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The attentional cost of comparisons: Evidence for a general comparison induced delay☆

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ABSTRACT

The current work aimed to uncover the pattern of attention given to external comparison standards when engaged in social judgments. In a series of 5 experiments ($N = 463$), a Modified Spatial Cueing Task provided evidence for a general Comparison Induced Delay (CID), but found no signs of visuospatial attention (Pilot, Study 1 & 2). However, the CID did not occur if cues did not remain visually available throughout the trials (Study 3 & 4). Heterogeneity in results prompted the use of a single-paper meta-analysis including all secondary studies. A consistent CID effect was found across studies when standards remained visually available ($K = 5$), but not when they were masked ($K = 2$). No direct signs of visuospatial attentional bias were found. These results suggest that the attentional cost of engaging with external comparisons is mainly cognitive in nature, although a minor reoccurring visual component could not be excluded.

1. Introduction

Whenever we meet someone, we instantly judge that person on a variety of variables. The basis for answering these types of questions relies heavily on the selection of a standard to which we can compare our new acquaintance. When selecting these standards and forming a comparative judgment, some attentional resources are likely diverted to this process. These may include both the reallocation of cognitive resources involved in the processing of the comparative information, but could also include visuospatial biases in the form of the initial inspection and potential ongoing visual adhesion to the standards. The current work will investigate this potential attentional cost of engaging with external comparison standards, and attempts to disentangle the visuospatial and cognitive aspects.

When making judgments about the self or others people often spontaneously use some social standard as a comparison (Dunning & Hayes, 1996; Festinger, 1954). In fact, this process of comparing is such a fundamental part of human cognition that presented comparison standards are used even when they are known to be irrelevant (Gilbert et al., 1995) or presented subliminally (Mussweiler et al., 2004a). This has led to the assertion that most, if not all, social judgments are to some degree comparative in nature; either relying on internally held standards or external ones found in the current social environment (Kahneman & Miller, 1986; Mussweiler, 2003). For instance, knowing a student can solve five math problems is not very diagnostic for a judgment of intelligence until we observe his peers solving only two (an external standard), or if we have prior knowledge that a good performance means solving at least three problems (internal standard). Furthermore, these standards can either be higher than the target on the dimension of interest (upward comparisons), for instance when one judges an amateur to the standard of a professional, or can be in the opposite direction (downward comparison), when the professional is judged in comparison to the amateur.

The largest amount of work in the social comparison literature has focussed on understanding the effects that these upward and downward standards have on various comparative outcomes; such as ability estimates, affect and self-esteem (for a recent meta-analysis of these effects see Gerber et al., 2018). Comparatively less work has investigated the attentional cost of engaging with these comparison standards, despite the fact that this attention is likely an essential part of the unfolding of the comparison process as a whole.

Although internal standards are used extensively in the form of routine standards (Mussweiler, 2003) and egocentric judgments

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(Dunning & Hayes, 1996), they are difficult to investigate directly, especially in regards to the attentional cost they may cause. With only very distant measures capable of measuring the internal comparison process, past investigations have resorted to measuring the efficiency in making subsequent comparative judgments in relation to the strength of the assimilative effect resulting from a primed internal standard (Mussweiler & Damisch, 2008). The results, thereby, rely heavily on theoretical assumptions and can only offer distant estimates of the cognitive engagement with the recruited standards.

Investigations using external standards, on the other hand, can directly measure the attention given to these comparison standards and do not need to rely on specific theoretical assumptions from one of the many social comparison theories (e.g. SAM: Mussweiler, 2003; I/E Model: Bless & Schwarz, 2010). Instead, one needs only to assume that this process must logically start with at least minimal early visuospatial attention; in so far that one must direct their gaze to a stimulus in order to assess its standing on the relevant dimension and to extract this information for the act of comparison. For this reason, the current work will limit its investigation mainly to the attentional cost of engaging with these external comparison standards, although it acknowledges that internal standards can still play a role in any comparative judgments and may affect response patterns.

The scarce previous work that has investigated the time course of the comparative process has shown that the first sign of cognitive engagement with external standards happens very early in the processing of information (Ohmann et al., 2016). Therefore, comparative information seems to be encoded quickly and efficiently, suggesting any attentional bias is relatively automatic in nature. However, this work only required participants to indicate which of two simultaneously presented stimuli reflected a certain dimension to a greater degree, but did not request any absolute judgment of either on this judgment dimensions. Therefore, the processes investigated in this work may be limited to the most fundamental initial steps in the entire comparison process, i.e. assessing the informational content of two stimuli and ranking them. Subsequent integration of the comparative information in a way that ultimately leads to shifts in evaluative judgments might still require additional attentional resources of some kind. This may be in the form of prolonged visuospatial attentional adhesion to the external stimuli, or may be an internal process that requires non-visuospatial resources, such as the occupation of working memory capacity while integrating the extracted information into the final judgment.

The many established measures of automatic attention can offer some guidance regarding how to disentangle these two possible forms of attention, as they have been successfully implemented in a diverse set of fields (for an overview see Fox et al., 2011). One of the best-established behavioral measures of automatic attention allocation is the Modified Spatial Cueing Task (MSCT; developed by Posner et al., 1980; modified by Fox et al., 2001) and would seemingly provide an excellent basis for the development of a comparison focused paradigm. The MSCT manages to dissociate the reaction to relevant and irrelevant cues by presenting them in separate trials as opposed to simultaneously (Fox et al., 2001). The basic task involves identifying a neutral stimulus (probe target) that varies in its spatial location on the screen. Before the onset of the probe, a supposedly irrelevant cue appears at either the same (valid cue) or the opposite side of the screen (invalid cue). Delays in response times for invalidly cued trials are considered indicative of automatic visuospatial attention given to the cue stimuli (Fox et al., 2011).

To adapt this paradigm for the purpose of estimating attention to comparison standards, a few adjustments are necessary since the cues themselves, which will form the comparison standards, are only one part of the comparison process. The other half of the comparison relates to the target of the judgment that needs to be judged on a specific dimension. Indeed, simply asking participants to make an absolute judgment about such a judgment target engages comparative processing, even when standards are presented subliminally and without explicit prompting (Mussweiler et al., 2004a). When this process is engaged, comparison standards should become a means to reach the goal of an accurate assessment. As a result, pertinent comparison cues that are presented subsequent to a social judgment task will gain a particular attentional advantage similar to those found for other goal-relevant stimuli in countless other domains (Vogt et al., 2010; e.g. Hunger and food; Tapper et al., 2010; and Mate selection; Maner et al., 2007). These effects can be exploited by instructing individuals to estimate a judgment target's standing on a specific dimension in absolute terms yet delaying the responses until after a pertinent comparison standard has been presented as a cue in the spatial cueing trial. This way the attention given to comparison standards can be assessed while participants are still fully engaged in a comparison related judgment. Specifically, visuospatial attention given to the comparison standards would be reflected in greater delays in completing the task during invalidly cued trials than validly cued ones when a pertinent comparison standard is presented as the cue. An overall delay in responding, regardless of cue position, when a comparison standard is presented would reflect non-visuospatial attention caused by the binding of cognitive resources (for a differentiation of these two processes in the domain of erotic stimuli, see Imhoff et al. (2019a)). Thus, such an adjusted MSCT procedure should be able to disentangle the visuospatial attention (the visual fixation on the comparison standard cue) and non-visuospatial attention (reflecting cognitive preoccupation with the comparison information and process) and clarify the overall pattern of attention to comparison standards.

1.1. The present research

In order to investigate the pattern of attention given to external comparison standards and their informational content, the current work will use an adjusted MSCT task to measure the overall attentional cost of engaging in social comparative judgments (Pilot study, Study 1 and 2) and attempt to disentangle visuospatial attention from non-visuospatial cognitive processes (Study 3 and 4). If comparison standards elicit visuospatial attentional adhesion (more or less deliberate continuation of attention to comparison cues), we would expect longer latencies for comparison relevant vs. irrelevant cues during invalidly cued trials, but not on validly cued trials. It is also conceivable that the effects on visuospatial attention are relatively minor and short-lived, but that non-visuospatial attention related to the internal social comparison processes nevertheless results in a general cognitive delay related to the cognitive engagement with the comparison information. Such a comparison-induced delay (CID) might present itself in a general slowing of response times regardless of cue location when engaging in a social judgment task rather than a control task when pertinent standards are present.

Throughout the presented studies, we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the studies. In addition to the studies reported here directly, an additional two studies were run as part of this project. These additional studies are described in detail in the additional materials and are included in the final summative meta-analyses. Furthermore, all anonymised raw[1] and aggregated data and additional materials for all studies can be found on the Open Science Framework page at: https://osf.io/hkem9/

2. Pilot test

This initial pilot test implemented a first version of the modified spatial cueing paradigm to test the procedure and its general ability to detect social comparison related bias. More specifically, this study

[1] The variables of study area, gender and timestamps are not included in these data to ensure the complete anonymity of participants, but are available upon request. In addition, the visual stimuli used in the studies are also not provided publicly due to copyright concerns, but can be requested.

aimed to assess if latencies on the cueing task would be higher during the presentation of social cues, compared to non-social cues, when participants were engaged in a social judgment rather than non-social judgment task. This was expected to be reflected in an interaction effect between task type and cue type. Additionally, a three-way interaction also including the validity of the cue would additionally indicate visuospatial attentional bias specifically.

2.1. Method

2.1.1. Participants

As no estimates of the size of the possible effects were known, this pilot study recruited 59 German speakers on campus at the University of Cologne. Sensitivity analysis showed this sample was enough to detect a simple effect in a repeated measures design 80 % of the time with $\alpha = 0.05$ for effect sizes of $\eta_p^2 > 0.123$ (determined in G*Power; Faul et al., 2007).[2]

Participants gave their informed consent after their rights and the data collection practices had been explained. The final sample consisted of 28.8 % female participants and was aged between 19 and 39 years ($M = 25.16$, $SD = 4.63$).

2.1.2. Design

The software package Inquisit 3 was used in the setup and running of all studies. The main task consisted of trials made of three parts. The initial part of the trial included the presentation of an image of a social judgment target (e.g., men and women) or non-social judgment target (e.g., boats or cars), which participants were required to judge on an open-ended question with a numerical estimate. An example of a social judgment item would be “How much weight can this man lift (in kg)?”, while a non-social one was “How fast is this boat (in km/h)?”. Importantly, these questions were not answered in this first step, but only at the end of the whole trial.

The second part of the trial consisted of a Spatial Cueing Task (Fox et al., 2001; Posner et al., 1980) in a modified form. This Modified Spatial Cuing Task (MSCT) required participants to rapidly identify a neutral stimulus, referred to as the “probe”, which was either randomly presented on the left or the right side of the screen. Responses were given by using the corresponding button on the keyboard, in this case the letters “u” and “n” were presented as a neutral probe stimulus to make position matching interferences less likely due to the vertically inverse shape and location of these characters on a standard keyboard (for the superiority of identification over locations tasks see Imhoff et al. (2019b)). Slightly before this probe appeared, a distracting cue was presented on either the same side (Valid cue), or at the opposite side (Invalid cue) of the screen slightly beside where the probe was to appear. These distractor cues comprised either social or non-social cues that represented upward or downward standards on the relevant dimension. For instance, a picture of a bodybuilder might be presented as a social cue when the strength of the social judgment target was being considered. Alternatively a rowing boat may be presented as a non-social cue in the case of a non-social judgment about a boat's speed. Participants were explicitly instructed to ignore these stimuli and focus solely on the quick and accurate identification of the probe. In the current study the slight delay between the appearance of the cue and the probe, i.e., the stimulus onset asynchrony (SOA), was set to 250 ms to coincide with expected early attentional processes. Both the cue and the probe remained onscreen until a response was given, see Fig. 1 for the layout of the screen at the end of the trial. After giving their response in the spatial cueing phase, participants were asked at the end of the trial to give a numerical response to the initial judgment question.

In this series of events, the social judgment task should induce social comparative thinking resulting in the relevant social cues presented during the spatial cuing phase gaining an initial goal-relevant attentional advantage, possibly followed by later cognitive preoccupation while the information is incorporated into the final judgment. Non-social cues should not show this advantage for these trials. However, for the non-social task the non-social cues may gain such an advantage, while here the social cues do not have any increased relevance though a slight general bias towards social cues may be present across trials.

Twelve trials were run for each judgment condition (social vs. non-social judgment), for social and non-social cues (social vs. non-social cues), and for upward or downward comparison standard (up vs. down), totalling 96 trials. Validly and invalidly cued trials each appeared in half the trials for each participant, as was the case for the probe position (left or right) and the probe identity (u or n). To ensure all combinations of factors occurred equally across the study these factors were also counterbalanced between participants.

2.1.3. Stimuli

Twelve social judgments items such as “How much weight can this man lift (in kg)?”, and twelve non-social items like, “How fast is this boat (in km/h)?” were created for this pilot study. These items were accompanied by 48 relevant neutral social and non-social images, and 48 comparison cues representing both upward and downward standards in equal numbers. All images were selected off the internet to have clear relevance to the judgment dimensions.

As previous research has noted individual differences in the extent to which people rely on comparative information, we explored this possibility by including the Iowa-Netherlands Comparison Orientation Scale (INCOM; Gibbons & Buunk, 1999) consistent of 11 items ($\alpha = 0.85$) to assess individual differences in social comparison orientation.

2.1.4. Procedure

Upon arrival, participants were sat in separate cubicles in front of a computer in a laboratory setting. Before starting the study, the general procedure of the study and data storage policy was explained to participants prior to the signing of an informed consent form. Following this, the general demographics, such as Sex, Age and Education level were recorded at the beginning of the study. In order to allow participants to become familiar with the main task, a detailed explanation was given followed by four practice trials. Participants were then given the opportunity to ask any further questions regarding the task. With no further questions, participants continued on to the main batch of 96 trials, which followed in random order. Finally, at the end of these trials the INCOM was administered, after which participants were debriefed and given their compensation.

2.1.5. Data treatment

Trials with erroneous probe detections were removed (2.8 %), and the remaining trials were truncated under 200 ms (2 trials) and above the Tukey criterion (1763 ms; 6.7 %).[3] This resulted in a total of 9.5 % of trials being removed. For use in the final analyses, these latencies were then log transformed. Furthermore, using the raw truncated scores, various difference scores were calculated for the social judgment condition and the non-social judgment control condition in an effort to gain indicators of individual differences in attentional bias not influenced by general interpersonal reaction speed variations. These scores, methods of calculation, and descriptions are presented in Table 1.

[2] Regretfully, the wrong version of η_p^2 was selected in the a priori power analysis (conducted in G*Power; Faul et al., 2007). This error was brought to our attention only after the project had concluded. Therefore, sensitivity analyses are presented in this section as post-hoc power analyses are uninformative (Hoenig & Heisey, 2001).

[3] This outlier criterion limit is calculated as 1.5 times the value range between the first and third quartile above the 3rd, or Q3 + 1.5(Q3-Q1).

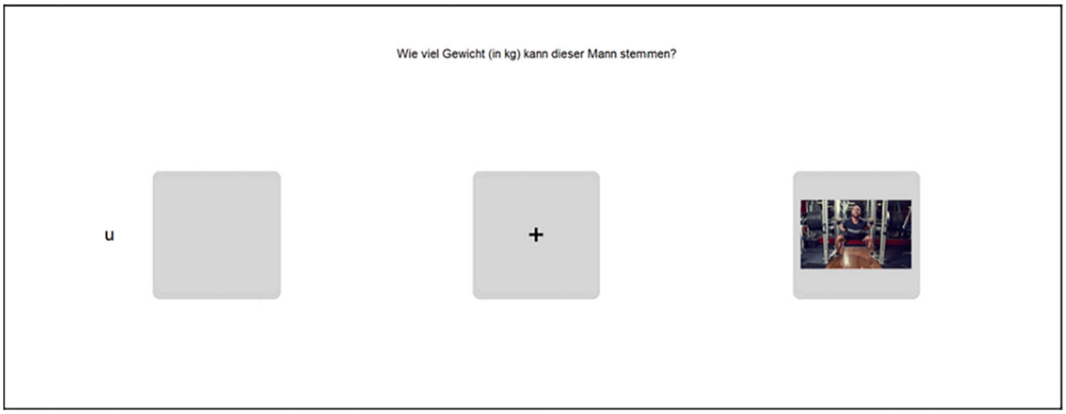


Fig. 1. Layout of a trial at the point of response, with the question remaining at the top of the page. The probe 'u' and cue are depicted on the left and right side respectively in this invalid trial.

2.2. Results

A 2 (Task type: Social vs Non-social) × 2 (Cue type: Social vs Non-social) × 2 (Comparison direction: Upwards vs Downwards) × 2 (Cue validity: Valid vs Invalid) repeated measures ANOVA was used to analyse the data. As such, participants who did not provide any usable trials, as per the exclusion criteria, for at least one of the factor levels were not included in the analyse.

The presence of social cues compared to non-social cues significantly increased the time to respond to the probe overall, $F(1, 56) = 12.94$, $p = .001$, $\eta_p^2 = 0.188$, 90 % CI [0.056, 0.328]. Furthermore, in line with the expectations, this effect was significantly moderated by the task subjects were engaged in, $F(1, 56) = 6.90$, $p = .011$, $\eta_p^2 = 0.110$, 90 % CI [0.014, 0.243]. Only social comparisons were associated with a significant increase in reaction times in the presence of social cues ($\Delta M = 0.053$, $SE = 0.012$, $p < .001$, 95 % CI [0.030, 0.076]), but no such difference appeared for non-social comparisons ($\Delta M = 0.012$, $SE = 0.012$, $p = .278$, 95 % CI [−0.011, 0.038]). This suggests the presence of attentional bias resulting from a unique social comparison process that does not occur for non-social comparisons. The expected 3-way interaction between task type, cue type and cue validity did not reach significance, however, $F(1, 56) = 1.13$, $p = .293$, $\eta_p^2 = 0.020$, 90 % CI [0.000, 0.112], meaning there were no signs of evidence for visuospatial attentional bias in these data.

The validity of the cue presentation did show a significant main effect, $F(1, 56) = 300.17$, $p < .001$, $\eta_p^2 = 0.843$, 90 % CI [0.775, 0.878], with invalid cues leading to longer reaction times. Lastly, task type also showed a significant interaction with the direction of the comparison, $F(1, 56) = 13.43$, $p = .001$, $\eta_p^2 = 0.193$, 90 % CI [0.059, 0.334], as well as the related three-way interaction including cue type, $F(1, 56) = 8.82$, $p = .004$, $\eta_p^2 = 0.136$, 90 % CI [0.026, 0.273]. Closer inspection showed that this effect of direction was limited to the non-social cues in a way where in social judgment trials upward non-social cues increased reaction time, ($\Delta M = 0.048$, $SE = 0.013$, $p = .001$, 95 % CI [0.021, 0.075]), while the opposite was the case for non-social judgments, ($\Delta M = -0.045$, $SE = 0.017$, $p = .009$, 95 % CI [−0.079, −0.012]). Although the current work will not investigate this effect any further, a speculative explanation for this may lie in the differential familiarity of the upward and downward objects, which has also been found to influence comparative judgments themselves (Häfner, 2009).

2.2.1. Correlations

The social and non-social Validity difference scores, Cue difference scores, CA, and CID were used in a correlational analysis with the INCOM, age and sex variables. The Validity difference scores for comparison trials were found to correlate positively with sex, $r = 0.273$, $p = .04$, 95 % CI [0.013, 0.498], meaning being male compared to being female was associated with longer latencies for invalid compared to valid cues when engaging in a comparison trials in these data. No other measures were significantly associated with any of the scales, $r < 0.26$.

2.3. Discussion

The results of this pilot study suggest that there is indeed attentional bias towards social cues when engaging in social comparisons, which does not extend to comparisons involving non-social judgments and relevant non-social cues. However, the presence of visuospatial attention to social comparison standards specifically was not detected. This could be due to the limited scope of the pilot study, in terms of the number of trials and stimuli that were included, which may have limited the power of the analyses to find these more subtle effects.

Furthermore, although the evidence in the current study does not suggest that non-social comparisons induce a similar bias, this is in contrast to previous work which indicated that the processing of basic social and non-social comparison information unfolded at similar speeds (Ohmann et al., 2016) despite the more complex nature of social stimuli. Therefore, some form of comparative processing could still be present in the control condition. In addition, some judgment dimension may apply to both social and non-social targets like speed for instance, which one might compare to non-social targets like animals or vehicles as well as other humans. Thus, it is possible that some comparative thinking could

Table 1
The names, calculation methods and descriptions of the various difference scores that were calculated in the pilot study.

Score name	Calculation method	Description
For the social judgment condition and the control condition separately:		
Validity difference score	Socially cued invalid trials – Socially cued valid trials	Reflect the amount of visuospatial attention granted to social cues with higher scores indicating more visuospatial attention
Cue difference scores	Social cue trials – non-social cue trials	Reflect the general amount of attentional bias caused by social cues vs. non-social cues regardless of validity
Composite scores:		
Comparison attention (CA) scores	Validity difference score in the Social judgment condition – Validity difference score in the Control condition	Capture increased visuospatial attentional bias for trials where social comparison information is task relevant compared vs. not. Large positive scores indicate large bias
Comparison induced delay (CID)	Cue difference score in the social judgment condition – Cue difference score in the Control condition	Captures the overall bias towards the social cue when engaging in social judgments compared to the control condition. Large positive scores indicate large bias in the social condition.

be present even when a social judgment is being made and a non-social cue is present. Taken together these possibilities could cause the effect of comparative bias to appear smaller in comparison to the control condition. For these reasons, the MSCT used in the subsequent studies replaced non-social comparisons with a memory task and increased power by including additional trials and stimuli.

3. Study 1

This study aimed to investigate whether the presence of relevant comparison targets indeed biases visuospatial attention during a social judgment task within the MSCT paradigm compared to a non-comparative control task. More specifically, the expectation was that the invalidly cued stimuli would increase response latencies more than validly cued ones when participants were engaged in a social judgment task compared to when they were engaged in a memory task.

3.1. Method

3.1.1. Participants

A sample size of 166 German speakers were recruited on campus at the University of Cologne to participate in the study for a monetary reward of 6 euros. This sample size is sufficient to detect an effect size of $\eta_p^2 > 0.046$ with $\alpha = 0.05$ and $\beta = 0.20$ according to a sensitivity analysis (determined in G*Power; Faul et al., 2007). Furthermore, this sample size should provide reasonable stability for the exploratory correlational analyses, $r > 0.20$, $w = 0.15$, $\alpha = 0.05$, $\beta = 0.10$ (see Schönbrodt & Perugini, 2013).[4]

Prior to their participation, respondents' consent was obtained after being informed about data collection and storage practices and their right to withdraw from the experiment without consequence. The final sample in this study was 68.7 % female and was aged between 16 and 62 years ($M = 24.17$, $SD = 5.72$).[5]

3.1.2. Design

The main task again consisted of trials with three parts. However, the initial part of the trial now only included the presentation of an image of a social target, accompanied by one of two tasks. One was an open-ended question that required a numerical judgment about the target's behaviours or skills (Social judgment task); while the other instructed participants to simply memorise the image (Memory task), see Fig. 2 for an overview of possible trial sequences. The social judgment trials were similar to those used in the pilot study (see section 3.1.3 for a more detailed report), while the memory prompt was simply the instruction to "Remember the image".

The second part of the trial was again an MSCT with an SOA of 250 ms, similar to that used in the pilot study. However, only relevant social stimuli were used as distractor cues in this investigation. After completing the spatial cueing phase, participants gave a numerical response to the initial social judgment question or, in the case of a memory trial, were asked a specific question about the previously presented image, for instance "How many bags was the woman carrying?". As a result of this procedure, one would expect participants to only engage in the social comparative thinking during the social judgment trials making the distractors cues goal-relevant. In contrast, these cues offer no such advantage in the memory trials and should not affect attention in the same way.

Next to the attentional cost of the comparison cues, the current study also attempted to measure theoretically predicted shifts in judgment estimates, assimilation or contrast, in the response patterns for the social judgments trials. In order to promote both consistent assimilation and contrast in these responses, the extremity of the social cues were manipulated in addition to the direction of the standards as this has been found to moderate the direction of the comparative outcomes (e.g. Mussweiler et al., 2004b). However, as these results are not the main focus and they did not show the theoretically expected patterns, they will not be described here in detail but can be found with the additional studies online (for a recent critical discussion regarding the heterogeneity of these effects across judgments and contexts, see Barker et al. (2020)).

For this extensive design, a total of 320 trials were run including twenty trials for each combination of the judgment task (social judgment vs. memory), cue direction (up vs. down), cue extremity (moderate vs. extreme), and its validity (valid vs. invalid). The probe presentation (left or right) and probe identity (u or n) were presented in equal numbers to each participant and were also counterbalanced between participants so that each pairing was presented for each factor level in equal numbers overall.

3.1.3. Stimuli

A series of 30 questions were generated relating to a variety of dimensions and relevant behaviours and attributes. For each of these questions 20 images were collected from various online sources that reflected the dimension of judgment. This collection of images was created with a large apparent variation in the extent to which the social target expressed traits related to the dimension of judgment. A pre-test was then conducted with 123 participants recruited at the University of Cologne, who consisted of 49.2 % females and were aged between 18 and 50 years ($M = 24.97$, $SD = 6.48$). Each participant was required to respond to the questions for a fourth of all the images, amounting to about 30 judgments per image. The ease of making the judgment and the clarity of the image were also measured. Guided by these data, 20 questions were retained based on their average ease of judgment and clarity scores. In addition, the presence of low intra-image variability (similar judgments of the image on the relevant dimension) and high intra-question variability (different images representing a variety of extremity levels) were also considered when selecting the questions. This was done to ensure clear images within the question groups that ranged substantially on, and reflected distinct values of the judgment dimension.

Within these question groups, the four lowest scoring images on the clarity and judgability scale were removed, leaving the 16 top rated images per question group. The eight images closest to the dimension average were used as the initial neutral judgment target in the first part of each trail, whereas the four highest and four lowest were selected to be used as upward and downward cues respectively within the MSCT. These cues were further divided with the two highest and lowest judged images in each question group forming the extreme standards, while the four left over cues formed the moderate standards.

3.1.4. Procedure

Other than the increase in trials, the procedure was identical to the one used in the pilot study.

3.1.5. Data treatment

Response times where the probe was misidentified were removed (4.1 %), with remaining latencies truncated below 200 ms (0.9 %) and above the Tukey criterion (1539 ms; 5.8 %). 10.2 % of trials met at least one of these exclusion criteria.[6] The remaining scores were then log transformed for use in the main analyses.

Furthermore, difference scores were again calculated in a similar manner. Firstly, validity difference scores for each judgment type were created by subtracting response times for valid trials from those of

[4] The size and stability for the correlations of interest correspond to the average size of correlations and standard deviations in social psychology respectively as determined in Richard et al. (2003).

[5] The student population includes mature students and the campus is open to all. No exclusion criteria for age were defined, resulting in the broad age range seen here. However, as seen in the mean and standard deviation, the majority of the population was of a typically young age for a student population.

[6] The distribution of these exclusions across the conditions for this and all following studies can be found in the supplemental materials online.

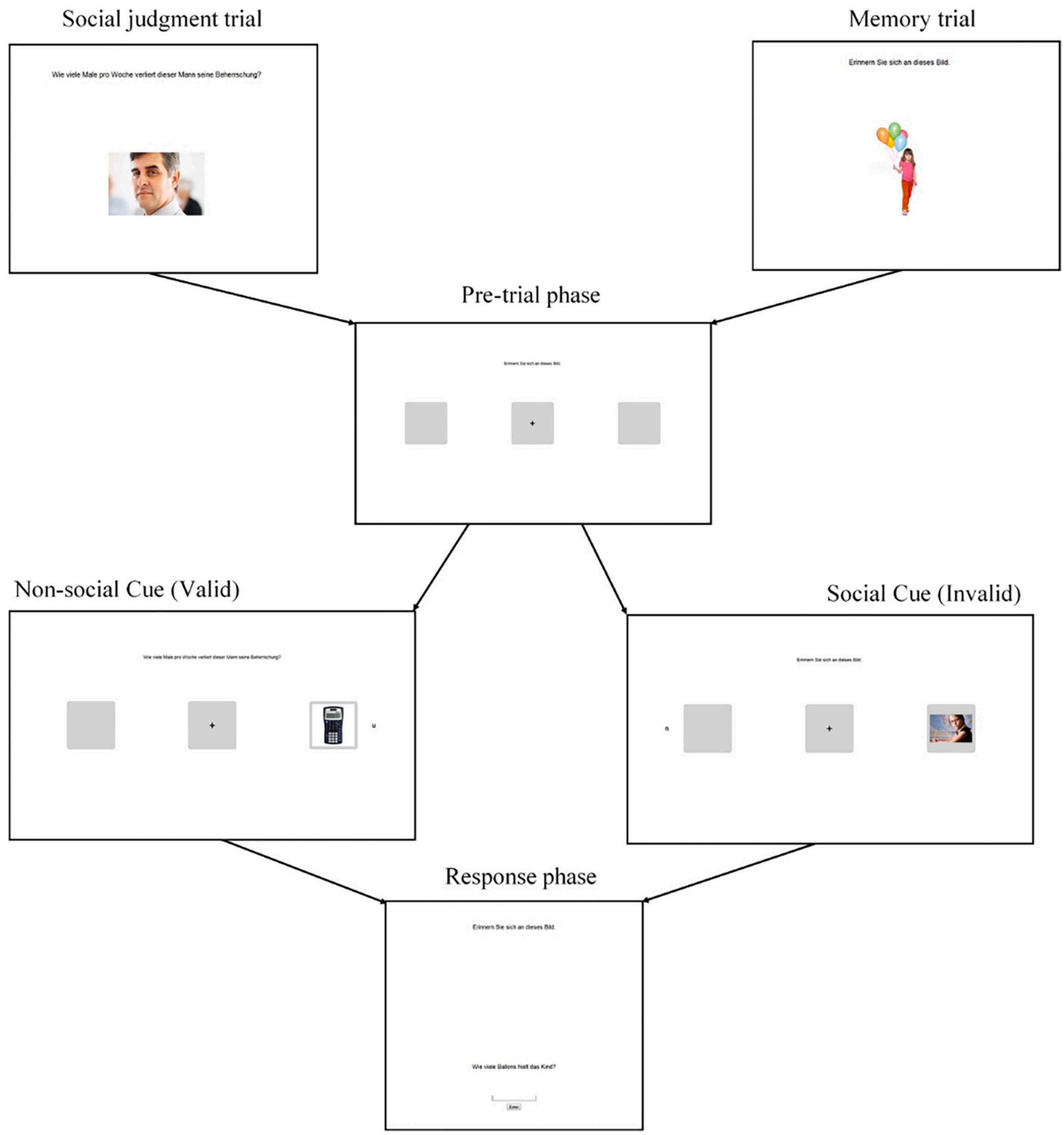


Fig. 2. MSCT trial in order; the social or memory trial is presented for 3000 ms; a short 500 ms pre-trial pause with fixation cross is presented; A Cue is presented followed by the probe 250 ms apart; finally, an open format response is given to the initial item.

invalid trials with higher scores indicating more visuospatial attention. CA scores were calculated again by subtracting the validity difference scores from the memory condition from those of the social judgment condition, reflecting increased visuospatial attentional bias in trials where the cues were task relevant compared to when they were not. As there were no non-social cues, no CID scores were calculated.

3.2. Results

A 2 (Task: Social judgment vs. Memory) × 2 (Comparison direction: Upward vs. Downward) × 2 (Comparison extremity: Moderate vs. Extreme) × 2 (Cue validity) factorial repeated measures ANOVA was conducted on the log transformed latencies. Again, participants without a single trial left in one of the factor levels, after application of the exclusion criteria, could not be included in the analysis.

The interaction effect of task type and validity of the cues, the focal test of the main hypothesis regarding visuospatial attention, was found to be significant, $F(1, 161) = 8.23$, $p = .005$, $\eta_p^2 = 0.049$, 90 % CI [0.009, 0.112]. However, although the social judgment condition showed the expected increased response times compared to the memory task for invalidly cued trials in the pairwise comparisons ($\Delta M = 0.057$, $SE = 0.005$, $p < .001$, 95 % CI [0.047, 0.066]), it also showed a similar, but larger effect for validly cued trials, ($\Delta M = 0.074$, $SE = 0.006$, $p < .001$, 95 % CI [0.061, 0.087]), see Fig. 3. In fact, this discrepancy means the valid-invalid difference score was larger for memory trials than social judgment trials, even though the social judgment task did increase reaction times overall, $F(1, 161) = 196.11$, $p < .001$, $\eta_p^2 = 0.549$, 90 % CI [0.465, 0.613].

Unsurprisingly, the validity of the cue overall also showed a large significant main effect, $F(1, 161) = 656.38$, $p < .001$, $\eta_p^2 = 0.803$, 90 % CI [0.760, 0.833], with invalid cues increasing the response times compared to valid ones. Lastly, a significant interaction was found between the task type and the direction of comparison, $F(1, 161) = 4.39$, $p = .038$, $\eta_p^2 = 0.027$, 90 % CI [0.001, 0.079]. This effect was marked by longer latencies for upward comparison cues during the social judgment task trials, ($\Delta M = 0.008$, $SE = 0.004$, $p = .038$, 95 % CI [0.000, 0.015]), but not the memory trials, ($\Delta M = -0.002$, $SE = 0.004$, $p = .648$, 95 % CI [−0.009, 0.006]). This attentional bias towards upward comparisons specifically may reflect, or be the underlying cause for, the preferential selection of upward over downward comparisons when no lateral comparison is provided, as reported in a recent meta-analysis (Gerber et al., 2018).

3.2.1. Correlational analyses

No significant correlations were found between the MSCT scores and the INCOM or the demographics.

3.3. Discussion

In this study, the data provided counterintuitive evidence that the largest signs of attentional bias towards comparison standards is to be found not in the invalid trials (as would be expected of visuospatial attention), but in the validly cued ones. Although surprising, these findings seem to indicate the external standards did receive some limited visuospatial attention, but that the extracting of the relevant social information is so short lived and efficient that only the extremely fast valid trials are affected. The overall longer latencies of the social comparison trials compared to the memory trials could indicate that, once the social information has been internalised, the largest part of the attentional cost might reside in an extended cognitive process for which no lingering visuospatial attention is necessary.

However, the current set-up cannot clearly disentangle this possibility from simple task demands that might not involve the presented cues at all. For instance, it is conceivable that being faced with the judgment task itself was sufficient for some participants to recruit an internal comparison standard and ignored the external standard all together. This scenario would still lead to an overall lengthening of reaction times for social judgment trials regardless of the presented cues. In order to distinguish between the external and possible internal comparison related effect, or other unrelated task demands, Study 2 will include a condition that displayed non-social cues that do not offer any social information in addition to those that do. Any difference between these conditions would reflect an attentional bias that is strictly the result of the informational content that the external standards provide during the social judgment task, beyond the possible influence of other task demands that could be present in both situations.

4. Study 2

In this study, the MSCT paradigm was implemented with the addition of presenting non-social cues in order to disentangle non-visuospatial attention bound by the content of external comparison cues from the potential use of internal standards and other unspecified task related cognitive demands. We expected the presence of social cues, compared to non-social cues, to increase reaction times to a larger extent during judgment task trials than during memory trials. An interaction between the social nature of the cue and the task would be indicative of comparison related non-visuospatial attentional bias. Additionally, we expected visuospatial attentional bias specifically to be reflected in this effect being more pronounced when cues are invalidly cued than validly cued.

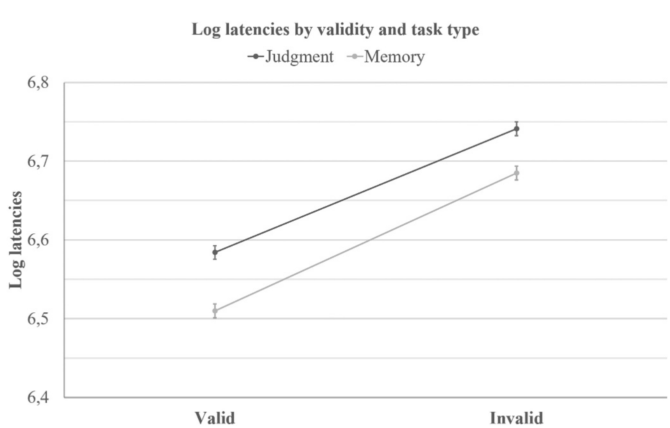


Fig. 3. Means and standard errors of log transformed latencies by Task type and Cue validity. Note: Standard errors in all figures were calculated using the formula described by Jarmasz and Hollands (2009).

4.1. Method

4.1.1. Participants

A sample of 66 German speakers was recruited on campus at the University of Cologne. The sensitivity analysis showed this sample size was sufficient to detect an effect of $\eta_p^2 > 0.111$ with $\alpha = 0.05$ and $\beta = 0.20$ (determined in G*Power; Faul et al., 2007).

Consent was obtained prior to the experiment, in which the participants were informed about the collection and storage of data in an anonymised form as well as their right to withdraw from the experiment at any time without consequence. Participants received a monetary compensation of 6 euros for their participation. The sample consisted of 66.7 % female participants and was aged between 18 and 38 years ($M = 22.54$, $SD = 3.45$).

4.1.2. Design

The current study used an identical three-step MSCT set-up as in the previous study. However, the standing of the comparison standards on the judgment dimension was no longer considered explicitly, but rather the same stimuli from the previous study were randomly presented across trials. In addition to these social cues, non-social ones were added, which did not offer any comparative information relevant to the social judgment. As a result, only the social cues represented pertinent comparison standards for the judgment task.

Twenty trials were run for each combination of the judgment task (social judgment vs. memory), cue type (social vs. non-social), and its validity (valid vs. invalid), for a total of 160 trials. The probe presentation (left or right) and probe identity (u or n) were presented in equal numbers to each participant and counterbalanced between participants to ensure equal presentation overall.

4.1.3. Stimuli

The pre-tested questions and stimuli were used in this study as in Study 2, with the exception of the non-social cues which were taken from the pilot study. This time no distinction was made between moderate, extreme social comparisons, as the judgments themselves would not be analysed further since no consistent assimilation and contrast effects were found in the initial study.

4.1.4. Scales

In addition to the main task, we again included scales hypothesized to be related to the comparison process. For exploratory reasons we included at the end of the study the INCOM (Gibbons & Buunk, 1999), the BFI-10 (Rammstedt & John, 2007), the Rosenberg self-Esteem scale (Rosenberg, 1965), the Benign and Malicious Envy Scale (BeMaS; Lange & Crusius, 2015), and the Body Dissatisfaction subscale (Garner et al., 1983). For a more complete description of these scales, refer to the supplemental materials online. As no correlations were found between these scales and the MSCT scores, results for the exploratory correlational analyses will not be described in text, but can be found in Table A1 in the Appendix A.

4.1.5. Procedure

The procedure was identical to Study 1 with the exception that there were only 160 trials as part of the main task. Furthermore, in addition to the INCOM, all described scales were administered at the end of the study, after which participants were debriefed and given their compensation.

4.1.6. Data treatment

Response times for erroneous trials (3.6 %) were excluded, latencies were further truncated below 200 ms (1.9 %) and above the Tukey criterion (1479 ms; 4.5 %). Due to co-occurrence of exclusion criteria, the total amount of excluded latencies amounted to 9 %. The remaining scores were subsequently log transformed for use in the main analyses.

Again, the truncated raw scores were used to create a number of difference scores for use in correlational analyses. These scores were calculated similarly to those presented in Table 1, but with the control condition now consisting of a memory task. If the comparison process does not rely heavily on visuospatial attention, but instead mainly binds cognitive resources without the need for continued visual inspection of to the cues, one would expect longer reaction time for social judgment trial regardless of cue location when comparison information is present. This should be reflected in differences in the cue difference scores for the two conditions, i.e. larger CID scores which capture the overall attentional bias that is caused by the presents of pertinent comparison standards when engaged in a social judgment task.

4.2. Results

A 2 (Validity) × 2 (Task: social judgment vs. memory) × 2 (Cue type: Social vs. non-social) factorial repeated measures ANOVA was conducted on the log transformed truncated latencies. If no trials remained in one of the factor levels, after the exclusion criteria were applied, the participant could not be included in this analysis. The results of this analyses showed that the data were in line with the main prediction concerning non-visuospatial attention, as seen in the significant Task type and Cue type interaction, $F(1, 64) = 4.76$, $p = .033$, $\eta_p^2 = 0.069$, 90 % CI [0.003, 0.183], see Fig. 4. The prediction regarding visuospatial attentional was, however, not supported, with the three-way interaction including cue validity failing to reach significance, $F(1, 64) = 0.05$, $p = .819$, $\eta_p^2 = 0.001$, 90 % CI [0.000, 0.032].

A significant main effect for the type of task, $F(1, 64) = 41.74$, $p < .001$, $\eta_p^2 = 0.395$, 90 % CI [0.239, 0.513], revealed that trials with social judgments overall showed increased response times for probe identification compared to trials with a memory task. Furthermore, validly cued trials overall were associated with far smaller latencies compared to invalidly cued trials as can be seen in the very large significant main effect of cue validity, $F(1, 64) = 353.71$, $p < .001$, $\eta_p^2 = 0.847$, 90 % CI [0.786, 0.880]. The last of the main effects, concerning the social nature of the cue, did not meet the conventional standards of significance in these data, $F(1, 64) = 3.44$, $p = .068$, $\eta_p^2 = 0.051$, 90 % CI [0.000, 0.158].

4.3. Discussion

In this second study, the reaction time data revealed that social cues entailed a higher attentional cost during the social judgment task than during the memory tasks, in line with the expectations regarding a general CID effect. However, in contrast to the theoretical expectations as well as to the surprising results found in Study 1, the validity of the cues did not moderate this effect in any way as would be expected if visuospatial attention played an extensive role.

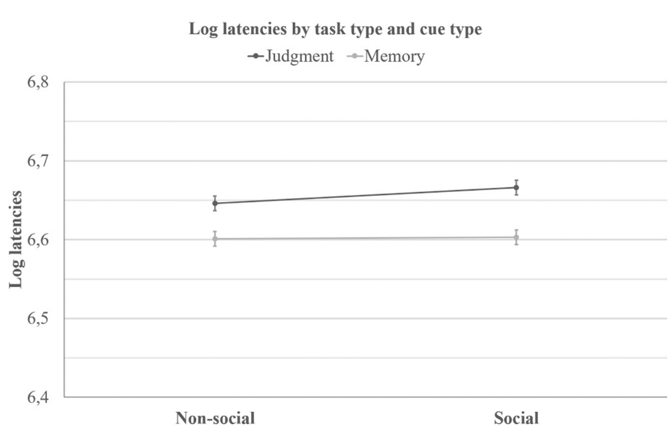


Fig. 4. Means and standard errors of log transformed latencies by Task type and Cue type.

Considering these results in addition to the previous findings, it seems likely that the increased latencies during the MSCT trials is indeed driven in large part by prolonged non-visuospatial attentional bias resulting from the comparison process. As opposed to the idea that participants allow their gaze to linger on the comparison standards throughout the comparison process, the current pattern is more indicative of cognitive engagement with the social information that is efficiently extracted from the cues after brief visual inspection in the first few hundred milliseconds of presentation. This pattern would suggest that the very early extraction of social information and ranking that was found by Ohmann et al. (2016) might be all that is needed to form sufficient mental representations of the standard to complete the entire comparison process. After this extraction, no additional visuospatial attention is necessary for the full comparison process to unfold, although cognitive engagement with these representations seems to continue to inhibit task performance for longer periods. This would also explain how even subliminally presented comparison standards can have an effect on the final comparative judgments (Mussweiler et al., 2004a).

If this is the case and no prolonged visuospatial attention is necessary for the comparison process to unfold, removing the cue from view at the onset of the probe should leave the CID effect intact. Therefore, the next study will investigate if the non-visuospatial attentional bias remains present when stimuli are covered by a mask after initial exposure.

5. Study 3

As both previous studies found no evidence of visuospatial attention, this third study limited the possibility of prolonged visuospatial attention completely by removing the cues at the probe onset. This allowed participants to extract the social information initially with the brief visuospatial attention necessary to internalise it, but limited later attentional bias to be purely cognitive in nature. As in the previous study, we expected that, compared to trials with non-social cues, trials with social cues would increase reaction times for social judgment trials more so then for the memory trials. Such an effect would be indicative of a non-visuospatial and likely purely cognitive attentional bias. However, as prolonged visuospatial attention was no longer possible after probe onset, we did not expect the validity of the cue to have any influence on this effect.

5.1. Method

5.1.1. Participants

Similar to the previous study, 60 German speakers were recruited on the University of Cologne campus, which sensitivity analysis showed would be sufficient to detect an effect size of $\eta_p^2 > 0.121$ with $\alpha = 0.05$ and $\beta = 0.20$ (determined in G*Power; Faul et al., 2007). These respondents offered their informed consent about the collection and storage of their data and their right to withdraw from the experiment without consequence at any time. Six euros were offered for their participation in this study. The sample was 35 % female and aged between 16 and 29 years ($M = 22.15$, $SD = 3.01$).

5.1.2. Design

The general design was identical to Study 2 with the exception that the cues no longer remained on the screen once the probe appeared, making sustained visuospatial attention impossible, but still allowing any cognitive processes that do not rely on visuospatial inspection to occur. Each combination of the judgment task (social judgment vs. memory), cue type (social vs. non-social), and its validity (valid vs. invalid) was measured in 20 trials, totalling 160 trials. The probe presentation (left or right) and probe identity (u or n) were again presented in equal numbers to each participant and counterbalanced between participants so all combinations occurred equally often overall.

5.1.3. Stimuli

Stimuli were identical to those used in Study 2. Since no strong associations were found between the additional scales and the reaction time measures in Study 2, the additional scales removed with the exception of the INCOM. However, as the exploratory correlational analyses in this Study once again did not reveal any consistent correlations, they will not be reported in detail.

5.1.4. Procedure

The procedure was identical to Study 2, except that the INCOM was the only scale administered at the end of the study.

5.1.5. Data treatment

Once again erroneous trials were removed (4.7 %), with remaining latencies truncated below 200 ms (0.6 %) and above the Tukey criterion (1539 ms; 3.8 %). In 8.6 % of trials met at least one of these exclusion criteria. The remaining scores were then log transformed for use in the main analyses. Again, the truncated raw scores were used to create the same difference scores presented in Table 1 for use in the correlational analyses.

5.2. Results

The log transformed truncated latencies were used in a 2 (Task: Social judgment vs. Memory) × 2 (Cue type: Social vs. Non-social) × 2 (Validity) factorial repeated measures ANOVA. Counter to the expectations, the interaction between Task type and Cue type did not produce a significant interaction, $F(1, 59) = 0.23$, $p = .637$, $\eta_p^2 = 0.004$, 90 % CI [0.000, 0.066], with the three-way interaction also failing to reach significance, $F(1, 59) = 2.15$, $p = .15$, $\eta_p^2 = 0.035$, 90 % CI [0.000, 0.138]. These findings, thus, offer no evidence of attentional bias when a mask was present. In addition to these main results, a main effect of the type of task was again found. Social judgment trials showed significantly increased latencies compared to ones with a memory task, $F(1, 59) = 48.94$, $p < .001$, $\eta_p^2 = 0.453$, 90 % CI [0.292, 0.566], again pointing towards higher cognitive demands for the social judgment task that may be the result of internally produced comparison standards being generated. Finally, the analysis again showed that participants identified the probe significantly more quickly when paired with a valid cue than an invalid cue, $F(1, 59) = 276.96$, $p < .001$, $\eta_p^2 = 0.824$, 90 % CI [0.752, 0.863]. However, the social nature of the cue did not significantly affect reaction times compared to non-social ones in these data, $F(1, 59) = 0.04$, $p = .845$, $\eta_p^2 = 0.001$, 90 % CI [0.000, 0.027].

5.3. Discussion

In the current study, where the visual availability of cues was restricted to the onset of the probe, no detectable signs of comparison related attentional bias were found. Contrary to the predictions and the lack of evidence for validity effects in the first two studies, it seems that the visual availability of the cues might yet be necessary for the CID to occur even though no signs were detected previously. Therefore, the type of visuospatial attention that occurs during the comparative process might not be limited to the fast initial inspection nor simple visual lingering. Instead, it may include a more complex pattern of gazes that the standard validity manipulation in the MSCT is not sensitive enough to detect consistently. However, based on the current study's absence of evidence this is too strong a claim to be supported by these data alone. Therefore, the next study will include both masked and unmasked trials to replicate the previous findings as well as test whether the masking indeed prohibits the CID effect.

6. Study 4

This fourth and final study combined aspects of the two previous studies, by presenting trials where the cues remain on screen until a response was provided, and trials where the cues were masked at probe onset. The former allowed both visuospatial attention and cognitive attention to affect reaction times, while the latter did not allow sustained visuospatial attention, isolating only the processes that can occur without the prolonged visual availability of the cue.

For unmasked trials, we expected to find a CID effect similar to Study 2; with social cues increasing reaction times compared to non-social cues for judgment trials more so than for memory trials. In this effect, both cognitive and complex visuospatial attentional components could be at play. As a last test of more classical pattern of visuospatial attention, cue validity would be expected to moderate this effect in the unmasked condition. However, if purely cognitive processes of comparison can occur without any type of prolonged visuospatial attention, masked trials would be expected to show a similar CID effect as unmasked trials.

6.1. Method

6.1.1. Participants

Considering the addition of the masked and unmasked conditions, sample size was doubled from the previous two studies to include 118 German speakers recruited at the University of Cologne campus. Sensitivity analysis showed this sample size was sufficient to detect an effect of $\eta_p^2 > 0.064$ with $\alpha = 0.05$ and $\beta = 0.20$ (determined in G*Power; Faul et al., 2007). Respondents' consent was obtained after being informed about data collection and storage practices and their right to withdraw from the experiment without consequence. A monetary reward of 6 euros was offered for participation. 63.6 % of the final sample was female and was aged between 16 and 64 years ($M = 24.88$, $SD = 7.56$).

6.1.2. Design

The design combined the ones used in Study 2 and 3 with both trials where cues remained on screen until a response was given as well as trials where cues were masked once the probe appeared. In order to reduce stress on participants, only 16 trials were included for each combination of the judgment task (social judgment vs. memory), cue type (social vs. non-social), validity (valid vs. invalid), and masking condition, totalling 256 trials. The probe presentation (left or right) and probe identity (u or n) were again presented in equal numbers to each participant and counterbalanced between participants to ensure all combinations occurred equally overall.

6.1.3. Procedure

The procedure was identical to that of Study 3.

6.1.4. Data treatment

Latencies for all trials where the probe was not correctly identified were removed (3.7 %), and then were truncated below 200 ms (0.6 %) and above the Tukey criterion (1488 ms; 4.2 %). One or more of these exclusion criteria were met in 8 % of trials. These remaining scores were then log transformed for use in the main analyses.

The non-transformed truncated raw scores were again used to create the same difference scores as in previous studies, now for masked and unmasked trials separately, see Table 1.

6.2. Results

A 2(Task: Social judgment vs. Memory) × 2 (Cue type: Social vs. Non-social) × 2 (Validity) × 2 (Mask) factorial repeated measures ANOVA was conducted on the log transformed truncated latencies. Counter to the expectations, the interaction between task type and cue type did not reach significance in this study overall, $F(1, 117) = 0.46$, $p = .501$, $\eta_p^2 = 0.004$, 90 % CI [0.000, 0.043], and the presence of an effect was also not moderated by the masking of the cues, $F(1, 117) = 1.29$, $p = .258$, $\eta_p^2 = 0.011$, 90 % CI [0.000, 0.061]. Follow up analyses looking at the unmasked and masked trials separately showed that neither unmasked, $F(1, 117) = 1.71$, $p = .194$, $\eta_p^2 = 0.014$, 90 % CI [0.000, 0.068], nor masked trials, $F(1, 117) = 0.278$, $p = .599$, $\eta_p^2 = 0.002$, 90 %

CI [0.000, 0.037], showed this interaction to be significant in these data.

The three-way interaction between task type, cue type and cue validity did not reach the standard level of significance in this sample either, $F(1, 117) = 3.82$, $p = .053$, $\eta_p^2 = 0.032$, 90 % CI [0.000, 0.099], indicating there was not enough evidence to support the hypotheses regarding visuospatial attention in these data, see Fig. 5. This effect was also not moderated by the presence of a mask, $F(1, 117) = 0.65$, $p = .420$, $\eta_p^2 = 0.006$, 90 % CI [0.000, 0.048]. Follow up analyses separated by mask condition did not show enough evidence that classical signs of visuospatial attention were present for unmasked, $F(1, 117) = 3.330$, $p = .071$, $\eta_p^2 = 0.028$, 90 % CI [0.000, 0.092], or masked trials in these data, $F(1, 117) = 0.573$, $p = .451$, $\eta_p^2 = 0.005$, 90 % CI [0.000, 0.046].

The social judgment task was again found to produce significantly larger latencies than the memory task was, $F(1, 117) = 118.78$, $p < .001$, $\eta_p^2 = 0.504$, 90 % CI [0.398, 0.583], reaffirming the undefined higher cognitive demand of the social judgment task found throughout the studies. The main effect of the validity of the cue did also reach significance in this sample, $F(1, 117) = 689.05$, $p < .001$, $\eta_p^2 = 0.855$, 90 % CI [0.816, 0.880], with valid trials being associated with faster responses than invalid ones.

Lastly, an interaction was found between the presence of a mask and the validity of the cue overall, $F(1, 117) = 4.33$, $p = .040$, $\eta_p^2 = 0.036$, 90 % CI [0.001, 0.105]. Surprisingly, in these data masking the cues actually significantly increased response times compared to leaving the cues visible only for valid trials ($\Delta M = 0.009$, $SE = 0.004$, $p = .026$, 95 % CI [0.001, 0.017]), but not for invalid trials ($\Delta M =$ -0.001, $SE = 0.004$, $p = .753$, 95 % CI [−0.009, 0.006]). Although a rather small and unexpected effect that should not be given too much weight, it could potentially be a sign that a general inhibition on return effect could result from the mask being present for valid trials.

6.2.1. Correlations

Finally, the extent to which the corresponding masked and unmasked scores correlate in these data can help shed some light on which indicators are consistent across the masked conditions and thus unaffected by the prolonged visual availability of the cue. Therefore, only these corresponding scores will be considered here, though all other correlations can be found in Table A2 in the Appendix A. The validity difference score for masked and unmasked social judgment trials showed a significant positive correlation, $r = 0.443$, $p < .001$, 95 % CI [0.285, 0.577], showing the visuospatial attentional bias for social judgment trials was relatively consistent whether the cue was masked or not. Masked and unmasked CID scores, however, showed a significantly negative association, $r = -0.218$, $p = .018$, 95 % CI [−0.383, −0.039], indicating that the amount participants show a social judgment task specific bias for social cues, regardless of cue location, for unmasked trials was inversely related to their performance when a mask was present. No other scores were significantly correlated with each other.

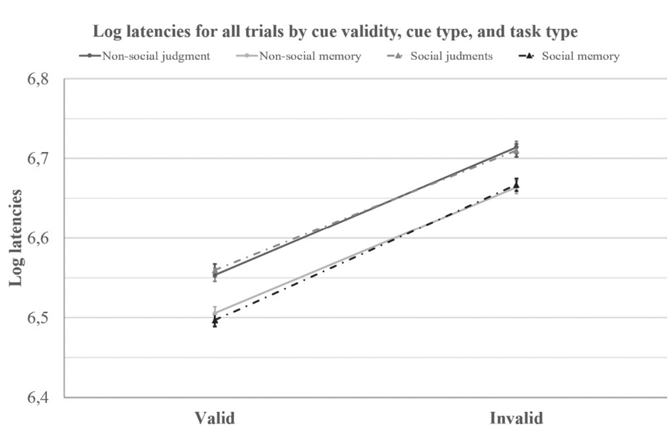


Fig. 5. Means and standard errors of log transformed latencies by Task type, Cue type, and Cue validity.

6.3. Discussion

The results of this final study somewhat contradict the evidence found in the initial two studies and the pilot study concerning the presence of a CID effect for unmasked trials, and found no evidence of such an effect in masked trials either. Consequently, there was no sign that masked and unmasked trials differed in the size of a potential CID in the main analyses. Lastly, there was once again no evidence of classical signs of visuospatial attention to the comparison cues, nor that such an effect might be influenced by the masking condition.

However, the exploratory correlational analyses did reveal a negative association between the masked and unmasked CID effects, suggesting engagement with the social stimuli did diverge systematically as a result of the masking procedure during the social judgment trials. Nevertheless, the results so far do not clearly support a CID with visual component, nor one that is purely cognitive in nature. This final study, far from presenting a clearer image of the attentional pattern, showed no obvious support for any of the findings in the initial studies. Although this lack of evidence is itself not evidence that the CID does not exist, it may cast some doubt on the size and robustness of CID effect. Therefore, the next section will summarise all findings in a single paper meta-analyses for a clearer overview.

7. Meta-analyses

Considering the variation of findings across this set of studies, a single paper meta-analysis was performed to gain a clearer overview of the robustness of the various effects and their sizes. Even though there are substantial differences across the studies in terms of methodology and stimulus selection, it is important to include all relevant studies that form part of this project in order to gain the most comprehensive overview the effects. Therefore, another study in the project that is not directly reported here will also be included.[7] The main analyses will estimate the effect of the social judgment task, the social nature of the cues, the cue difference scores, and the validity effects for unmasked trials found within this project. As only two instances for estimating the effects of masked trials exist, the results for these studies are described in a shorter summative overview included at the end. It is, also, important to note that these analyses should be treated as summative of the findings in this paper rather than a direct separate test of the hypotheses themselves due to the small number of selected studies and variation among methods. All means, standard deviations and correlations used in the meta-analyses can be found in the supplemental materials online, and all corresponding forest plots can be found in the Appendix.

7.1. Unmasked trials

7.1.1. Task

Throughout the studies, engaging in social judgments seemed to be more cognitively demanding than performing the memory task. This effect of the judgment task itself will be investigated first. For each of the five studies the log-transformed latencies were averaged for both task types in unmasked trials. Separate repeated measures *t*-tests were conducted using the truncated average log latencies for social judgment verses control trials for each study to estimate Cohens d_z effect sizes of

[7] All studies that are not directly reported here are available on the project's OSF page. The choice to not directly describe study S1 was made in the sake of clarity and brevity as the reported line of studies focuses more on quick automatic attention, while this study uses an extended SOA (1000 ms). We felt this would further complicate the narrative of an already heterogeneous set of results. Furthermore, in the interest of transparency, a second line of research that explored self-relevant comparisons using a similar paradigm is also described as Study S2, but is not included in the meta-analyses as it was not deemed relevant since the focus of this project is specifically on other-related judgments.

task type. The Cohens d_z's were then used in a meta-analysis (utilizing the metafor package in R; Viechtbauer, 2010), which suggested the presence of an overall effect of task type on the average log latencies, $d_z = 0.78$, 95 % CI [0.49, 1.07], $Z = 5.27$, $p < .001$. However, the Q was highly significant, $Q(4) = 794.64$, $p < .001$, and the I^2 was high (99.29 %), indicating very large amounts of heterogeneity in effect sizes likely reflective of the different control task used in the pilot study, variations in SOA, and stimulus effects. Individual studies were left out one by one to probe the main cause of the heterogeneity and the robustness of the effect, with the largest reduction in heterogeneity being achieved by excluding the pilot study increasing the estimate, $d_z = 0.94$, 95 % CI = [0.84, 1.04], $Z = 17.92$, $p < .001$, although heterogeneity remained very large, I^2 (92.68 %). Estimates in all analyses varied between $d_z = 0.70$ to 0.94. Notwithstanding these issues, all estimates remained positive, indicating that across studies an overall increase in response latencies was recorded for the social judgment task, which was highly sensitive to inter-study variation. This indicates that regardless of the validity and cue type, the social judgment task requires more cognitive resources leading to longer latencies. This is presumably due to the fact that the comparison process can take place internally with the use of internal standards even when no external stimuli are presented (Kahneman & Miller, 1986; Mussweiler, 2003). However, as noted in the introduction, the exact nature of such internal processes are not easily assessed and remain speculative within the limits of the current data as they may still be related to other unspecified task demands.

7.1.2. Social cues

The second main effect of interest is the possible bias towards all cues of a social nature independent of the task type. To summarise the effect the presence of social cues had on response latencies in the unmasked trials across studies, we included only the four studies that included unmasked social as well as non-social trials. For each of these studies, the average truncated log latencies of unmasked social trials and non-social trials were included in paired sample t-tests to calculate Cohen's d_z effect sizes. A meta-analysis of the resulting effect sizes showed a significant meta-analytic effect of social cues on the average log latencies, $d_z = 0.21$, 95 % CI [0.01, 0.41], $Z = 2.06$, $p = .040$. There seemed to be significant heterogeneity in this effect across the studies, $Q(3) = 206.52$, $p < .001$, and the I^2 was high (97.84 %), again possibly caused by the differences in the stimuli used across the studies. For this reason, individual analyses were again run excluding individual studies one by one to probe the main cause of the heterogeneity and the robustness of the effect. Heterogeneity was most reduced by excluding Study 4, $d_z = 0.29$, 95 % CI [0.10, 0.48], $Z = 3.02$, $p = .003$, although heterogeneity remained large, I^2 (95.70 %). Across the analyses, estimates remained positive, $d_z = 0.12$ to 0.29. The positive nature of these summative results speaks to the presence of a small general bias towards social cues across the studies, indicating social stimuli themselves are more engaging than non-social images regardless of the task that was presented.

7.1.3. CID

The main goal of this project was to investigate the presence or absence of attentional bias towards social cues when engaged in a social judgment task as a sign of comparative thinking. Some studies indeed showed signs of such a general CID, hinting at a slowdown in reaction times resulting from the comparison process. The following meta-analyses will estimate the aggregated effect of this CID across all relevant studies by comparing the cue difference scores of social judgment versus control tasks.

Cue difference scores were calculated for each of the four relevant studies by subtracting the log transformed latencies of all unmasked trials with non-social cues from those with social cues for social judgment and control trials separately. These scores were then used in multiple repeated measures t-tests to estimate the Cohens d_z effect sizes. These scores were again used in a meta-analyses, which showed a significant positive aggregate effect, $d_z = 0.20$, 95 % CI [0.06, 0.33], $Z = 2.87$, $p = .004$, indicating increased attentional bias towards social cues when engaged in a social judgment with no significant heterogeneity in the effect sizes, $Q(3) = 1.71$, $p = .63$, $I^2 = 0$ %. This summation shows across studies there is evidence that a consistent CID did occur, reflecting the presence of a distinct attentional cost associated with engaging in external social comparisons. However, the exact nature of this attentional bias (be it visuospatial, purely cognitive, or a combination of the two) cannot be assessed based on this effect alone. Therefore, the next analyses will isolate the evidence for classic signs of visuospatial attention by looking at the validity difference scores.

7.1.4. Visuospatial bias

The question remains whether there is a visuospatial aspect to the CID described above. If it does, the validity of the cue in the MSCT paradigm is usually expected to play a moderating role in this bias (Fox et al., 2011). However, only Study 1 showed any effect related to validity, and even this was in the opposite direction as would be expected. To investigate if on aggregate there is any evidence visuospatial attentional bias to the comparison cues when engaging in a social judgment, a final meta-analysis will compare the validity difference scores for social judgment versus control trials.

For each of the five studies log transformed latencies from all unmasked valid trials were subtracted from those of unmasked invalid trials separately for social judgments and control tasks only for trials with social cues to create the validity difference scores. Multiple repeated measures t-tests were then used to estimate Cohen's d_z for each study. A meta-analysis was then conducted using these effect sizes, showing a non-significant overall effect, $d_z = -0.04$, 95 % CI [−0.22, 0.13], $Z = -0.49$, $p = .62$, that had signs of significant heterogeneity, $Q(4) = 14.91$, $p = .005$, $I^2 = 68.11$ %. As with previous cases of heterogeneity, separate analyses were run in which individual studies were left out one by one to test the robustness of the effect and cause of heterogeneity. The greatest reduction in heterogeneity was achieved by removing Study S1 in which the stimulus onset asynchrony was increased, $d_z = -0.12$, 95 % CI [−0.26, 0.02], $Z = -1.67$, $p = .094$, $I^2 = 46.10$ %. This might suggest that any validity effects are sensitive to differences in SOA, in line with the notion that social comparisons take place early on in processing (Ohmann et al., 2016), although in these data such an effect still remained non-significant and in the opposite direction as would be expected. Indeed, most effect size estimates in these analyses were largely in the opposite direction, ranging from $d_z = 0.02$ to −0.12, and remained non-significant. Therefore, this summative analysis suggests the current line of studies did not provide evidence to support the hypotheses regarding visuospatial attentional bias towards comparison standards.

7.2. Masked trials

Data treatment for all analyses with masked trials was identical to the ones described for unmasked trials described above. The task effect for the two studies that included masked trials, the effect of task type on the average log latencies also reached significance, $d_z = 0.91$, 95 % CI [0.87, 0.95], $Z = 46.92$, $p < .001$. Overall the effect of the social nature of the cue was in the opposite direction of the effect found in the unmasked trials and did not reach significance, $d_z = -0.02$, 95 % CI [−0.05, 0.00], $Z = -1.68$, $p = .09$. Similarly, no evidence for a CID effect was found for masked trials as reflected in the non-significant difference between the two masked cue difference scores, $d_z = -0.05$, 95 % CI [−0.24, 0.14], $Z = -0.55$, $p = .58$. In sum, evidence for both cue related effects was only present in trials where the stimuli remain visually available throughout the trials and was not found when the cues were masked. Despite the theoretical contradiction of visuospatial attention for masked stimuli, a meta-analysis was run for the masked validity difference scores for comparison purposes. Estimates for unmasked trials were similar to those found in unmasked trials and non-significantly different from zero, $d_z = -0.10$, 95 % CI [−0.27, 0.06], $Z = -1.23$, $p = .22$.

8. General discussion

Across the presented studies, the social comparison task itself and the presence of a social cue were both associated with increased latencies for unmasked trials, though these effects proved quite sensitive to methodological variations. The fact that the task related effects also extended to the masked trials, and those with non-social stimuli implies the forming of a social judgment is in and of itself somehow cognitively demanding. Theoretically, this could be explained by the ubiquity of the comparison process that often occurs completely internally with preexisting standards when external standards are not available (Kahneman & Miller, 1986; Mussweiler, 2003). In this line of reasoning, a comparison process occurs with internally selected standards in the absence of external ones when asked to make a social judgment. The internal comparison process is one that exerts its own cognitive demands and, therefore, impedes performance on parallel tasks, although the current findings cannot exclude other explanations related to unspecified task demands.

More interestingly for the current project and research question, unmasked social cues were found to exert a higher attentional cost during the social judgment task than the control tasks, indicating a CID caused by the increased engagement with the external comparison standards during the comparison process. Although this overall effect does not help us clearly distinguish the visuospatial from non-visuospatial cognitive attention, the lack of evidence for the CID across studies with masked stimuli is an initial indication that it might include some form of prolonged visual component. However, the single direct test in this study did not confirm this assertion, and the simple absence of a significant CID effect in masked trials, while suggestive, is not evidence that it does not exist. Indeed, the complete lack of CID in masked trials is surprising, as previous work has reported that even subliminally presented comparison standards can directly affect judgment outcomes (Mussweiler et al., 2004a). This discrepancy may be due to the novel nature of the standards presented as cues in the current work, where previous literature has relied on famous individuals about whom participants already had sufficient internal knowledge. For instance, novel standards might require extended or reoccurring visuospatial attention, where known standards need merely be activated.

In any case, the current work has shown that the whole comparative process, at least when it comes to forming actual social judgments, is one that extends far beyond the efficient initial inspection and ranking of stimuli that is described in the earlier work done by Ohmann et al. (2016). Instead, the current findings show that after the initial processing, the formation of the social comparative judgments require some type of further engagement with the comparative information in order to integrate the acquired information. In further contrast to this previous work, the social comparisons did require a significantly longer processing time than non-social comparisons as seen in the pilot study. Hence, despite the similar timeframe associated with processing of the social and non-social comparative information, the later stages of the comparative process associated with the formation of judgment estimates appear to be increasingly affected by the more complex nature of social stimuli (Dahlgren, 1985; Tversky, 1977).

Furthermore, although the CID effect necessarily implies some minimal level of visuospatial attention in the form of the initial gaze and internalisation of the comparative information, no direct evidence was found for this visuospatial bias. On the contrary, Study 1 actually showed a validity effect in the opposite direction. The summative results of the meta-analyses, however, did not find these results to be robust across the studies. The overall lack of validity effects might suggest that visual engagement with comparative information occurs very early on in information processing and is completed before the probe onset at 250 ms, a notion that is bolstered by the fact that a change in the SOA was the largest contributor to effect size heterogeneity in the meta-analysis. Hence the necessary initial visual inspection seems to be very short lived and efficient in extracting social information in congruence with previous findings concerning the processing of comparative information (Ohmann et al., 2016). The rest of the process might well continue at a largely cognitive level once the visual information has been internalised in the first few hundred milliseconds of exposure. This would explain the occurrence of a CID effect in the later studies even without any of the classic signs of visuospatial attention within the current MSCT design. However, it fails to account for the difficulty of finding a CID effect once cues were masked, leaving the possibility of a more complex form of visuospatial attention being part of the CID.

Nonetheless, there are some important limitations to the evidence presented for such an explanation. Most obviously, the proposed early visual component that would be necessary to initially assess the comparison information was not detected using this standard spatial cueing set-up and is thus only speculatively based on previous findings (Ohmann et al., 2016). Although it is theoretically unlikely that a CID effect could occur without any kind of visuospatial attention, it seems the sensitivity of the current paradigm proved insufficient to detect and investigate it. Similarly, the lack of evidence for a CID in masked trials is only suggestive of some type of prolonged visual aspect of the effect, but this could not be determined definitively within the current paradigm. Whether prolonged visuospatial attentional in some form is part of the CID or if cognitive processes exclusively drive the effect is, therefore, still an open question. Future work using measures that are more sensitive might still yield robust cueing effects, though they likely occur very early on and are very small in size, if present at all.

Furthermore, given the lack of clear evidence for a substantial visual aspect to the CID, the current MSCT paradigm falls short in its capacity to gain deeper insight into non-visuospatial component of the effect. A more complex procedure would need to be implemented in order to determine directly which step or steps of the comparison process are a main driver in the CID effect itself. However, some initial suggestions can be made based on the current findings. Namely, given the overall longer latencies in social judgment trials and the theoretical ubiquity of the comparison process (Dunning & Hayes, 1996; Festinger, 1954; Kahneman & Miller, 1986; Mussweiler, 2003), it could be assumed that even in the social judgment trials without external standards a number of comparative processes are taking place. In fact, all steps of the comparative processes other than the initial visual inspection, information extraction and information processing of the external comparative information can theoretically occur for internal standards as well. Hence, these steps, certain to be unique to the socially cued trials, could be the most likely causes behind the CID, at least if social comparisons are indeed as ubiquitous as suggested in the literature.

Notwithstanding these issues and need for further investigation, the current work demonstrates a basic CID effect across all studies as evidence for attentional preoccupation with the comparison relevant stimuli that extends long past initial visual inspection. The pattern is, instead, suggestive of an initial very early short-lived visuospatial component, followed largely by non-visuospatial attention in the form of cognitive engagement with the extracted social information. These finding can form the basis for future work looking at attentional patterns in the early comparison process that aim to expand and clarify the questions raised in this underdeveloped area of comparisons research.

Data availability statement

All raw and aggregated data, and additional materials for all studies can be found on the Open Science Framework under: https://osf.io/hkem9/

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Table A1
Means, standard errors and correlations for all measures and scores used in Study 2.

	N	M	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. Age	61	22.54	3.45																	
2. Sex	66	1.33	0.48	0.11																
3. INCOM	66	3.37	79.22	−0.07	−0.01															
4. Self-esteem scale	66	29.62	5.54	−0.08	−0.16	**−0.25***														
5. Body dissatisfaction scale	66	2.25	0.65	0.05	**−0.29***	0.07	**−0.39****													
BeMaS																				
6. Benign envy	66	3.86	1.15	−0.11	0.04	**0.61****	−0.22	0.22												
7. Malicious envy	66	2.35	1.18	−0.18	0.07	**0.37****	**−0.36****	**0.25***	**0.42****											
BFI-10																				
8. Extraversion	66	3.51	1.11	−0.18	**−0.30***	−0.17	**0.60****	−0.12	−0.16	**−0.33****										
9. Agreeableness	66	3.52	0.71	0.12	0.11	−0.02	0.08	−0.12	−0.07	−0.24	0.02									
10. Conscientiousness	66	3.49	1.01	−0.13	**−0.32****	−0.16	**0.37****	−0.02	−0.05	−0.18	0.18	−0.10								
11. Neuroticism	66	3.08	1.03	0.01	−0.21	**0.33****	**−0.43****	**0.34****	**0.29***	**0.36****	**−0.36****	**−0.29***	0.05							
12. Openness to experience	66	3.51	1.06	−0.18	−0.08	−0.05	**0.32****	**−0.28***	0.03	**−0.28***	0.24	0.09	−0.11	−0.23						
13. Validity difference score (memory)	66	123.17	72.56	0.23	−0.09	0.09	−0.19	0.24	0.08	0.01	−0.17	0.12	−0.07	0.23	−0.15					
14. Validity difference score (judgment)	66	117.92	64.96	−0.08	0.05	−0.17	−0.06	0.08	0.07	0.05	−0.06	0.22	0.06	−0.03	0.20	0.06				
15. CA	66	−5.25	94.64	−0.23	0.11	−0.18	0.11	−0.13	−0.01	0.03	0.09	0.06	0.10	−0.19	**0.25***	**−0.73****	**0.64****			
16. Cue difference score (memory)	65	8.46	84.52	−0.03	0.15	0.07	−0.03	−0.13	−0.07	−0.07	0.00	0.22	−0.05	−0.17	−0.10	0.12	0.23	0.07		
17. Cue difference score (judgment)	66	22.99	121.64	0.17	0.21	0.17	−0.11	**−0.28***	0.14	0.07	**−0.25***	**0.30***	−0.19	−0.08	0.17	−0.19	0.15	**0.25***	0.19	
18. CID	65	25.91	104.43	0.10	0.06	0.02	0.00	−0.05	0.07	0.04	−0.14	−0.01	−0.01	0.14	0.01	−0.17	−0.19	0.00	**−0.66****	**0.61****

Note. * $p < .05$, ** $p < .01$ (printed in bold).

Table A2
Means, standard errors and correlations for all measures and scores used in Study 4.

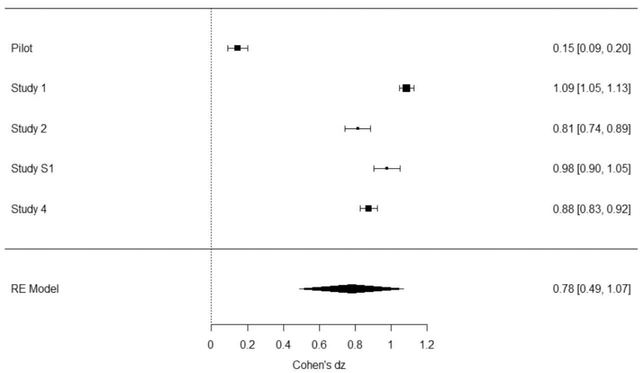
	N	M	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Age	117	24.88	7.56														
2. Sex	118	1.36	0.48	0.10													
3. INCOM	118	3.37	0.78	**−0.29****	**−0.25****												
Un-masked:																	
4. Validity difference score (memory)	118	123.41	74.98	0.15	0.06	−0.03											
5. Validity difference score (judgment)	118	109.98	84.07	0.07	0.01	−0.08	**0.28****										
6. CA	118	−13.43	95.74	−0.05	−0.03	−0.04	**−0.54****	**0.66****									
7. Cue difference score (memory)	118	−0.958	83.46	−0.04	**0.23***	0.03	0.00	−0.02	−0.02								
8. Cue difference score (judgment)	118	11.29	98.17	0.05	0.10	−0.07	0.03	0.16	0.12	0.14							
9. CID	118	20.87	119.40	0.07	−0.08	−0.08	0.03	0.15	0.11	**−0.58****	**0.72****						
Masked:																	
10. Validity difference score (memory)	118	115.48	68.61	**0.23***	0.00	0.03	0.07	**0.31****	**0.22***	−0.09	**0.20***	**0.23***					
11. Validity difference score (judgment)	118	102.85	72.85	0.14	0.04	−0.10	**0.26****	**0.44****	**0.19***	0.00	0.05	0.04	**0.25****				
12. CA	118	−12.63	86.79	−0.07	0.04	−0.07	0.16	0.13	−0.01	0.07	−0.12	−0.14	**−0.58****	**0.64****			
13. Cue difference score (memory)	118	1.80	84.49	−0.11	−0.01	0.03	−0.12	**−0.22***	−0.10	−0.05	−0.03	0.01	0.05	−0.11	−0.13		
14. Cue difference score (judgment)	118	−3.50	85.87	0.01	0.15	0.11	0.00	−0.12	−0.11	**0.24****	−0.15	**−0.29****	0.08	−0.06	−0.11	0.02	
15. CID	118	−5.30	119.40	0.08	0.11	0.06	0.09	0.07	−0.01	**0.21***	−0.09	**−0.22***	0.02	0.03	0.01	**−0.70****	**0.71****

Note. *$p < .05$, **$p < .01$ (printed in bold).

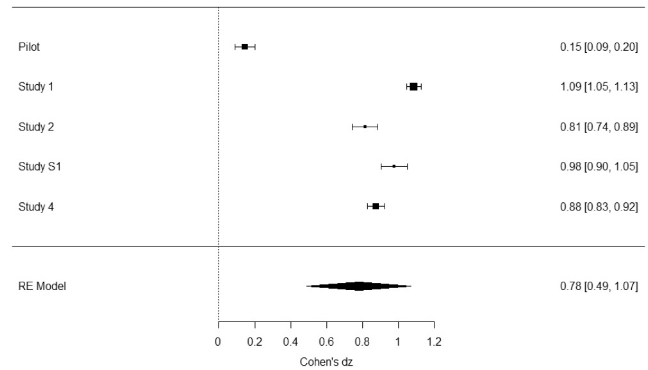
Appendix B. Appendix

Task:

Unmasked

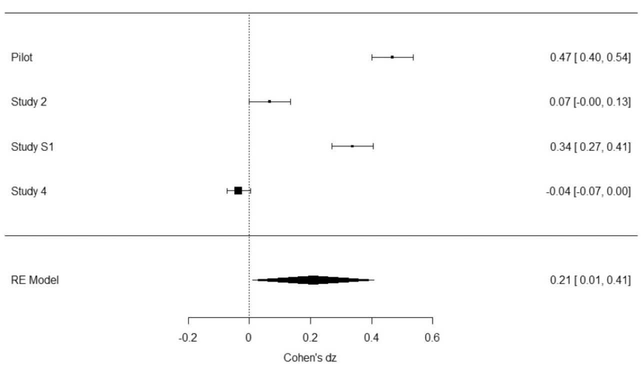


Masked



Social:

Unmasked



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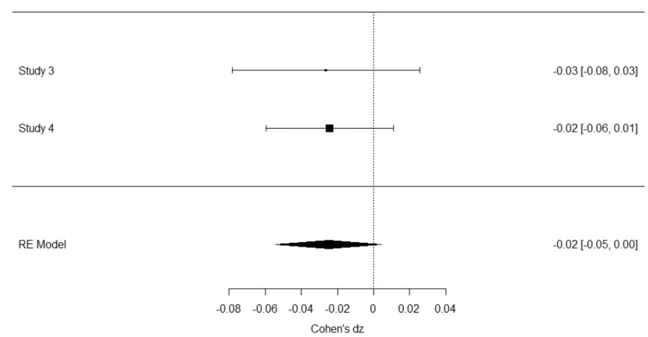
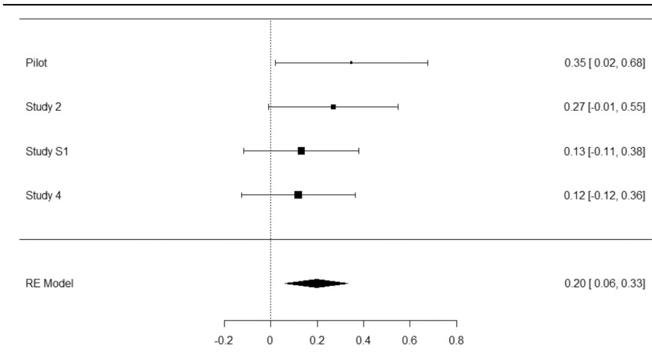
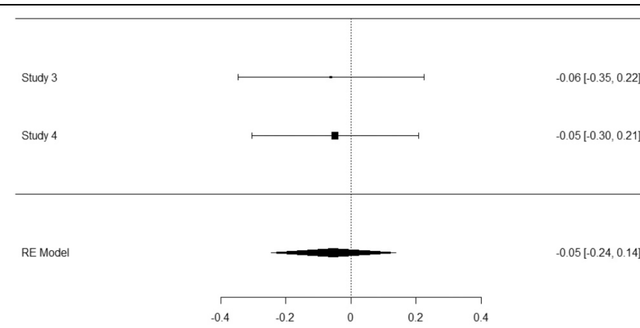


Cue difference:

Unmasked



Masked



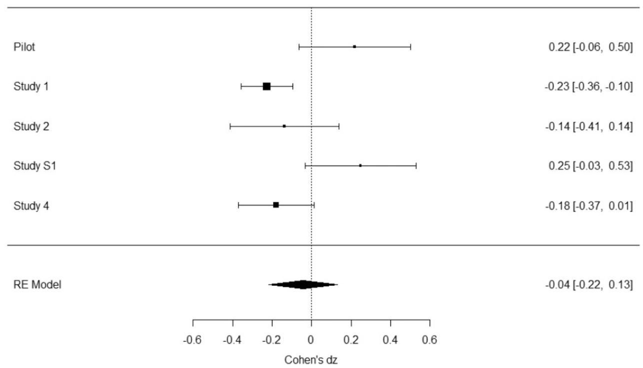
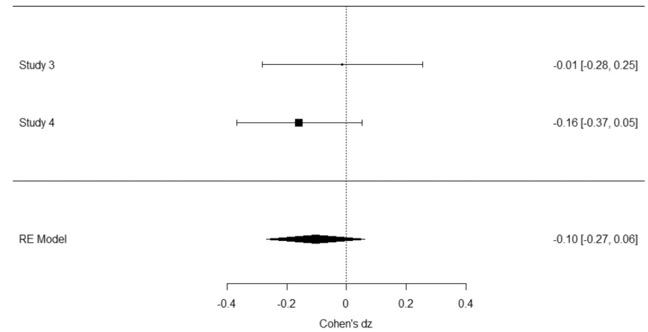
Validity difference:

Unmasked

Masked

(*continued on next page*)

(*continued*)

Validity difference:	
Unmasked	Masked
	

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