (Srull & Wyer, 1979), using sentence stimuli that were previously used to study automatic imitation (Wang & Hamilton, 2013). Participants were told they were participating in a language comprehension task. Three booklets, each containing 20 sentences, were used and each participant received only one booklet; either PS-1ST, PS-3rd or the non-social control. Taking around 10-15 minutes, the task consisted of partially completed sentences with a list of words above them, with one word being irrelevant. Participants were instructed to select the correct words to write a grammatically correct sentence. PS-1st and PS-3rd sentences contained words such as together, collaborate, affectionate, share and help, which were designed to drive a prosocial attitude for the self or about the other respectively. All PS-1st sentences started with 'I' whereas PS-3rd used other people such that it was another person performing the prosocial act. For example, a completed first person, prosocial sentence might read "I always comfort my friends when they are upset" whereas the same sentence in the third person would read "David always comforts his friends when they are upset". To produce a neutral attitude, control sentences were purely factual (e.g. London is the capital of England).

3. Visual Perspective Taking

Following priming, the Director's Task was administered. The Director's Task used a computerized version (Apperly et al., 2010) of the task originally designed by Keysar and colleagues (2000). The specific stimuli that we used were shared with us by Dumontheil and colleagues (2012). Displayed on screen was a picture of a block of shelves (4x4 configuration) housing a number of recognisable objects, all of which were visible to the participant. Some shelves had a back on them such that anybody standing on the other side could not see the items in those slots (Figure 1). A person (the "Director") was positioned on the other side of the shelves. The Director would issue an instruction (e.g. "Move the mouse down") that the participant had to follow by selecting the named object with the mouse and dragging the cursor to the appropriate slot. Three practice trials were presented prior to the test beginning. Participants were made aware of the backing on some shelves and told someone on the other side would not be able to see all of the items.

For the main task, there were 48 trials in total; 32 control trials (one object visible to both participant and director, see Figure 1a), 8 non-conflict (NC) trials (more than one object of varying size, all visible to both participant and Director) and 8 conflict/experimental trials (more than one object of varying size, all visible to the participant but not all visible to the Director). To be correct on an experimental trial, the participant had to identify and move the object to which the Director was referring (see Figure1a and 1b for examples). Trials were presented in blocks of three with participants only being given a short amount of time to respond before the next trial would automatically begin. The task was presented by ePrime version 2.

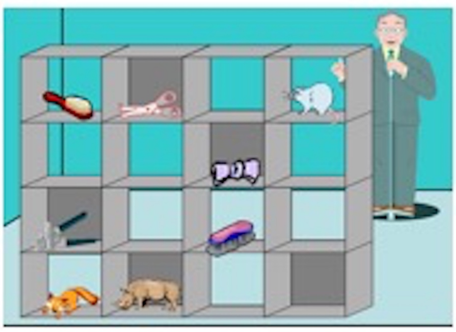

Figure 1a: An example of a control trial in the Director's task "move the mouse down"

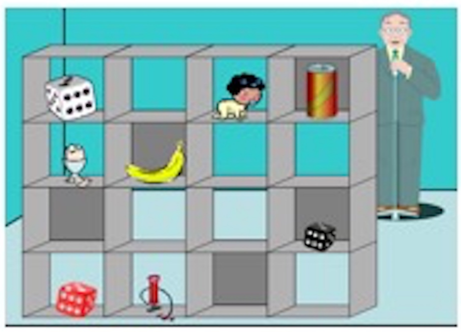

Figure 1b: An example of an experimental trial in the Director's task "move the small dice up"

4. Automatic Imitation Task

Finally, participants completed the automatic imitation task. The automatic imitation task was based on the task designed by Brass and colleagues (Brass et al., 2000). Instructions were provided by the experimenter and in written form at the beginning of the test. At the start of each trial, participants were instructed to keep their index and middle fingers of their right hand pressed down on keys n and m respectively. Prior to each trial onset, the screen displayed a small fixation cross in the centre of the screen for 500ms. The image of a hand in a neutral position would then appear. Participants were instructed to raise their index finger when the number '1' appeared on screen, as fast as they could. When the number '2' appeared, they were to raise their middle finger. To be correct on a trial, participants had to raise the finger that matched the number; index for '1', middle for '2'. At the same time as the number appeared (target stimulus) appeared, the hand in the background would raise either its index or middle finger (irrelevant stimulus). Participants would then return their fingers to the start position. For congruent trials, the other hand (irrelevant stimulus) would raise the same finger as indicated by the target stimulus (Figure 2). Conversely, for incongruent trials, the other hand would raise the alternative finger denoted by the target number. For example, the number two would appear, but the other hand would raise its index finger. The quick succession from the still hand to the target stimulus gave the illusion of a moving hand.

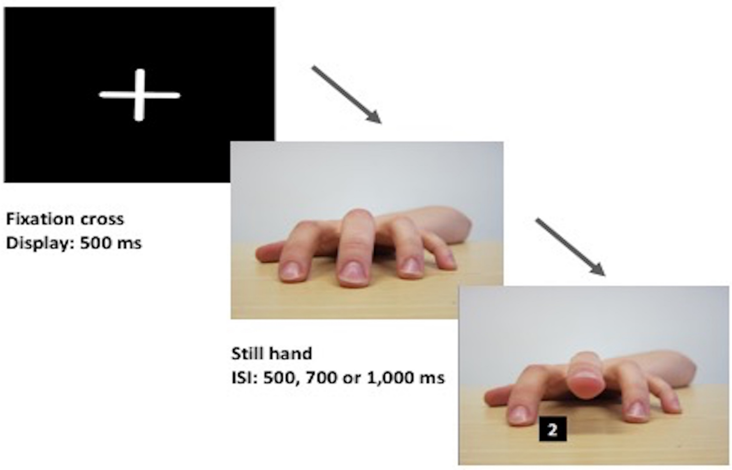

Figure 2: Example of a congruent trial in the automatic imitation task

Data for 32 practice trials was collected prior to priming but not analysed. In the main task, there were 128 experimental trials in total, displayed in a random order, comprising 64 congruent trials (32 index and 32 middle) and 64 incongruent trials (32 index and 32 middle). Trials were presented in four blocks of 32 trials with an opportunity for a break being provided between each block. The task took around seven minutes to complete in total. In order to prevent participants from anticipating when the stimulus would appear, inter-stimulus intervals of 500, 700 and 1,000 milliseconds were randomly applied to the neutral hand before the next image appeared. The image of the hand and number would remain on screen until the participant lifted their finger or after 2,000ms, whichever came first, before returning to the fixation cross. The task was written in Matlab and presented using Psychophysics Toolbox.

Following completion of all tasks, participants were debriefed on the nature of the experiment. No participants reported guessing what the experiment was investigating and all were unaware that the scrambled sentences were trying to prime a prosocial attitude.

Data analysis

Questionnaires

Participants completed three questionnaires, the short form autism questionnaire (Allison, Auyeung & Baron-Cohen, 2012), a self-esteem questionnaire (Rosenberg, 1965) and the interpersonal reactivity index (IR) (Davis, 1983). Each of these uses a Likert rating scale. Consisting of 10 questions, the autism questionnaire is marked out of 10 with higher scores indicating greater autistic traits. The self-esteem questionnaire administered here had 10 questions each with Likert based scores ranging from 1-4. The maximum score a person can receive is 40, with higher scores relating to higher self-esteem. Finally, the IRI questionnaire, which measures self-reported empathy across four components (fantasy, empathic concern, personal distress and perspective taking), consists of 28 questions and can return a maximum score of 112. As with the other questionnaires, a higher score indicates higher levels of empathy.

Visual Perspective Taking task – The Director's task

In the version of the director's task we used, RT was not an instructive measure because there was no starting position for the cursor (meaning participants did not all begin trials from the same place) and participants could start to move the mouse before the instruction had finished. The accuracy of performance as a function of trial type and group was analysed. For each trial, participants could be correct, wrong or not answer (omit). Overall accuracy, based on correct responses for all 48 trials, was calculated for each participant. The mean accuracy and SD of each group was calculated. Participants' average accuracy across all trial types was calculated. Those with accuracy rates of less than three SD from their group's mean were removed from their group, as this indicated they may not have understood the task instructions. This resulted in seven participants being removed in total (PS-1st: 2, PS-3rd: 3 and Control: 2) and 146 being taken forward for analysis. For completeness, we also ran the analysis without removing outliers.

Automatic Imitation Task

In the automatic imitation task, RT was measured as the time taken from the appearance of the imperative cue ("1" or "2") to when the finger was released. Trials were defined as accurate if the finger lifted matched the target number cue and incorrect if there was a mismatch between finger movement and target number cue. All incorrect responses were removed prior to analysis (<4% congruent trials and <10% of incongruent trials). Trials with a RT of less than 250ms or more than 2,000ms were also removed (<.1% of overall trials) as these were suggestive of expectancy errors and lapses in attention, respectively. Index and middle finger responses were collapsed. Accuracy and RT were calculated for each participant for each trial type; congruent and incongruent. Participants' congruency effects, an index of imitation, were calculated by subtracting congruent RT from incongruent RT.

Outliers were considered in the context of both the individual (deviation from their own mean) and their group (deviation from the group mean). At participant level, trials falling outside of three SD either side of their mean RT were removed. RT and accuracy for each participant was recalculated and taken forward into the group calculations. Group RT and accuracy means were then calculated and participants falling outside of three SD of their group's mean (for either RT or accuracy) were removed from further analysis. This resulted in six participants (PS-1ST: 1; PS-3RD: 1; and control: 4) being removed from further analysis and 147 being taken forward.

Results

Visual Perspective Taking Task – the Director's Task

Accuracy and RTs for all trial types across all groups are reported in Table 1. Performance on the task was high across all groups, with average accuracy exceeding 90% for experimental trials (Figure 3). Errors on experimental trials were rare (.24% of trials) and omissions (left unanswered) were more common (Figure 4). This would suggest, of the trials completed, there was a ceiling effect present in performance (95 % Accuracy, 12.2% SD).

	Trial Type		Overall
	Control	Experimental	Accuracy
PS-1st	99.3 (1.7)	97.3 (5.2)	97.7 (2.8)
PS-3rd	98.5 (3.6)	97.2 (6.4)	97.6 (3.8)
Control	97.8 (4.5)	95.7 (11.4)	96.3 (5.2)

TABLE 1: Summary of accuracy (%) results from the Director's Task. Mean accuracy (%) for control and experimental trials, together with overall accuracy, for each group are provided (sd in brackets)

Accuracy for control and experimental trials (conflict between participant's and Director's perspective) were compared between groups (see Figure 3). Two one-way ANOVAs revealed no significant differences between groups for accuracy on control $F(2,143)= 2.31$, $p=.103$, $np^2=.031$ or experimental $F(2,143)= 0.53$, $p=.587$, $np^2=.007$ trials. Given the overall high accuracy across all groups, further analyses using visual perspective taking data were not performed.

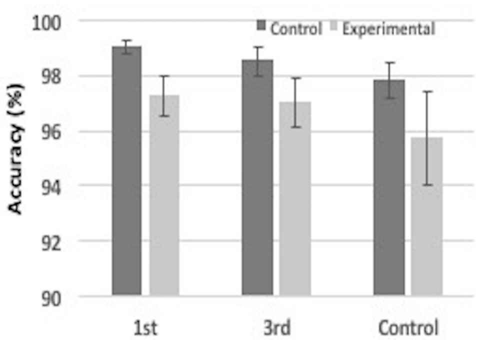

FIGURE 3: Accuracy (%) for control and experimental trials on the Director's Task for each group. Bars represent SEM

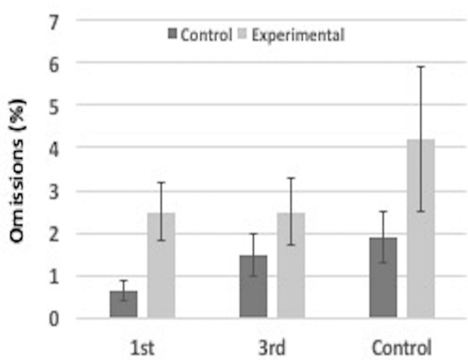

FIGURE 4: Trials omitted (%) for control and experimental trials on the Director's Task for each group. Bars represent SEM

Questionnaires

Questionnaires were intended to be analysed with reference to the Director's Task. The aim being to associate stable personality traits with visual perspective taking performance. The lack of variation across participants' scores on the Director's Task prevented such analysis. For completeness, the results of the questionnaires are presented in the supplementary materials (Supplementary Table 1).

Automatic Imitation task

Mean RTs for congruent and incongruent trials, as well as the congruency effect are reported in Table 2. To confirm that there was an overall effect of congruency, t-tests were performed comparing congruent with incongruent trials. As expected, RTs were significantly faster for congruent than incongruent trials $t(146)=25.52$, $p<.001$ and participants were more accurate on congruent than incongruent trials $t(146)=11.38$, $P<.001$ (Figures 5 and 6).

	PS-1st		PS-3rd		Control	
	RT	Accuracy	RT	Accuracy	RT	Accuracy
Congruent Trials	411 (42)	96.58 (2.9)	382 (38)	96.09 (3.6)	414 (50)	96.44 (3.7)
Incongruent Trials	482 (59)	90.13 (6.8)	445 (54)	89.15 (7.5)	479 (63)	91.80 (8.6)
Congruency Effect	71 (29)	N/A	63 (26)	N/A	65 (39)	N/A

TABLE 2: Summary of results from the automatic imitation task with reaction times (ms) and accuracy rates (%) for each trial type and the congruency effect (incongruent RT – incongruent RT) for each group (sd in brackets)

A repeated-measures analysis of variance (ANOVA) was performed with Congruency (trial type: congruent and incongruent) as the within-subjects factor and Group (PS-1st, PS-3rd and control) as the between-subjects factor. There was a significant main effect of congruency $F(1,144)=647.759$, $p<.001$, $\eta p^2=.818$ with congruent trials being significantly faster than incongruent trials. There was also a significant effect of group $F(2,144)=7.882$, $p=.001$, $\eta p^2=.099$. Post-hoc, t-tests on the mean RT of congruent and incongruent trials revealed the group differences to be driven by faster RTs from PS-3rd, with both their congruent and incongruent trials being significantly faster than both PS-1st ($t(100)=3.65$, $p<.001$) and control ($t(94)=3.32$, $p=.001$) (see Figure 5). There was, however, no mean RT difference between

PS-1st and Control (t(94=.004, p=.997). The PS-3rd difference was not analysed further as a mean group RT difference was not predicted and the reasons behind such a difference are beyond the scope of this study. Importantly, however, there was no interaction between congruency and group F(2,144)=0.943, p=.392, ηp^2=.013 indicating there was no effect of priming on congruency effects between groups.

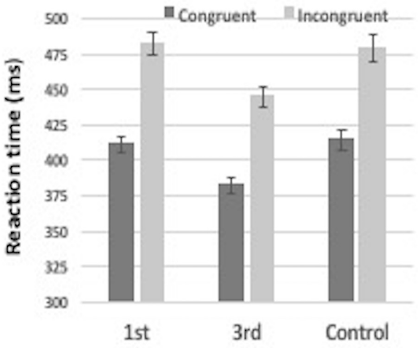

Figure 5: Reaction times (ms) for the AI task for congruent and incongruent trials for each group. Bars represent SEM

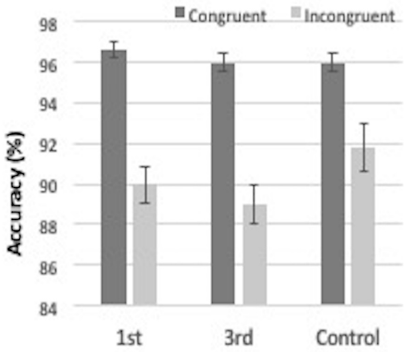

Figure 6: Accuracy (%) for the AI task for congruent and incongruent trials for each group. Bars represent SEM

As prior studies analysed the congruency effect (Wang & Hamilton, 2013; Leighton et al., 2010; Cook & Bird, 2011), we carried out an independent one-way ANOVA on congruency effect as a function of group (Figure 7). There was no significant difference between the groups' congruency effects (F(2,144)=0.96, p=.387, ηp^2=.013) . To ensure that the removal of outliers had not changed the results, we ran the same test with all participants included. The result was the same (F(2,150)=1.24, p=.291). In addition, we wanted to ensure that English language proficiency did not impact priming effects. When removing non-native English speakers (N=29), there was still no effect of priming on imitation F(2,121)=1.2, p=.304.

To provide quantitative evidence for the null hypothesis, a Bayesian analysis was performed in JASP using the independent t-test function (JASP Team, 2016). The returned Bayes factor BF^{01} provides an estimate of how likely the null hypothesis (0) is compared to the experimental hypothesis (1), given the data. A Bayes factor of 3.3 suggests that the null hypothesis was three times more likely than the experimental hypothesis (Dienes, 2016; Jeffreys, 1939).

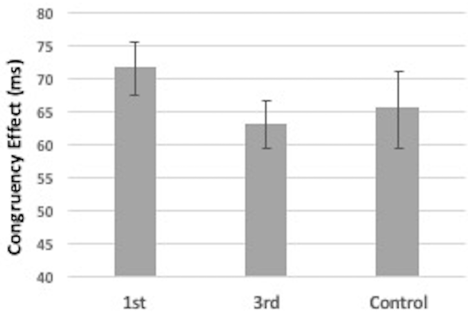

FIGURE 7: Congruency effects (ms) for each group. Bars represent SEM

M*eta-Analysis of AIT results: PS-1st vs Control groups*

To put our result in context, we performed a meta-analysis. Along with the current study, the three previous studies that used first person, prosocial priming (scrambled sentences) to investigate the effects on automatic imitation were included in the meta-analysis (Table 3). While these studies utilised both within (Wang & Hamilton, 2013) and between (Cook & Bird, 2012; Leighton et al., 2010) designs and employed slightly different methods for testing automatic imitation (finger vs hand, spatial vs orthogonal), they are conceptual replications of one another; all indexed automatic imitation as the difference between incongruent and congruent trials. In the absence of raw data, we used the values available from the published studies to compute figures such as standard deviations and standard errors. Cohen's d (1992) was calculated as: (Congruency effect PS-1st – Congruency effect Control) / Pooled standard deviation. It is important to note that the calculations inevitably contain a degree of error.

Study	Design	Stimuli	Sample/ Group size	PS-1st (2) CE	Control (1) CE	Effect Size (d) (2-1)/pooled sd
Wang & Hamilton (2013)*	Within	Original – Spatial	16	28 (16)	16 (16)	0.75
Cook & Bird (2011)	Between	Orthogonal	28	71 (63)	38 (37)	0.66
Leighton et al (2010)	Between	Hand – Opening/Closing	12	38 (31)	26 (14)	0.53
Current study	Between	Original – Spatial	45-50	71 (39)	65 (29)	0.18

TABLE 3: Summary of studies included in the meta-analysis. Mean congruency effects (CE - ms) for PS-1st and control groups (sd in brackets) are used to calculate the effect size (Cohen's d)

The meta-analysis was performed using Exploratory Software for Confidence Intervals (ESCI; Cumming, 2011). ESCI calculates a weighted contribution for each study based on sample size and variance, with larger sample sizes and smaller variance receiving the highest weighting. Estimated population effect sizes are returned for both original units (in this instance, milliseconds) and standardized units (Cohen's d). Based on recommendations (Cumming, 2011), we used a random effects model to estimate both. 95% CIs are reported as a measure of precision of these population estimates. The results of these two calculations are reported here using forest plots (Figures 8a and 8b).

Figure 8a: Forest plot for random effects for original values (ms)

Figure 8b: Forest plot for random effects for standardised values (Cohen's d)

Larger boxes represent larger weightings. Red diamond represents 95% CI surrounding the absolute effect

The estimated difference between 1st-PS and controls is 11ms [95% CI 4, 19] (Figure 8a). The forest plot shows two of the four studies have confidence intervals that cross over the zero line, indicating the effect may not always be present. The 95% confidence intervals (as shown by the spread of the red diamonds) for the population effect, however, suggest that the effect lies somewhere between four and 19 milliseconds. The standardized effect size is d=0.43 [0.15, 0.7] (Figure 8b), but also varies across the four studies. Here, the confidence intervals (red diamond) estimate the true population effect could lie anywhere between d=0.15 and d=0.7, which is somewhat imprecise. Prior to running this study, the cumulative effect size based on the prior studies was d=0.64. By adding the current study, which has a sample size between two and four times larger than prior studies, the cumulative effect size is reduced by a third to d=0.43 (Figure 8b). Such a substantial reduction following the addition of one study intimates that the effects reported by previous studies are less than robust.

Weighted average scores for the Director's Task

The Director's Task was used because many studies report high error rates and a ceiling effect was not, therefore, anticipated. Near perfect scores across all experimental groups in this study prompted a (non-exhaustive) review of studies using the same task without subjecting participants to any experimental stimuli prior to its administration. Studies identified and their results can be seen in the supplementary materials (Supplementary Table 2). From those studies identified, accuracy rates ranged from 54 to 88%. To estimate the accuracy one could expect to find when using this task with a typically developed, adult population, we calculated a weighted average (based on sample size) accuracy score. The result returned was 79%. Worth noting is the fact that this task uses just eight experimental trials. A score of 79% translates to less than two errors. It would be interesting to know whether these occur at the beginning of the task, meaning after initial mistakes, the participate adjusts their perspective and correctly identifies the imperative stimulus for the remainder of the task.

Discussion

This study had two main aims, neither of which were accomplished. Firstly, we did not replicate findings that first person, prosocial priming (PS-1st priming) increased imitative tendencies. Secondly, we observed a group wide ceiling effect on the Director's Task and, as a consequence, were unable to explore the relationship between prosocial priming and visual perspective taking. Pursuant to these findings, results of the automatic imitation and visual perspective taking tasks are considered separately hereafter.

Prosocial Priming and Automatic Imitation

Previous studies have shown that PS-1st priming leads to increased congruency effects on an automatic imitation task (Wang & Hamilton, 2013; Leighton et al., 2010; Cook & Bird, 2011). Although the current study included the largest sample size to date and had the statistical power to detect effects as large as those previously observed, we failed to replicate these prior results. While we did find a small reaction time difference (6ms) between the PS-1st priming and control groups in the same direction as previous studies, the difference was not statistically distinguishable from zero. Further, a Bayesian analysis provided three times more support for the null over the experimental hypothesis. The meta-analysis that we performed illustrated the variability of findings to date, with confidence intervals for the population effect size (Cohen's d=0.46) ranging from 0.15 to 0.70. This spread of possible effects is not conducive to the design of future studies. Of the four studies included in the meta-analysis, one has a 95% confidence interval that touches the zero line and two actually cross the line. This is suggestive of a very small effect that, contrary to the estimated population effect size, might not exist at all if the lower confidence intervals are accurate.

We failed to replicate previous reported effects and instead demonstrate that the true nature of the relationship between prosocial priming and automatic imitation is likely to be subtle and far from robust. The overall picture painted by the meta-analysis is somewhat different to that produced by any one of the studies it includes. Performing a meta-analysis allowed us to better interpret both our own results and the theory put forward by previous research (Schmidt, 1992). We thought it important to disseminate this information so that future researchers are better informed about both the strength of empirical data in support of the theory and see the ease with which one can perform a meta-analysis that offers insight into an otherwise ambiguous finding. Future studies should, therefore, be mindful that although the meta-analysis suggests prosocial priming has a medium effect size (Cohen, 1992), there is wide variability across studies.

It would be remiss to leave our deliberations here. An alternative explanation that should be addressed in response to our findings is that the effect of prosocial priming on automatic imitation could actually be very small and the lack of effect found here could be representative of the population effect. The vast majority of studies investigating the modulation of mimicry have adopted observational designs recording explicit imitation (van Baaren et al., 2009). Further, in these instances, imitation occurs unconsciously. That is to say, it occurs outside of the focus of the imitator's attention as they are attending to something else, such as a conversation (van Baaren et al., 2009). Contrastingly, the automatic imitation task (Brass et al., 2000) is the focus of the individual's attention; participants are instructed to attend to stimuli that are visible alongside the social stimulus (a hand). While they may have been told to only attend to the number (i.e. not the hand), the nature of the paradigm is such that they cannot help but attend to the irrelevant object (Boyer, Longo & Bertenthal, 2012). Unlike observational designs, the automatic imitation task is designed to capture a person *avoiding* imitation. It is possible, therefore, that while both observational methods (social psychology) and automatic imitation tasks (cognitive psychology) aim to measure the same imitative effects, the differing methods applied may actually result in measuring two different processes. This notion is in keeping with research into autism, a disorder characterized by (among other things) reduced social orienting. Compared to typically developed individuals, autistic people show reduced spontaneous imitation in social situations (Ingersoll & Schreibman, 2006; Ingersoll & Gergans, 2007), yet their behaviour during automatic imitation tasks is on par with their typical counterparts (e.g. Bird, Leighton, Press & Heyes, 2007). This would infer that two separate mechanisms may be in operation during unconscious imitation and the inhibition of imitation. Spontaneous imitation may signal a desire to affiliate (Chartrand & Bargh, 1999) and prosocial priming may lead to increased mimicry (van Baaren et al., 2009), but it may not necessarily follow that prosocial priming has a strong and reliable modulatory effect on the inhibition of imitation. To further our understanding of the mechanisms behind spontaneous imitation in the social domain and the inhibition of imitation in the cognitive arena, future research should seek to directly compare the two.

We can conclude that the cumulative evidence in support of the theory that prosocial priming influences automatic imitation is prone to variation. Future studies should, therefore, be mindful that although the meta-analysis suggests prosocial priming has a medium effect size (Cohen, 1992), there is wide variability across studies. Overall, the pattern of results is in keeping with suggestions in the literature that published effects are commonly over-estimated (Ioannidis, 2005; Open Science Collaboration, 2015).

Prosocial Priming and Visual Perspective Taking

We found a ceiling effect in accuracy for the Director's Task and could not, therefore, perform our primary analyses of interest. Scores were ubiquitously high across all three experimental groups, meaning exceptional performance could not be attributed to the prime. Indeed, our result was contrary to research suggesting that visual perspective taking is effortful and error prone (Epley & Caruso, 2008; Birch & Bloom, 2004).

So as to better place our results, we reviewed published studies that have administered the Director's Task to both adults (over 18) and adolescents (13-18) and reported their accuracy rates (Supplementary Table 2). This brief, non-exhaustive review found that the task returns a range of baseline results (54-88%). As a consequence, these findings suggest that the Director's Task could have reliability issues, in that task performance appears to vary quite substantially from study to study. Further, concerns over the validity of the Director's Task as a measure of visual perspective taking (Rubio-Fernández, 2016; Heyes, 2014; Santiesteban, Shah, White, Bird & Heyes, 2015), together with linguistic confounds associated with the task (Symeonidou, Dumontheil, Chow & Breheny, 2016), cast doubt over its appropriateness for use in experimental designs seeking to explore perspective-taking skills in adults. Not all studies specifically state the number of experimental trials analysed, so it is possible that accuracy scores vary across studies because of analysis differences. Further, interpretation of accuracy scores is confounded by the fact that there are often only eight experimental trials included; a factor we did not fully consider when designing the study. Scores of 75% and 87.5% may seem substantially different, but in this task, the difference is only one error. Our brief review of scores obtained by other studies suggests that overall accuracy for adults completing this task lies at around 79%, which translates to most participants making less than two mistakes. This does not bode well for studies such as ours, which aim to improve perspective taking scores through experimental manipulations or training. There simply isn't enough "room" to measure any true increase in the skill. It could be argued that more trials are needed in the experimental condition, however, given the accuracy rates returned in our data, participants seem to reach ceiling quickly, rendering the data from those extra trials superfluous.

We offer caution to those interested in visual perspective taking in using the Director's Task, especially if the research question relies on score variability or score manipulation. Certainly, if visual perspective taking is indeed cognitively demanding (Birch & Bloom, 2004; Epley & Caruso, 2008), then our results are suggestive of a task that is not so much measuring visual perspective taking, as it is visual trial and error or linguistic inference (Symeonidou et al., 2016). Alternatively, low-level perspective taking (Flavell, et al., 1978), such as that thought to be investigated by the Director's Task, may be too easy to really push a mature cognitive system. Typically developed adults may simply be able to pass this test as a matter of course. Whether the task captures perspective taking or not, our results highlight the need for a more demanding task when the population of interest is typical adults.

Limitations & Future Directions

It is noted that the design of the imitation task used in this study may have been confounded and contributed to the null result. By using mirror image stimuli, the task has a strong spatial compatibility component that introduces noise to the data that overshadows the imitative tendencies of the participants (Heyes, 2011; Shaw et al., 2016; Jimenez et al., 2012). See Heyes (2011) for a thorough review of the literature concerning the effects of spatial compatibility on measures of automatic imitation. While the method used may have been imperfect, it is unlikely to have been the reason behind our null results. Another study used the same design and was able to generate a difference in congruency effects between manipulations in a within-subject design (Wang & Hamilton, 2013). Given the presence of both a spatial and an imitative component in the design, it could be argued that their result does not provide direct evidence of increased automatic imitation following prosocial priming. Thus, had this study have found an effect, we would have been unable to conclude that automatic imitation specifically was modulated by prosocial priming. However, we failed to return any difference in congruency effects between the experimental groups, meaning that even if the imitative component of the task is small and the task is capable of its detection, it was not altered at all here. Put another way, unless the task affected spatial and imitative properties in such a way that the differences cancelled each other out, we did not find evidence that prosocial priming affects automatic imitation. In order to rule out the possibility that our null result was the product of a methodological error, future studies should use an automatic imitation task that is capable of isolating imitative tendencies from spatial compatibility (Heyes & Catmur, 2011; Shaw et a., 2016; Gowen, Bolton & Poliakoff, 2016).

One further limitation concerns the sequencing of tasks. To avoid any influence of the imitation task on the Director's Task, we used a fixed order across participants. It is therefore possible that, by administering the Director's Task prior to the automatic imitation task, we unwittingly introduced another prosocial prime that either diluted or overrode the effects of the intended prosocial prime. That is to say that taking someone else's perspective may serve as a prosocial prime that increases the tendency to imitate. This would mean that our lack of group differences was due to the fact that each group, including the control, had been prosocially primed during the Director's Task and that our results could include a sample wide increase in imitation. While this scenario is possible, a number of counter-arguments immediately spring to mind. If the prosocial prime and the visual perspective taking task both activated a goal to affiliate, we might still expect to observe overall greater imitative tendencies in the first person, prosocial group. This owing to the fact that only this group had been shown previously to respond to the prosocial priming and that the effects on behaviour from both primes might be expected to be additive. Alternatively, the visual perspective taking task could have overwritten, or heavily diluted, any effects the prosocial priming task may have generated. However, with only eight critical trials among 40 other trials, the visual perspective taking task would need to exhibit strong effects to remove those created by the prosocial priming task administered just five minutes previously. A future study is required to determine whether the Director's Task can function as a prosocial prime that modulates imitative tendencies

Conclusion

The current study reduces the strength of evidence in favour of the hypothesis that first person, prosocial priming enhances automatic imitation. In addition, due to an unforeseen ceiling effect in the Director's Task, we could not evaluate whether prosocial priming modulates visual perspective taking and this question remains open for future studies to address. Taken together, when contemplating future research into the effects of prosocial priming on automatic imitation, it should be noted that its effects are variable and, if they do exist, are likely to be small. Finally, when investigating visual perspective taking using the Director's task, the possibility that the task has low reliability with adult populations should be given due consideration. More generally, by reporting null results, as well as a ceiling effect, we hope to avoid the file drawer problem and inherent bias in the published literature (Rosenthal, 1979; Ferguson & Heene, 2012). Also, by meta-analysing results as studies emerge (Cumming, 2011), we hope to move towards a more cumulative science of social cognition that future studies can build upon. The addition of just one study can make all the difference to a theory.

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Supplementary Results

SUPPLEMENTARY TABLE 1: Summary of scores for each questionnaire for each group (sd in brackets). The full scores for the IRI together with the perspective taking (PT) component of the questionnaire are provided

Questionnaire	PS-1ST	PS-3RD	Control
ASD	3.35 (1.94)	2.77 (1.64)	2.69 (1.81)
Self-esteem	27.08 (4.42)	29.63 (4.85)	27.37 (4.84)
IRI – Full	71.23 (10.86)	69.90 (13.38)	72.39 (12.64)
IRI – PT	19.31 (4.66)	19.92 (4.12)	19.39 (3.94)

<u>SUPPLEMENTARY TABLE 2</u>: Accuracy rates for the Director's task reported by other studies identified as having used the task with adults, adolescents or both

Study	Accuracy (%)	Age Category
Dumontheil, Kuster, Apperly & Blakemore (2010)	88	Adults
Dumontheil, Hillebrndt, Apperly & Blakemore (2012)	87 84	Adults Adolescents
Santiesteban, Shah, White, Bird & Heyes (2015)	54	Adults
Fett, Shergill, Gromann, Dumontheil, Blakemore, Yakub & Krabbendan (2014)	56	Adolescents
Dumontheil, Apperly & Blakemore (2010)	56 40	Adults Adolescents
Symeonidou, Dumontheil, Chow & Beheny (2016)	70 45	Adults Adolescents
Shaw, Czekoova & Porubanova (2016)	73	Adults