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Asymmetric visual representation of sex from human body shape

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Abstract

We efficiently infer others' states and traits from their appearance, and these inferences powerfully shape our social behaviour. One key trait is sex, which is strongly cued by the appearance of the body. What are the visual representations that link body shape to sex? Previous studies of visual sex judgment tasks find observers have a bias to report "male", particularly for ambiguous stimuli. This finding implies a representational asymmetry – that for the processes that generate a sex percept, the default output is "male", and "female" is determined by the presence of additional perceptual evidence. That is, female body shapes are positively coded by reference to a male default shape. This perspective makes a novel prediction in line with Treisman's studies of visual search asymmetries: female body targets should be more readily detected amongst male distractors than vice versa. Across 10 experiments (N=32 each) we confirmed this prediction and ruled out alternative low-level explanations. The asymmetry was found with profile and frontal body silhouettes, frontal photographs, and schematised icons. Low-level confounds were controlled by balancing silhouette images for size and homogeneity, and by matching physical properties of photographs. The female advantage was nulled for inverted icons, but intact for inverted photographs, suggesting reliance on distinct cues to sex for different body depictions. Together, these findings demonstrate a principle of the perceptual coding that links bodily appearance with a significant social trait: the female body shape is coded as an extension of a male default. We conclude by offering a visual experience account of how these asymmetric representations arise in the first place.

*Keywords***:** social vision; body perception; sex perception; visual search; search asymmetry; visual experience

1. Introduction

From a brief encounter with another person, we rapidly make inferences about their states and traits. These inferences are normally spontaneous and effortless; they are also consequential, in that they shape our social cognitions and behaviours. Accordingly, it is vital that we understand how such inferences are made. To that end, extensive research over the past decades has explored how an observer extracts socially-relevant information about another person's age, race, sex, emotions, health, and other characteristics – veridically or otherwise -- based on their visual appearance (Adams et al., 2010; Fiske et al., 2010; Hall et al., 2019; Johnson & Shiffrar, 2012; Macrae & Quadflieg, 2010; Todorov, 2017).

While the great majority of this work has emphasised face perception, social vision does not stop at the neck. The visual appearance of the rest of the body provides a rich source of socially relevant cues (Aviezer et al., 2012; de Gelder, 2009; Downing & Peelen, 2011; Hill et al., 2016; Hu et al., 2018; Johnson & Tassinary, 2005; Knoblich et al., 2006; Lawson et al., 2009; Rice et al., 2013; Rosenthal et al., 1979; Sell et al., 2009). Yet our understanding of visual body perception remains limited, especially when compared to a mature neurocognitive model of face perception (Bruce & Young, 2013; Duchaine & Yovel, 2015; Haxby et al., 2000). Core questions remain about the processes and representations that enable us to "read" the appearance of the body. Analogies between faces and bodies have their value (Minnebusch & Daum, 2009; Peelen & Downing, 2007), but these are likely to be imperfect given the significant physical differences between these two kinds and the ways in which they convey social signals. However, the constructs and experimental approaches that are used to dissect face perception, and visual perception more broadly, can be readily adapted to learn more about how we see the body. That is the strategy we adopt for the present study, an examination of the mental representations behind judgments of the sex[1] of other humans from their body shape, that builds on previous evidence from person perception, and on concepts and tasks from studies of the component features of visual processing in general.

1.1 Visual perception of sex.

The psychological salience and social significance of sex have inspired efforts to identify the visible cues that can be used by observers to judge anothers' sex. In relation to the face, these are manifold, and include: evaluations of metric differences between the shapes of male and female faces, and their links to behavioural performance (Burton et al., 1993; Gilani et al., 2014); tests of the signal value of specific face parts in isolation and in combination (Brown & Perrett, 1993; Faghel-Soubeyrand et al., 2019; Schyns et al., 2002; Yamaguchi et al., 2013); contributions from external features (Macrae & Martin, 2007); and signals found in texture, contrast, colour, and facial motion (Berry, 1991; Bruce & Langton, 1994; Hill et al., 1995; Nestor & Tarr, 2008; Russell, 2009). In the aggregate, these findings illustrate how richly sex is conveyed to observers over multiple facial dimensions.

How do we judge sex from the body? The adult body's appearance carries strong signals about sex that are attended by observers (Gandolfo & Downing 2019a; Hewig et al., 2008; Johnson & Tassinary, 2005; Johnstone & Downing, 2017; Matsumoto et al., 2017; Nummenmaa et al., 2012). Judgments of sex from the shape and movements of others' bodies are generally highly efficient, even for impoverished stimuli (D'Argenio et al., 2020; Gandolfo & Downing, 2019b; Gaetano et al., 2014; Johnson & Tassinary, 2005; Kozlowski & Cutting, 1977; Mather & Murdoch, 1994; Palumbo et al., 2013; Runeson & Frykholm, 1983) although they are also subject to the influence of expectations (e.g. Johnson et al., 2011) and recent perceptual experience (Alexi et al., 2018). Much of the

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[1] In line with current guidance (e.g. https://orwh.od.nih.gov/sex-gender), we use "sex" to refer to a categorical distinction between face or body images, and "gender" in reference to our participants. We regard "sex" as the appropriate term for our experimental manipulations of body shape. While these images capture key visible anatomical aspects of typical differences between adult bodies, they are not likely to be construed by viewers as real individuals having gender identities.

emphasis in this literature has been on identifying potential stimulus cues to sex – such as waist-to-hip ratio (Johnson and Tassinary, 2005; Singh, 1993) or centre-of-moment in the walking gait (Cutting et al., 1978; Cutting, 1978). Further, recent studies have demonstrated contrastive aftereffects of adaptation to body shape – e.g. so that an ambiguous body appears more male after adapting to a female body (Palumbo, Laeng, & Tommasi, 2013). Additional manipulations (e.g. of stimulus size, orientation, and spatial location) establish that these adaptation effects reflect the action of a relatively high level representation of body sex that is not accounted for by simpler visual analysers (Brooks et al., 2018, 2019; Sturman et al., 2017).

One notable and consistent finding, of particular relevance for the present work, appears in multiple studies of visual sex perception: in general, observers tend to report a male percept by default, particularly under conditions of uncertainty or ambiguity. This bias is itself the main subject of several studies, and an incidental observation in others. For example, participants making binary male/female choices, continuous judgments (how male/female?), or comparisons (which is more male?) about faces drawn from a morph series, show a significant bias to report “male” even for faces that are objectively composed more from a female than a male component (Armann & Bülthoff, 2012; Watson et al., 2016). A similar bias in favour of the male is found in perception of infants’ faces (Tskhay & Rule, 2016; Wild et al., 2000), in judgments of profile silhouettes of adult faces (Davidenko, 2007; Gaetano et al., 2016), and in judgments about texture-free renderings of face geometry (Gilani et al., 2014).

There is also consistent evidence for a male bias in sex judgments from body shape, hand shape, and in patterns of whole-body movement. One example was found in a study of the influence of waist-to-hip ratios on sex judgments. Relative to a ground-truth distribution of measured ratios, observers’ judgments were shifted, such that a range of ratios that are generally female in the population were instead frequently reported by observers as male (Johnson et al., 2012). Further, in judgments of sex from the shape of the hand, observers tend to report “male” by default, particularly for ambiguous exemplars (Gaetano et al., 2012, 2016). And likewise, the percept of an objectively balanced point-light walker, constructed equally of male and female measurements, is typically judged as male (Troje et al., 2006; Troje and Szabo, 2006).

A male bias in judging the sex of other individuals (whether from the face or body) may be understood in terms of its distal causes, and also with regard to proximate mental mechanisms (Clifford et al., 2015). Regarding the former, researchers have suggested the hypothesis (which we do not address here) that a male bias may be functional because males are more likely than females to present an imminent physical threat. That is, to assume male incorrectly may be less consequential for the observer than to assume female incorrectly (Haselton & Buss, 2000; Haselton & Nettle, 2006; Johnson et al., 2012).

Considered from the mechanistic perspective, our focus here, a male bias suggests the following hypothesis: For the mental processes that generate a sex percept, the default output is “male”, and “female” is determined only in the presence of additional, positive perceptual evidence. In other words, where incoming signals indicating “female” are not unambiguously present, then the perceptual system will arrive at a “male” interpretation. From this perspective, the mental representations of male and female are not symmetrical with respect to each other. In regards to the body, for example, this logic suggests that while male and female body shapes share many properties in common (e.g. the basic structure of the trunk and limbs) the female shape is positively coded by additional features or properties, relative to the male. This hypothesis stands in contrast to a balanced coding scheme, in which male and female would each be encoded in exactly symmetrical opposition to the other sex.

The following experiments were motivated by similarities between this hypothesis of an asymmetric body representation, and a coding scheme developed by Treisman to describe visual representations more generally (Treisman & Souther, 1985; Treisman & Gormican, 1988; see also Wolfe, 2001). Treisman relied on evidence from visual search performance, amongst other metrics, to emprically identify the fundamental features that are combined to encode complex objects. A key finding in this programme was that in some search tasks, performance is strikingly asymmetric depending on the assignment of the same items to the role of target or distractor. For example, in search for a Q target amongst O distractors, time to detect the target is nearly constant against set size (“pop out”); in contrast, search for an O amongst Q distractors is increasingly difficult amongst larger sets of distractors (Treisman and Souther, 1985). In other cases, performance is asymmetric yet neither target “pops out”. For example, converging line pairs are found more efficiently amongst parallel pairs than vice versa, and search for an ellipse amongst circles is more efficient than the converse; in all cases search times depend linearly on set size.

In part to explain findings like these, Treisman suggested that the coding of visual dimensions is organised around canonical values and deviations from those values (Treisman & Souther, 1985; Treisman & Gormican, 1988). An ellipse, for example, is a deviation from a canonical circle; converging lines deviate from a parallel default. A key proposal is that in the mental representations of these dimensions, both kinds of stimuli activate detectors for the canonical property, but deviations are further positively coded by additional activity over selective detectors that are not tuned to the default. In other words, the activity generated by the default is *included* within that generated by the deviant (cf. French et al., 2004). It follows that the asymmetry in search performance favouring a deviating target arises because it represents a presence (an increment in activity) and this is more readily detected than an absence (a decrement; Neisser, 1963; Rajsic et al., 2020).

Might a similar logic apply to the mental representation of sex from body shape, which we propose to be similarly asymmetric, so that the female form is encoded positively relative to the canonical male? It may seem too great a leap in complexity to extend from the kinds of elementary features examined by Treisman with visual search, to something as complex as body shape. However, a wide range of studies of visual search efficiency has now been applied to understanding the “higher level” representations of faces and objects (Cohen et al., 2016; Horstmann and Bauland, 2006; Levin, 2000; Ro et al., 2007; Suzuki and Cavanagh, 1995; Tong and Nakayama, 1999) and indeed of bodies (Bindemann et al., 2010; Fletcher-Watson et al., 2008; Cass et al., 2019; Papeo et al., 2019; Reeder et al., 2015; Ro et al., 2007; Talbot et al., 2019; Vestner et al., 2019). Likewise, the search asymmetry logic has previously been adapted to understand the encoding of complex emergent stimulus properties (Enns & Rensink, 1990, 1991; Kristjánsson & Tse, 2001; Hulleman et al., 2000; Sun & Perona, 1996a,b) including dimensions of the face (Becker et al., 2011; Becker & Rheem, 2020). Taken together, this previous literature suggests that the visual search task, and the search asymmetry approach specifically, could inform the nature of visual body representations.

Accordingly, here we adapted the search asymmetry logic to examine the mental encoding of sex from body shape. If, as hypothesised above, the female body shape is positively coded with reference to a default male body shape, then observers should more efficiently detect female body targets in arrays of male distractors than *vice versa*. Such a finding, if robust, would establish a key principle underlying the poorly-understood visual representations of body shape. Over the following ten experiments, our approach was to test this hypothesis in multiple ways, varying image format, orientation, and task, as well as applying multiple techniques to assess and control possible confounding variables.

2. General Methods

Here we describe aspects of the procedures that were shared across most or all of the experiments. Further details, and variations on these procedures, are noted in the Methods section for each experiment.

2.1 Participants.

Participants were students at Bangor University. They took part in return for course credit in a research methods module. No individual participant took part in more than one experiment. The procedures were approved by the Research Ethics Committee of Bangor University's School of Psychology, and participants provided written informed consent. The sample size for each experiment was arbitrarily set at N=32, with the aim of testing substantially larger samples than previous search asymmetry studies. This decision was pre-registered along with other aspects of the procedure of Experiment 1 here: https://aspredicted.org/8st4x.pdf. Participants with mean response times or accuracy (averaged across conditions) of more than 2.5 SD below or above the group mean were considered outliers. Their data were excluded and new participants were tested to replace them to reach a sample size of N=32. Exclusion numbers were as follows: 1 in Experiment 1; 2 in Experiment 2; 1 in Experiment 3; 2 in Experiment 4; 3 in Experiment 5; 3 in Experiment 6; 2 in Experiment 7; 2 in Experiment 8; 1 in Experiment 9; 0 in Experiment 10. Age and gender of the participants are reported within each experiment.

2.2 Stimuli and Apparatus.

The stimuli used in all the experiments are shown in **Figure 1** and are available to download here: https://osf.io/cjvqd/. The bodies in Experiments 1-8 were rendered as black silhouettes on a white background. Silhouettes have the advantage of capturing the overall shape of the body without including confounding internal features such as clothing or texture. Silhouetted stimuli have been used successfully in previous studies of object (e.g. Wagemans et al., 2008), face (Davidenko, 2007; Davidenko et al., 2012), and body (Bell et al., 1986; Downing et al., 2004; Gaetano et al., 2014; Palumbo et al., 2013; Reeder and Peelen, 2013; Reeder et al., 2015) perception. We also know that brain regions and electrophysiological signatures that are closely tied to body perception (Minnebusch & Daum, 2009; Peelen & Downing, 2007; Sadeh et al., 2011) can be strongly and selectively engaged by minimal or iconic body depictions such as silhouettes as well as line drawings, stick figures, and point-light animations (Downing et al., 2001; Grossman et al., 2000; Kana & Travers, 2012; Peelen & Downing, 2005; Peelen et al., 2006; Schupp & Renner, 2011; Thierry et al., 2006; Uher et al., 2005). Such findings provide neural evidence for the effective engagement of body representations by minimalistic stimuli similar to the silhouettes tested here. In Experiments 9 and 10 we used realistic body photographs that were obtained with internet searches and further matched for low-level visual features.

In Experiments 1-4, realistic body silhouettes were presented without the head and face. If the images were to include a face whose sex matched the body, then either or both cues could drive the hypothesized search asymmetry, rendering it difficult to interpret. If instead an ambiguous or “neutral” face were included, this would conflict with the sex signalled by the body, possibly interfering with typical sex judgment processes. Therefore by presenting bodies only, we were able to exclude some other factors that would complicate interpretation of the results. In contrast, in Experiments 5, 6 and 8, the silhouettes were stylised body “icons”. Because of their abstract nature, it was possible to include “heads” in these figures that were identical across male and female items, without influencing the apparent sex of the body. Finally, in Experiments 9 and 10, the head region of each figure was covered by a grey oval.

The experiments were administered using the Psychtoolbox package (Brainard, 1997; Pelli, 1997) running in Matlab (MATLAB Release 2012b, The MathWorks, Inc., Natick, Massachusetts, US) on an Apple iMac computer. Viewing distance was approximately 60 cm from the screen but was not fixed.

2.3 Design and Procedure.

Except as noted, participants searched in separate blocks either for a male body amongst female distractor bodies or *vice versa*. Four blocks, each comprising 128 trials, were presented in a counterbalanced order (target: MFFM or FMMF, divided equally across participants). Within blocks, trial orders were randomised such that each chunk of 16 trials consisted of two trials each from the crossing of target (present, absent) by set size (1, 2, 4, or 8). Participants were encouraged to take a short break between blocks.

Each trial started with a central fixation cross of random duration between 800 and 1200 ms. Next, the search array of images was presented for 3 seconds or until the participant responded. Each item could appear randomly in one of 8 possible equally-spaced locations that fell on a virtual circle (radius ~6 cm) around the fixation point. The distractors were randomly chosen from the image set, with the constraint that no given image could appear more than once in a given trial. The target, selected at random from the relevant item set, was present in 50% of the trials. Participants were instructed to "press J if a male [female] is present, press F if no male [female] is present". Participants were encouraged to respond quickly without sacrificing accuracy.

2.4 Data Analysis.

Search efficiency was measured by assessing the time required to detect the two target types over varying set sizes, and by sensitivity to detect a target as assessed by d-prime. Search rates were determined by estimating with a linear fit the slope relating search set size to response times (RT) for present targets in accurate trials. Smaller values (flatter slopes) reflect more efficient search for the target. These linear fits were conducted with the function "lm" in base R (Version: 3.6). Sensitivity was assessed by computing d-prime measures (Macmillan & Creelman, 2004), collapsing over set sizes. Higher d-prime reflects better discrimination of a target present trial from a target absent trial. Extreme hit and false alarm proportions ($p = 0$ or $p = 1$) were adjusted according to Hautus (1995). Search slopes for male targets amongst female distractors were compared to slopes for female targets amongst male distractors with paired-samples two-tailed t-tests. Analogous contrasts were applied to the d-prime measures. For all the t-tests, confidence intervals calculated over the difference between male and female target conditions are reported.

As an exploratory analysis, we also measured response bias (*ß*). The value for *ß* is defined as the ratio of the height of the signal plus noise distribution at the criterion to the height of the noise distribution at the criterion. As *ß* gets larger the observer is said to be more conservative (less likely to report “present”), and as it approaches 0 the observer is considered to be more liberal (more likely to report “present”). Criterion and d-prime were calculated in R (Version 3.6) using the package “Psycho” (Makowski, 2018) where the signal detection theory methods are calculated using the algorithms of Pallier (2002).

The mean search slopes by target sex for each experiment are reported in **Figure 2**, the mean d-prime by target sex for each experiment in **Figure 3**, and plots of mean accurate RT against set size, as a function of target sex and target presence, in **Figure 4**. The raw accuracy by condition for each experiment is reported in **Table 1**.

3. Experiment 1: Profile silhouettes

3.1 Introduction

In Experiment 1 we conducted the first test of our hypothesis that observers would more efficiently detect female body targets in arrays of male distractors than *vice versa.* Here we tested realistic body silhouettes presented in a profile view such that the front of the body was oriented to the left.

3.2 Method

3.2.1 Participants. The final group of participants in Experiment 1 comprised 32 students (16 female) with a mean age of 24 years +/- 5.38.

3.2.1 Apparatus and Stimuli. Images of leftward-facing, headless body profile silhouettes were generated using Poser (Curious Labs, Santa Cruz, CA). Each image was 180 x 180 pixels, and the body shape covered ~1 cm (width) x ~5 cm (height) on screen. The image set comprised 42 silhouettes (21 males, 21 females) that varied moderately in their overall body shape (**Figure 1a**).

<<<<INSERT FIG 1 HERE >>>>>>

In the raw output of the Poser software, the male silhouettes occupied more surface area than the females. Visual size *per se* may be a veridical covariate of sex in body shape (men, on average, being larger than women). It is also known from previous search asymmetry studies (Treisman & Gormican, 1988) that targets that comprise “more” visual content (e.g. longer lines, pairs of lines) are found more readily amongst distractors with “less” content (e.g. shorter lines, single lines) than *vice versa.* Hence we controlled the stimulus size difference in the present study, so that if an asymmetric pattern of search efficiency were observed, it could be attributed to differences between the body shapes taken by the two sexes rather than size. Accordingly, the male silhouette images were rescaled, so that the proportion of black:white pixels in the items from the two categories did not differ on an independent samples T test, t(40) = 0.6, p = 0.55.

<<<<INSERT FIGURE 2 HERE >>>>

<<<<INSERT FIGURE 3 HERE>>>>

<<<< INSERT FIGURE 4 HERE>>>>

Results

A paired samples t-test on search slopes for accurate target present trials showed a significant difference between searching for female vs male bodies, $t(31) = -5.19$, $p < 0.001$, $d = -0.92$, 95% CI = [-40.15, -17.49]. Search for female body silhouettes among male distractors (M = 102 ms/item; SE = 6.61) was more efficient than for males among females (M = 131 ms/item; SE = 7.99; see **Figure 2**). A paired-samples t-test on d-prime showed significantly higher sensitivity when searching for a female target (M = 3.08, SE = 0.14) vs a male target (M = 2.76, SE = 0.11), $t(31) = 2.71$, $p = 0.01$, $d = 0.48$, 95% CI = [0.09,0.61] (see **Figure 3**). A more conservative criterion was observed when searching for female (M = 7.15, SE = 0.43) vs male target (M = 2.17, SE = 0.43), $t(31) = 3.14$, $p = 0.004$, $d = 0.55$, 95% CI = [1.74, 8.22].

3.3 Discussion

As predicted by the hypothesis that the shape of the female body is represented as a departure from a reference male body shape, females were detected more rapidly and more sensitively than were males, amongst distractors of the opposite sex. Furthermore, the high mean level of performance on the task, as indicated by the d-prime results, confirms that participants were readily able to categorise the silhouettes in this study as female or male.

4. Experiment 2: Frontal silhouettes

4.1 Introduction

In Experiment 2, we assessed the generality of the previous finding by repeating the study with body silhouettes shown from a frontal view. Frontal and lateral views differ in respect to the aspects of body shape that they reveal or obscure. To the extent that the same search asymmetry is found again, this indicates that it is less likely to be driven by an idiosyncratic property of the images in either stimulus set, and more likely to relate to a general property of body shapes.

4.2 Methods

4.2.1 Participants. The final sample of participants included 32 students (16 female; mean age 24 years +/- 5.84).

4,2,2 Apparatus and Stimuli. Images of frontal body silhouettes were generated using the open source software MakeHuman (Version 1.0.1, www.makehuman.org). The depicted bodies held a neutral standing pose with arms open, and were cropped to exclude the head (**Figure 1b**). The pool of images comprised 32 body silhouettes (16 males, 16 females) that differed in body shape. These were obtained by generating random MakeHuman characters for which the sex parameter was set to the most extreme value for each sex, while weight and and body proportion parameters varied freely. The resulting images were silhouetted by applying the phong shader (with emissive set to black) in the material editor of the software. Surface area of the silhouettes was controlled as in Experiment 1, and did not differ between sexes, t(30) = 1.25, *p* = 0.22.

4.3 Results

A paired samples t-test on search slopes for accurate target present trials showed a significant difference between searching for female vs male bodies, *t*(31) = -4.29, *p* < 0.001, *d* = -0.76, 95% CI = [-33.64, -11.99]. Search for female body silhouettes amongst male distractors (M = 129 ms/item; SE = 5.57) was more efficient than for males amongst females (M = 152 ms/item; SE = 6.90). A paired-samples t-test on d-prime showed significantly higher sensitivity when searching for a female target (M = 3.23, SE = 0.12) vs a male target (M = 2.76, SE = 0.13), *t*(31) = 4.70, *p* < 0.001, *d* = 0.83, 95% CI = [0.26, 0.67]. A more conservative criterion was observed when searching for female (M = 6.87, SE = 1.28) vs male target (M = 3.33, SE = 0.67), *t*(31) = 2.73, *p* = 0.01, *d* = 0.48, 95% CI = [0.90, 6.20].

4.3.1 Participant Gender. As a *post hoc* test of whether the participants' gender influenced asymmetries in search efficiency, we combined the data on slopes from present targets from Experiments 1 and 2 in a mixed design ANOVA with participant gender and target sex as factors. Search was more efficient for female than for male body targets, F(1,62) = 41.89, $p < 0.001$, $\eta_p^2 = 0.40$, and female participants were more efficient in the search task (M = 118 ms/item, SE = 6.58) than were male participants (M = 136 ms/item, SE = 6.55), F(1,62) = 4.09, $p = 0.047$, $\eta_p^2 = 0.06$. However, the interaction of these two variables was not significant, F(1,62) = 0.61, $p = 0.44$, $\eta_p^2 = 0.001$. The same analysis on d-prime results showed significantly higher discriminability for female than male body targets F(1,62) = 25.19, $p < 0.001$, $\eta_p^2 = 0.29$, and neither a significant main effect of participant gender, F(1,62) = 0.92, $p = 0.34$, $\eta_p^2 = 0.01$, nor a target sex x participant gender interaction, F(1,62) = 0.85, $p = 0.36$, $\eta_p^2 = 0.01$.

4.4 Discussion

Experiment 2 revealed a search asymmetry for body sex as did Experiment 1, demonstrating that this result generalises across viewpoint. Female participants performed better on the task than male participants. This pattern was not predicted *a priori*, although it is superficially similar to previous findings of a face recognition advantage for female participants (e.g., Rehnman & Herlitz, 2006). Importantly, the search asymmetry pattern did not differ as a function of participant gender, and as such in subsequent experiments we made no further effort to balance for gender when recruiting participants.

5. Experiments 3 and 4: GIST-matched profile and frontal silhouettes

5.1 Introduction

Experiments 3 and 4 were further efforts to replicate and confirm our initial findings. Our focus was on intra-class heterogeneity -- that is, the variance amongst exemplars within each sex. In general terms, a given search target will be harder to find to the extent that the distractors are dissimilar to each other, other factors being equal (Duncan & Humphreys, 1989). Furthermore, in a critique of some previous search asymmetry findings, Rosenholtz (2001) identified asymmetry of heterogeneity as a confounding factor. For example, in a study of asymmetries for visual motion, search for a target moving in one direction amongst uniformly static distractors was compared to a static target among distractors moving in diverse directions – an asymmetry of design that limits the interpretation of underlying representational (a)symmetries. If it were the case that in Experiments 1 and 2 the female silhouettes were more dissimilar to each other than were male silhouettes, this could in part account for the observed differences in search efficiency. Although any heterogeneity differences in Experiments 1 or 2 were likely to be subtle if present, this variable was not explicitly controlled.

A further motivation for Experiments 3 and 4 is that after completing Experiment 1 we noted that for a small number of female silhouettes, the spatial position of the figure within its surrounding square was off-centre (by 13 pixels, approximately 0.33 cm on screen) both when the items served as a target and as a distractor. This variance may have added unwanted noise to the findings of that study.

Because Experiments 3 and 4 were highly similar to each other, and built closely on Experiments 1 and 2 respectively, we report them here jointly.

5.2 Methods

5.2.1 Participants. The final sample of participants included 32 students in each experiment (Experiment 3: 24 female; mean age 19 years +/- 1.2; Experiment 4: 23 female; mean age 21 years +/- 1.3).

5.2.2 Apparatus and Stimuli. The challenge for measuring and controlling intra-class heterogeneity for complex stimuli is in identifying the right metric to describe an item and its similarity to another item. Pixel-level measures are almost certainly too simplistic and are unlikely to relate meaningfully to perceptual judgments of heterogeneity. At the same time, it would be impractical to attempt to assess within-class similarity subjectively over a large range of stimuli – nor is it clear what task would be suitable for such an effort.

Accordingly, we adopted the GIST descriptor (Oliva & Torralba, 2001) as a compromise measure that is objectively determined and also plausibly captures aspects of early visual processing. Briefly, each image is redescribed by a vector that summarises its visual features, over a grid of sub-cells, a range of spatial frequencies, and a range of edge orientations. Representing each body image in the GIST vector format enables us to determine a measure of the geometric distance between any two images in the space formed by the dimensions of this vector. With this measure in hand, we can then assess the variances of the distances amongst sets of male and female exemplars. The details of how we used the GIST logic to control within-sex heterogeneity of images are reported in the supplementary materials (Appendix A).

5.3 Results

5.3.1 Experiment 3. A paired samples t-test on search slopes for accurate target present trials showed a significant difference between searching for female vs male body profile silhouettes, $t(31) = -5.45$, $p < 0.001$, $d = -0.96$, 95% CI = [-39.35, -17.93]. Search for females amongst male distractors (M = 74.52 ms/item; SE = 5.79) was more efficient than for males amongst females (M = 103 ms/item; SE = 7.38). A paired-samples t-test on d-prime showed significantly higher sensitivity when searching for a female target (M = 3.21, SE = 0.13) vs a male target (M = 2.94, SE = 0.14), $t(31) = 2.14$, $p = 0.04$, $d = 0.38$, 95% CI = [0.01, 0.52]. No significant difference in the criterion was found between search for female (M = 3.18, SE = 0.78) and male (M = 1.78, SE = 0.33) targets, $t(31) = 1.63$, $p = 0.11$, $d = 0.29$, 95% CI = [-0.35, 3.16].

5.3.2 Experiment 4. Search for female body icons amongst male distractors (M = 117 ms/item; SE = 6.55) was numerically more efficient than for males amongst females (M = 131 ms/item; SE = 7.77), but this difference was not significant in a paired-samples t-test, t(31) = -1.91, p = 0.07, d = -0.34, 95% CI = [-28.31, 0.91]. A paired-samples t-test on d-prime showed significantly higher sensitivity when searching for a female target (M = 2.93, SE = 0.14) vs a male target (M = 2.66, SE = 0.12), *t*(31) = 2.37, *p* = 0.02, *d* = 0.42, 95% CI = [0.03, 0.51]. A more conservative criterion was observed when searching for female (M = 4.18, SE = 0.94) vs male targets (M = 2.01, SE = 0.26), *t*(31) = 2.27, *p* = 0.03, *d* = 0.41, 95% CI = [0.22, 4.12].

5.4 Discussion

In Experiments 1-4 we found, as hypothesised, that search for female targets is more efficient amongst male distractors relative to the converse, in terms of either search rates, sensitivity, or both. This is consistent with the default-plus-deviations coding scheme that we proposed in the Introduction, similar to Treisman’s proposal for more elementary visual characteristics. We further develop the implications of these findings, and their possible root causes, in the General Discussion, after additional experiments aimed at confirming and extending the findings.

The properties that distinguish bodies of the two sexes in Experiments 1-4 are almost certainly related to curvature, given that most other visual features are absent from silhouettes. Studies of search for simple visual elements have shown that search for a curve among straight lines is more efficient than the converse (Treisman & Gormican, 1988). This finding was interpreted as indicating that curvature is encoded as a deviation relative to a linear standard. Moreover, there is evidence for search asymmetries favouring concavities over convexities (Hulleman et al., 2000), and favouring shapes that contain curvature discontinuities (a local change in the rate of curvature) relative to those that do not (Kristjánsson & Tse, 2001). These findings are particularly relevant for Experiments 1-4, in that silhouettes of female bodies may have more (or more pronounced) concavities or curvature discontinuities than silhouettes of male bodies, which could in turn explain at least part of those findings. These considerations motivated the following three experiments.

6. Experiment 5: Body icons

6.1 Introduction

In Experiment 5, we examined search amongst iconic body images consisting only of linear elements. In these figures, the bodies did not contain continuous curves, thereby eliminating potential confounding differences in curvature between the two conditions. Furthermore, the stimuli were constructed such that identical geometric elements were arranged in different configurations in order to produce a percept of sex from body shape. In this way other potential confounds of visual properties between the two conditions were eliminated, as they were matched at the parts level. Likewise, with this manipulation we can exclude possible heterogeneity differences in the images of the two sexes, further addressing this issue that was initially tested in Experiments 3 and 4.

The additional experimental control that is offered by testing iconic bodies comes with a tradeoff against ecological validity relative to the more naturalistic stimuli of Experiments 1-4. While (as will be seen below) the iconic figures were readily accepted and identified by participants as human figures with a defined sex, they are not realistic in appearance. However, note that an extensive previous literature on other aspects of social vision, particularly work on faces, has similarly used averaged, filtered, cropped, edited, schematic, cartoon, or caricatured images to great effect in order to control stimulus confounds and to test key hypotheses (Johnson et al., 1991; Loffler et al., 2005; Öhman et al., 2001; Oosterhof & Todorov, 2008; Rhodes et al., 1987; Rhodes et al., 1999; Schyns & Oliva, 1999; Suzuki & Cavanagh, 1995; Tong et al., 2000; Rhodes et al., 2013).

6.2 Methods

6.2.1 Participants. The final sample included 32 students (25 female; mean age 19 years +/- 1.93).

6.2.2 Stimuli and apparatus. Icon images of human male and female bodies were prepared using PowerPoint (Microsoft Office, 2016; **Figure 1e**). To begin, we created 8 upward-pointing trapezia (narrower at the top) and 8 downward-pointing trapezia (narrower at the bottom) of varying proportions. Upward-pointing trapezia were treated as the torso for female figures, and downward-pointing trapezia as torsos for male figures. These shapes were then flipped around the horizontal axis, in order to create 8 more torsos of each sex, resulting in a final set of 32 images (16 males, 16 females). These torsos were elaborated, equivalently for each sex, with rectangles representing iconic legs, arms, neck and a head. Pose was varied such that the arms variously pointed up, down, or to the side (matched across the two sexes). The surface area of the figures did not differ between sexes, t(30) = 0.77, *p* = 0.44.

6.3 Results

A paired samples t-test on search slopes for accurate target present trials showed a significant difference between searching for female vs male icon bodies, *t*(31) = -2.25, *p* = 0.03, *d* = -0.40, 95% CI = [-21.55, -1.03]. Search for female body icons amongst male distractors (M = 63 ms/item; SE = 4.68) was more efficient than for males amongst females (M = 74 ms/item; SE = 5.12). A paired-samples t-test on d-prime showed significantly higher sensitivity when searching for a female target (M = 3.46, SE = 0.14) vs a male target (M = 3.06, SE = 0.11), *t*(31) = 4.21, *p* < 0.001, *d* = 0.74, 95% CI = [0.20, 0.59]. No difference in the decision bias between male (M = 2.45, SE = 0.41) and female (M = 2.07, SE = 0.22) search was found, *t*(31) = -0.80, *p* = 0.43, *d* = 0.14, 95% CI = [-1.33, 0.58].

6.4 Discussion

The effect of sex on search efficiency amongst body images does not depend entirely on the presence of naturalistic curvature in the image. Even in curvature-less icon stimuli, search for female figures amongst males was more efficient than the converse.

Further, the rapid search rates and high d-prime values observed here confirm that our participants accepted these icon silhouettes as representations of male and female bodies, and were able to categorise them efficiently.

The following two studies pursued this finding, with aims to further rule out possible confounding factors, and to examine the relative contributions of local body elements vs holistic shape to sex judgments. Specifically, we tested whether the search asymmetry persists for inverted icon figures (Experiment 6) and whether it can be explained by the orientation of the central “torso” element of the icon figures (Experiment 7).

7. Experiment 6: Inverted body icons

7.1 Introduction

Inverting a face (Rossion & Gauthier, 2002; Yin, 1969; Yovel & Kanwisher, 2005) or a body (Matsuno & Fujita, 2018; Minnebusch et al., 2009; Minnebusch et al., 2010; Reed et al., 2003, 2006, 2018; Stein et al., 2012; Sumi, 1984; Yovel et al., 2010) in the image plane can result in disproportionate impairment of perception of these stimuli, relative to other kinds of objects. For bodies, it is proposed by several authors that inversion interrupts normal whole-body perceptual processes, so that perceivers must instead rely more on a local, part-based analysis to perform visual tasks (Reed et al., 2003; Robbins & Coltheart, 2012; Stekelenburg & de Gelder, 2004; Urgesi et al., 2007). Therefore, inversion provides an opportunity to better understand the body representations that underlie the search asymmetry observed in the preceding experiment. If the search advantage for female bodies persists for inverted icon figures, then this would suggest that the effect is driven, at least in part, by local or part-based aspects of the body shape. In contrast, if inversion reduces or eliminates the search asymmetry, this would suggest instead a process operating at the whole-figure level.

Finally, if the same search asymmetry is not found for inverted icon figures, this would provide compelling evidence that the asymmetry found in Experiment 5 for those icons presented upright, cannot be attributed to a confounding (orientation-invariant) low-level property of the stimuli.

7.2 Methods

7.2.1 Participants. The final sample included 32 students (22 female; mean age 19.27 years +/- 1.85).

7.2.2 Apparatus and stimuli. The stimuli consisted of the icons from Experiment 5, rotated by 180º in the image plane (**Figure 1f**). There is previous evidence that body inversion effects are only present, or are stronger, when the head or face is also included in the stimulus (Brandman & Yovel, 2012; Minnebusch et al., 2009; Yovel et al., 2010) although the underlying reasons for this finding are still being revealed (e.g. Arizpe et al., 2017; Robbins & Coltheart, 2012). Because the icons used in Experiments 5 and 6 included a simple “head”, we assume that at least in this respect they are suitable to generate inversion effects in line with those previous findings.

7.2.3 Procedure. We sought to ensure that participants were aware that the inverted icons were depictions of human bodies. Were they not aware, then a failure to detect a search asymmetry in this study might have been attributable to a difference between experiments in participants’ understanding of the images. Accordingly, participants were first briefly shown examples of the upright body icons on paper, and were told that they had been used in a previous study about perception of sex from the body. They were then told that they were taking part in a study in which those body pictures would appear upside down; the paper was then rotated to show how these inverted body figures would look in the task. Participants were then instructed as in the previous experiments to search in different blocks for either a female body icon among male distractors, or a male body icon among female distractors.

7.3 Results

A paired-samples t-test on search slopes for target present trials with accurate responses revealed no significant search asymmetry between inverted female (M = 120 ms/item; SE = 7.68) and inverted male icons (M = 108 ms/item; SE = 6.03), $t(31) = 1.69$, $p = 0.10$, $d = 0.25$, 95% CI = [-2.55, 27.60] (see **Figure 2**). A paired-samples t-test on d-prime showed no significant difference in sensitivity when searching for a female target (M = 3.16, SE = 0.10) vs a male target (M = 3.23, SE = 0.11), $t(31) = -1.33$, $p = 0.19$, $d = -0.24$, 95% CI = [-0.07, 0.32] (see **Figure 3**). No significant difference in the criterion was found between male (M = 2.55, SE = 0.29) and female (M = 3.87, SE = 0.86), $t(31) = 1.55$, $p = 0.13$, $d = 0.27$, 95% CI = [-0.41, 3.04].

A direct comparison revealed that this pattern was significantly different from the search asymmetry found in Experiment 5: the interaction of Orientation (between participants) x Target Sex (within participants) was significant on search rates, F(1, 62) = 6.08, $p = 0.02$, $\eta_p^2 = 0.09$, and on d-prime F(1, 62) = 15.32, $p < 0.001$, $\eta_p^2 = 0.20$. Further, as expected, search in target present trials was more efficient overall for upright icons (Experiment 5: M = 68 ms/item, SE = 4.21) than for inverted icons (Experiment 4: M = 110 ms/item, SE = 5.81; F(1, 62) = 34.60, $p < 0.001$, $\eta_p^2 = 0.35$). No main effect in overall d-prime was found between the two orientations (F(1,62) = 0.07, $p = 0.79$, $\eta_p^2 = 0.001$).

7.4 Discussion

Inverting the body icons increased task difficulty (as measured in search slopes) and removed the advantage for detecting female amongst male bodies seen in the preceding experiment. This finding suggests that, in line with the previous findings noted in the Introduction to this experiment, body perception processes were interrupted here by inversion. More specifically, the present finding suggests that the search asymmetry favouring female bodies lies in emergent characteristics of the whole figure. This is as opposed to a basis in perception of specific local elements, whose processing we assume to be relatively unimpaired by inversion. Of course, this conclusion applies only to the body form as rendered here, and (as will be seen) may differ for other kinds of body images.

Finally, a benefit of directly comparing search for upright and inverted versions of the same stimuli is that they are perfectly matched for visual properties at the pixel-by-pixel level. Therefore, this manipulation rules out any account of the search asymmetry that would seek to explain it entirely on the basis of (orientation-invariant) lower-level stimulus properties that may be confounded between the male and female figures tested here.

8. Experiment 7: Isolated trapezia

8.1 Introduction

The male and female icons tested in Experiments 5 and 6 differed only in the orientation of the trapezium that formed their “torsos”. Although the results of Experiment 6 would appear to rule out the possibility, it may be that this variation in itself, rather than perceived sex, influenced search efficiency. To test this directly, we repeated the experiment with figures that contained only the “torso” element. In instructions to participants, no reference to sex or bodies was made. If a similar asymmetry were observed here, such that the upward-pointing trapezia (which were the basis for the female icons) were found more rapidly amongst downwards-pointing trapezia than vice versa, it would suggest that geometric shape rather than perceived sex best explains the results of Experiment 5. In contrast, a previous finding suggests the opposite prediction: visual search tasks with triangles show an asymmetry favouring downward-pointing triangles amongst upward-pointing triangles (Larson et al., 2007).

8.2 Methods

8.2.1 Participants. The final sample included 32 students (26 female; mean age 20.71 years +/- 3.38).

8.2.2 Stimuli. The stimuli consisted of the icons from Experiments 5 with all other elements aside from the central “torso” removed (**Figure 1g**). An independent samples t-test comparing upright and inverted trapezia images confirmed that they did not differ reliably in the proportion of black pixels, t(30) = 0.59, *p* = 0.56. (That they were not strictly identical was due to small variances introduced in resizing and jpeg-compressing the images from the original PowerPoint figures).

8.2.3 Procedure. At the start of each block, an example of a target shape and a distractor shape were shown to participants in the instructions that informed them how to respond. Images of targets and distractors were used rather than verbal labels, to avoid using descriptions such as “upward-pointing” that could bias participants’ framing of the stimuli and hence search efficiency. No mention of body perception was made in the study recruitment materials nor in the task instructions.

8.3 Results

A paired samples t-test on search slopes for accurate target present trials showed a significant difference between searching for upward- vs downward-pointing trapezia, *t*(31) = 3.61, *p* = 0.001, *d* = 0.64, 95% CI = [6.74, 24.0]. Search for downward-pointing shapes (M = 34 ms/item; SE = 3.84) was more efficient than for upward-pointing shapes (M = 50 ms/item; SE = 4.51) (see **Figure 2**). A paired-samples t-test on d-prime showed a significant difference in sensitivity favouring search for a downward-pointing shape (M = 3.61, SE = 0.13) vs an upward-pointing shape (M = 3.29, SE = 0.12), *t*(31) = -3.44, *p* = 0.002, *d* = -0.61, 95% CI = [-0.50, -0.13] (see **Figure 3**). No significant difference in the criterion between downward-pointing (M = 2.59 , SE = 0.32) and upward-pointing shapes (M = 2.80, SE = 0.36) targets was found, *t*(31) = 0.43, *p* = 0.67, *d* = 0.08, 95% CI = [-1.21, 0.79].

8.4 Discussion

The search asymmetry found in Experiment 5 cannot be explained by the orientation of the “torso” element of the body icons, which was the only difference between the bodies of the two sexes in that study. We conclude instead that the asymmetric pattern of search efficiency for iconic figures must be due to distinctions in the representations of male and female bodies that those icons engage.

In fact, the asymmetry for single shapes in isolation was in the opposite direction, such that the upward-pointing trapezia that formed the female torsos in Experiment 5 were detected amongst distractors less efficiently than the downward-pointing shapes. This is consistent with a previously reported attentional advantage for simple shapes containing a “V” or downward-pointing triangle, which has been attributed to a resemblance to the schematic structure of a face (Larson et al., 2007). In other words, comparing Experiments 5 and 7, we can see that the influence of the orientation of these central geometric elements is strongly driven by the context in which they appear. Viewing them in the context of a head and limbs leads to them being interpreted as part of a body, with the effect of reversing their relative influence on search efficiency (cf. Suzuki & Cavanagh, 1995; Weisstein & Harris, 1974).

9. Experiment 8: Odd-one-out task

9.1 Introduction

In the preceding experiments, the search target type was fixed for blocks of trials. This design permits both top-down guidance (participants are able to continuously maintain a template of the target over a series of trials) and priming effects (targets and distractor types repeat over a series of trials), either or both of which may influence search efficiency (Duncan & Humphreys, 1989; Maljkovic & Nakayama, 1994). If the search asymmetry favouring female targets is entirely dependent on these factors, then this pattern should not be found in a task in which the status of each sex as a target or distractor varies unpredictably. If instead a similar asymmetry is observed again, this would suggest that the underlying mechanisms relate more closely to immediate stimulus-driven influences of body shape.

To test this, in Experiment 8 we adopted an “odd-one-out” search task. The search arrays in this task were formed from the upright icon figures of Experiment 5, and were either homogenous with respect to sex (all male or all female; target absent) or else had a single deviating item (one male amongst females or vice versa; target present). These four trial types were randomised within blocks, so that from trial to trial participants could not anticipate whether male or female items would serve as target or distractor. Therefore, the only viable search strategy was to examine the items for a figure that deviated from the others by its sex.

9.2 Methods

9.2.1 Participants. The final sample included 32 students (25 female; mean age 21.03 years +/- 3.55).

9.2.2 Design and Procedure. Participants were instructed to indicate on each trial whether an odd item was present (by pressing the F key) or absent (by pressing the J key). Because “oddity” is not defined for set sizes of 1 or 2, we only tested the larger set sizes of the previous experiments (4 or 8). Participants performed four blocks of 64 trials each. Trial orders were randomised such that each chunk of 16 trials consisted of four trials from each combination of target (present, absent) and set size.

9.3 Results

A paired-samples t-test on search slopes for accurate target present trials showed no significant asymmetry in search efficiency when the odd target was male ($M = 70$ ms/item, $SE = 7.90$) compared to an odd female target ($M = 64$ ms/item, $SE = 7.22$), $t(31) = -0.64$, $p = 0.53$, $d = -0.11$, 95% CI = [-24.80, 13.00]. A paired-samples t-test on d-prime showed significantly higher sensitivity when the odd target was female ($M = 2.52$, $SE = 0.09$) vs male ($M = 2.21$, $SE = 0.10$), $t(31) = 4.34$, $p < 0.001$, $d = 0.77$, 95% CI = [0.16, 0.45]. No significant difference in the criterion was found between male-target ($M = 1.43$, SE = 0.13) and female-target (M = 1.73, SE = 0.15) trials, $t(31) = 1.59$, $p = 0.12$, $d = 0.28$, 95% CI = [-0.09, 0.69].

9.4 Discussion

In an "oddity" task, female targets were still more discriminable among male targets than vice-versa, even though target and distractor roles varied unpredictably from trial to trial. These findings support the hypothesis that the search asymmetry we find reflects the perceptual organization of body sex representation and is not entirely a consequence of top-down guidance processes (Friedman-Hill & Wolfe, 1995; Wang et al., 2005) nor of trial-by-trial priming effects.

That said, unlike in Experiments 1-5, the search asymmetry was revealed primarily in the d-prime analysis of sensitivity rather than in RT slopes. This may in part be accounted for by task difficulty. The requirement to detect an odd-one-out target was significantly more difficult (as seen by intercepts, slopes, and d-prime) relative to detecting a pre-specified target in arrays of the same stimuli in Experiment 5. In a more difficult search task, observers may spend a greater proportion of the search time re-examining individual items, hence diluting the impact of categorical differences on measures of RT slope. Another possibility, not mutually exclusive, is that the estimates of search slopes were less powerful in Experiment 8 relative to the preceding experiments, given that set sizes 1 and 2 were not tested and so slope calculation here relied on half of the data relative to the preceding experiments, and on only two set sizes.

10. Experiment 9: Upright body photographs

10.1 Introduction

The final two experiments were aimed at testing whether the search asymmetry observed here extends to photographic images of the body. That finding would provide further converging evidence for a generalisable effect, and would partly address the limited ecological validity of the silhouette images used to this point. Of course, using more realistic stimuli may also introduce other confounding differences between male and female body images that could in themselves influence search efficiency. We applied a series of image pre-processing steps aimed at controlling at least some such variables.

10.2 Methods

10.2.1 Participants. The final participant sample included 32 students (23 females, mean age 19 ± 1).

10.2.2 Stimuli and Procedure. Photographs of human bodies were collected through Google searches (Google, Inc). Twenty-four male and 24 female pictures with a neutral posture and a frontal view were initially selected. Pictures were selected to have, so far as possible, neutral and similar clothing (e.g. jeans and t-shirt) across males and females. These images were next pre-processed using Photoshop CC (Adobe, Inc.): the bodies were cropped and pasted on a light gray background; where necessary, strong cues present on the clothes (brands, pins, complex textures) were removed or obscured; and the head of each picture was cropped and the remaining body (including the neck) was centred in the frame. These pre-processed images were further processed in R with the “Imager” package (Barthelmé and Tschumperlé, 2019), where we computed the mean of the whole set of 48 pictures. Using this mean image, we defined the left-most, right-most, top-most and bottom-most pixels containing body information in any image, and cropped all the images with the resulting bounding box. These images were converted to grey-scale to remove colour cues.

The grey-scale body images of males and females were next matched for luminance and spatial frequency using the Shine Toolbox (Willenbockel et al., 2010) in Matlab (Matlab 2018a, the Mathworks, Inc.). The equalization steps were performed in this order: first we matched the luminance histograms of each image with the average luminance distribution of the whole set of images; second, we used the SHINE function *sfMatch* to equate Fourier amplitudes across stimuli. This function preserves the amplitude distribution across orientations while ensuring that the rotational average amplitudes for a given spatial frequency are equated between images. Preserving the amplitude distribution among orientations ensures that the resulting images do not differ too highly from the input images. Importantly, luminance and spatial frequency were matched across sex to remove any possible systematic lower-level difference between the male and female images chosen. Next, a 50 pixels diameter grey oval, pixelated in 15x15 pixel cells with the default Photoshop mosaic filter, was added to each image to cover the missing head, and a right and left middle-grey border were added to the images to obtain a square of 800 x 800 pixels. Finally, the resulting images were resized to 200 x 200 pixels using the Lanczos resizing filter of the Imager package. The search arrays were presented against a light grey background.

Owing to the increased diversity and complexity of the photographic stimuli used here, compared to the silhouettes of Experiments 1-8, we reduced the maximum search set size: set sizes 1, 2, 4, and 6 were tested.

10.3 Results

A paired samples t-test on search slopes for accurate target present trials showed a significant difference between searching for female vs male body photographs, *t*(31) = -2.97, *p* = 0.006, *d* = -0.52, 95% CI = [-27.28, -5.05]. Search for female body pictures amongst male distractors (M = 132 ms/item; SE = 6.25) was more efficient than for males amongst females (M = 148 ms/item; SE = 8.02). A paired-samples t-test on d-prime showed no significant difference in sensitivity when searching for a female (M = 3.16, SE = 0.12) vs a male target (M = 3.10, SE = 0.11), *t*(31) = 2.37, *p* = 0.48, *d* = 0.12, 95% CI = [-0.12, 0.25]. No significant difference between search for male (M = 5.92, SE = 1.05) and female (M = 5.62, SE = 1.21) targets was found in the criterion, *t*(31) = -0.19, *p* = 0.84, *d* = -0.03, 95% CI = [-3.49, 2.88].

11. Experiment 10: Inverted body photographs

11.1 Introduction

As described above in relation to Experiment 6, stimulus inversion offers the opportunity to test to what extent the search asymmetry depends on local as opposed to whole-figure cues. To that end, in Experiment 10 we examined search amongst the inverted photographic body images of Experiment 9. Finding no search asymmetry here would suggest participants were judging sex from these images on the basis of holistic properties that are disrupted by inversion. In contrast, if the female advantage were replicated for inverted stimuli, this would suggest a reliance on local, or at least orientation-invariant, properties.

11.2 Methods

11.2.1 Participants. The final sample included 32 participants (29 females, mean age 20 ± 2.1).

11.2.2 Stimuli and Procedure. The stimuli were those from Experiment 9, rotated by 180˚ in the image plane. As in Experiment 9, set sizes 1, 2, 4, and 6 were tested.

11.3 Results

A paired samples t-test on search slopes for target present trials showed a significant difference between searching for inverted female vs male body pictures, $t(31) = -2.74$, $p = 0.01$, $d = -0.48$, 95% CI = [-47.42, -6.98]. Search for female body pictures amongst male distractors (M = 180 ms/item; SE = 11) was more efficient than for males amongst females (M = 207 ms/item; SE = 12.89). A paired-samples t-test on d-prime showed no significant difference in sensitivity when searching for female (M = 1.79, SE = 0.13) vs a male target (M = 1.67, SE = 0.14), $t(31) = 1.56$, $p = 0.13$, $d = 0.27$, 95% CI = [-0.03, 0.27]. No significant difference between search for male (M = 2.22, SE = 0.74) and female (M = 1.37, SE = 0.35) targets was found in the criterion, $t(31) = -0.99$, $p = 0.33$, $d = -0.18$, 95% CI = [-2.57, 0.88].

11.4 Discussion

The findings of Experiments 9 and 10 again confirmed the predicted search asymmetry in favour of female body targets amongst male distractors. Together with the preceding experiments, these results demonstrate the generality of the phenomenon, and further establish that it relates to aspects of body-specific mental representations *per se*, as opposed to possible confounding image properties of a specific stimulus set.

In contrast to Experiments 5 and 6, in which body icon stimuli were tested in upright and inverted conditions, here we found in measures of RT slopes (but not sensitivity), an advantage for female targets both in the upright and inverted cases. A direct comparison across these four experiments demonstrates that this difference in inversion effects on search asymmetry is reliable: Interaction of Orientation (Upright/inverted) x Stimulus Type (Icon/Photograph) x Target (Male/Female), $F(1,124) = 5.84$, $p = 0.02$, $\eta_p^2 = 0.04$. This finding suggests that while the body cues that drive the search asymmetry for the icon figures are indeed holistic, in contrast, for realistic photographic body images local cues or orientation-invariant cues are available. This may be expected given the visually richer (and necessarily less finely controlled) nature of the photographic stimuli, which likely contain elements of texture, or of local part structure, that co-vary with sex. Judging sex from body shape may be either local or configural, depending on the specifics of the stimulus and other contextual objects such as clothing.

Interestingly, the same appears to be true for perceiving sex from the visual appearance of the face. On the one hand, observers making facial sex judgments spontaneously rely strongly on specific regions of the face, and similarly are able to judge sex above chance when presented with some face features in isolation (e.g. Chronicle et al., 1995; Dupuis-Roy et al., 2009; Yamaguchi et al., 2013), suggesting a local, featural process. On the other hand, image manipulations such as inversion and scrambling – which disrupt whole-face patterns while leaving local elements relatively intact – are found to significantly impede judgments of face sex (Baudouin & Humphreys, 2006; DeGutis et al., 2012; Zhao & Hayward, 2010). In sum, the visible signals that convey sex in the body, and the face, are diverse and may draw variably on local and holistic perceptual processes.

12. Meta-analyses

We conducted meta-analyses over the RT slopes from the experiments in which we predicted a search asymmetry favouring female bodies (**Figure 5**), and, separately, on the d-prime measures of sensitivity (**Figure 6**). For these analyses we excluded Experiment 7, for which an effect was not predicted, and the inversion experiments (Experiments 6 and 10) for which competing hypotheses were proposed and tested.

<<<<< *INSERT FIGURE 5 HERE*>>>>>

<<<< *INSERT FIGURE 6 HERE*>>>>>>

12.1 Method

Using the package “metafor” (Viechtbauer, 2010) and the function “escalc” we computed the raw mean change between female and male conditions in each experiment, for RT slopes and d-prime measures separately. Raw mean differences were taken because all studies used the same unit of measurement; they have the further advantage of being more directly interpretable than standardised effect size measures. The resulting values were used to fit a metanalytic random effect model for each dependent measure with the default restricted maximum likelihood estimator for heterogeneity. The results of each study included in the meta-analysis represent a study-specific effect size that varies around a mean population effect size. The random-effects model assumes that each study included in the meta-analysis represents a random sample from a population of studies.

12.2 Results

The results of the metanalyses for RT slopes (**Figure 5**) and d-prime measures of sensitivity (**Figure 6**) are shown in forest plots. We found a statistically significant overall estimated mean change across the included studies. Search for female bodies is estimated to be 19.23 ms per item faster on average relative to male bodies (95% CI [13.05, 25.42], zval = 6.10, $p < .001$), and female targets 0.30 d-prime points more discriminable than males (95% CI [0.20, 0.40], zval = 5.78, $p < .001$).

13. Additional analyses: Criterion effects, target-absent trials, and Bayes factors

Might decision bias explain some or all of our search asymmetry effects? Specifically, if participants were simply more prepared to report “female” than male, this could in principle relate to faster response times for female as opposed to male targets. Note that of course this would contradict the “male bias” found in the previous studies on sex judgments that were reviewed in the Introduction. The logic of d-prime is ideally suited to distinguishing participants’ sensitivity to targets of different kinds from their decision criteria. Indeed, to the extent we did find significant differences on criterion measures, they generally reflected a more liberal threshold to report “male” (a more conservative threshold to report “female”). Hence we both confirm, to some extent, reports of a male bias in sex judgments of the body, and also establish a superior efficiency to detect female bodies amongst distractors.

Target absent trials are often treated as of secondary interest in visual search tasks. Response times to these trials may be more influenced by decision processes -- when should the observer elect to give up searching for something that is not there? – than target present trials. In the present studies, target-absent trials do of course inform the sensitivity measures, in that these data determine the false alarm rate which is used to compute d-prime and criterion. In general, we observed that response time slopes from accurate target-absent trials mirrored the effects of target sex on accurate target-present trials (see **Figure 4**). This is in line with previous findings that the two measures tend to be highly correlated with each other (Wolfe, 1998). An exception was found in Experiments 9 and 10, in which target absent slopes (unlike target present slopes) were highly similar for male and female searches. It may be relevant that in those experiments we also did not find the same d-prime advantages for female targets, as seen in several of the other experiments. However, we did not predict this variation between studies and do not have a *post hoc* account to explain it.

The analyses reported so far all followed a frequentist approach. To further assess the evidence for competing hypotheses, we performed Bayesian paired-sample t-tests comparing performance for male and female targets, for search slopes and for d-prime measures in each experiment. In general, the results of these are consistent with the findings reported above, and are detailed in Appendix B.

14. General Discussion

Visual search for female bodies among male distractors is more efficient than the converse. This search asymmetry was predicted on the basis of a logical extension of previous findings from face and body perception, in combination with Treisman's proposals for the organisation of visual representations generally. It reveals a new principle behind the organisation of mental representations that link a person's visual appearance to categorical, socially-relevant information.

When examining visual perception of complex stimuli such as bodies, it is sometimes difficult to completely rule out the contribution of lower-level image properties. (Nor is it always desirable to attempt to do so, given that such properties may contribute reliably to perceiving and categorizing an image). However, several aspects of the present work mitigate the possibility that simple image properties in themselves are responsible for the search asymmetry. In multiple studies we tested silhouettes, which exclude many potentially co-varying aspects of colour, texture, and shading. Silhouettes were presented in two different viewpoints, each revealing and concealing different aspects of body shape. Further, the silhouettes were matched for surface area and for intra-class homogeneity, both of which could in themselves influence search efficiency. With schematic “icon” silhouettes, finding a different pattern of search efficiency amongst otherwise identical upright and inverted figures provides further control against local visual confounds. Likewise, a control experiment limited to the “torsos” of the icon figures rules out a geometric account of those findings. Finally, with more realistic photographic figures, image processing was used to carefully match male and female images on elementary visual characteristics. The most parsimonious account of our findings as a whole is that asymmetric visual search performance reflects the properties of high-level visual body representations, rather than the effects of confounding visual properties *per se*.

14.1 Mental representations of body appearance

If that is the case, then what are the properties of mental body representations that account for asymmetric search? Suppose that male and female body representations are organised in pools of body-selective cells that collectively act as detectors that are tuned to shape properties, including those related to sex. (There is strong evidence describing local concentrations of body-selective cells in primate inferotemporal regions, albeit not specifically on how they are tuned to sex; Kumar et al., 2019; Kumar & Vogels, 2019; Popivanov et al., 2014, 2016). Our hypothesis is that detectors that are primarily tuned to the standard (male body shapes) are more strongly activated by the off-standard (female) than *vice versa*. In other words, female bodies also activate the male detectors, whereas male bodies produce little effect on female-tuned detectors. A corollary, identified in general terms by Treisman and Gormican (1988) for more elementary visual properties, is that the tuning profiles of these populations are different. That is, the tuning of detectors for the standard (male) is broader, such that responses are evoked by a relatively wider range of stimulus types, compared to detectors tuned for the non-standard (female). This view predicts that when the non-standard (female) is a distractor, this generates high background activity in the detectors for the standard (male), leading to a more difficult target/non-target discrimination. In contrast, when the non-standard (female) is a target, it is more detectable by virtue of the additional unique activity over its more narrowly tuned detectors.

Following this logic, then, what is the feature or property that is generally present in female body shapes but absent in male body shapes (cf. Treisman & Souther, 1985), or present to a greater degree in females than males (cf. Treisman & Gormican, 1988)? Note that answering this question is not trivial even for apparently simpler search asymmetries. For example, are Q targets so readily found among O distractors because of the additional line segment itself, or the junction formed where it joins the curve of the letter, or the interruption of that curve, or the introduction of higher spatial frequencies, or all of these factors in combination? The question is still more complex for bodies, and the answer likely does not correspond to a single simple visual property being present in all images of female bodies and absent in every male, given that we found the same pattern over different image formats (and not in otherwise identical inverted icons). For example, in frontal views, one possible key property is waist-to-hip ratio (Singh, 1993), which is systematically lower in females than males, and which relates to overt sex judgments

(Johnson & Tassinary, 2005). However, this feature is obscured in silhouetted lateral views of the body, which also generated the search asymmetry.

Indeed, our findings with body icons show that the search asymmetry can be generated by abstractly implied features of the two sexes, because real bodies do not take these specific visual shapes. Here it is important to note previous visual search studies showing that efficiency can be strongly influenced by implied features and emergent properties as much as (or more than) by primitive visual characteristics (Rensink & Enns, 1995). For example, search for shapes defined by implied edges can be as efficient as for shapes defined by real, contrast-defined edges (Gurnsey et al., 1992; Li et al., 2008). Similarly, search efficiency amongst simple clusters of black and white patches is strongly improved when their arrangement is consistent with the 2D projection of a 3D shape (Enns & Rensink, 1990) and can be driven more by the apparent surface reflectances of shapes than by local patterns of brightness (Sun & Perona, 1996b). Conversely, search is highly inefficient for high-contrast shapes that are consistent with the shadow cast by another object, suggesting these surfaces are discarded as background early in perception (Rensink & Cavanagh, 2004). In other words, search performance and search asymmetries are driven not only by the physical characteristics of the stimulus, but also strongly by their implied real-world significance.

Drawing these considerations together, we argue that the present findings are not best explained by the presence or absence of a specific, concrete, and isolable stimulus element or property. Instead, they reflect the influence of an emergent representation of body shape that distinguishes female body form by reference to a male default, a representation that captures the underlying properties of the body’s shape that relate as much to the subjective percept as to the physical stimulus itself.

14.2 Origins of sex representations

Here we speculate about the possible origins of an asymmetric encoding of sex from body shape. Visual experience is an important factor in shaping the mental representations of the objects we know about. For example, visual search efficiency is known to be influenced by an observer's experience with the relevant stimuli, especially when this experience is extensive (e.g. Qin et al., 2014). This is shown in previous studies of visual search with complex stimuli such as faces, objects, and words. For example, observers reliably detect their own faces highly efficiently amongst familiar distractor faces (Tong & Nakayama, 1999). Car expertise relates to the ability to rapidly detect cars in arrays of objects or complex natural scenes (Golan et al., 2014; Hershler & Hochstein, 2009; Reeder et al., 2016). And detection can be facilitated for real word targets, relative to closely-matched nonwords (Christie & Klein, 1995; Flowers & Lohr, 1985).

Certainly, for most people, the form of the human body will be extremely familiar, as a result of extensive daily exposure to other people. This experience could partly account for our ability to efficiently detect bodies amongst other kinds of visual stimuli (Downing et al., 2004; van Koningsbruggen et al., 2013; Ro et al., 2007; Stein et al., 2012; Fletcher-Watson et al., 2008) and may also partly account for the effect of inversion on body perception (Reed et al., 2012). Of course it does not in itself account for a search asymmetry favouring female bodies. However, in many cultures, exposure to other people is highly biased in favour of females in the first few months and years of development, exactly when developing visual representations of other people are being shaped by experience (Quinn & Eimas, 1998; Rennels & Davis, 2008). For example, data from head-mounted cameras show that in the first few months of life infants are disproportionately exposed to adult female faces (and presumably bodies) of people of their own race (Sugden et al., 2014). And recent data from the UK show that about 97% of the workforce in childcare and early years providers is female (UK Survey of Childcare and Early Years Providers, 2018).

There are good reasons to think that this strong bias in early experience has an impact on visual development and behaviour (Ramsey-Rennels & Langlois, 2006). Much of the key evidence concerns the face. For example, in one influential study, infants aged 3 to 4 months looked longer at female faces when they were presented paired together with male faces (Quinn et al., 2002). Importantly, this preference depended on the participants having females as primary caregivers; the pattern was reversed in a sample of infants raised primarily by male caregivers (see also Quinn et al., 2019; Ramsey et al., 2005; Rennels et al., 2017; Juvrud et al., 2019). Related phenomena are revealed in neural measures; for example, in ERP recordings with 7-month-old infants, differential cortical activity was evoked by primed vs novel female faces, but not for male faces (Righi et al., 2014). Furthermore, biased early exposure to conspecifics may have a lasting influence on social vision, to the extent that core representations are being shaped at that time. This idea is supported by studies of early visual deprivation: following correction of congenital cataracts in infancy, patients are impaired quite specifically in face tasks that rely on holistic face processing -- even after years of subsequent visual experience -- suggesting that such representations critically depend on visual experience in the first months of life (Le Grand et al., 2001; Le Grand et al., 2004; Maurer, 2017; Robbins et al., 2010; Young et al., 1987).

Given that natural visual experience of faces and bodies is tightly yoked (Hu et al., 2020), it is reasonable to assume that early visual representations of the body are also typically shaped by a much richer sampling of female than male bodies. While studies of infants' perception of body structure initially suggested a slower developmental trajectory relative to face perception (Heron-Delaney et al., 2011; Slaughter et al., 2004), other recent evidence reveals significant changes in infants' understanding of the body in the first year of life (Bhatt et al., 2016; Gliga et al., 2005; Zieber et al., 2015). Five-month-olds discriminate between whole-body postures that differ in limb positions, but not between postures of isolated limbs (Hock et al., 2016), and infants of 9 months distinguish normal from proportionally-distorted upright bodies (Zieber et al., 2010). Further, looking-time evidence from 5-month-olds shows sensitivity to the congruence of the sex of the face and body (Hock et al., 2015), and gaze behaviours reveal sex-dependent attention to body regions in line with those of adults (e.g. preferentially scanning the torsos of female bodies; White et al., 2018). Finally, under some conditions young infants prefer to attend female over male bodies (Alexander et al., 2016) as they do faces (Quinn et al., 2002). Collectively, these findings suggest that in the first year, at least a crude whole-body representation has developed, one that encodes some aspects of sex from body shape.

Taken together, the above evidence supports a speculative but coherent account of the basis of the search asymmetry favouring female body shape, as follows: Significant development of the visual representations of other people occurs in the first year of life, establishing foundations that may have lasting effects on social vision into adulthood. In many cultures, social experience in infancy is largely with female adults, meaning that these representations are built disproportionately on the basis of female bodies and faces. Evidence on how experience shapes the tuning of relevant neural populations (e.g. Clifford et al., 2015; Fischer and Pena, 2011; Ganguli and Simoncelli, 2014) suggests that this asymmetric experience may result in denser neural encoding of female relative to male body shapes. In turn, in line with Treisman and Gormican’s (1988) analysis, this richer encoding of the female body shape equates to female “detectors” that are more narrowly tuned to their preferred stimuli compared to male “detectors”. This imbalance, as described above, generates asymmetric search performance -- revealed here by observers’ improved efficiency to detect a female target – because neural activity generated by female bodies *extends* that generated by males. Finally, following the same logic, we suggest that the relatively broader tuning of male “detectors” could contribute to the previously-described bias to judge body stimuli as male, particularly when the visual signal is impoverished. (This does not exclude other possible contributions, for example biases arising at the response-selection level).

Before concluding, it is worth emphasizing that multiple other aspects of visual experience, aside from asymmetric exposure to males and females, also influence developing visual representations of other people. This is revealed, for example, in effects of age, puberty, race, and observer gender on tasks of attention and memory for social stimuli (Anzures et al., 2013; Herlitz & Lovén, 2013; Levin, 2000; Picci & Scherf, 2016; Rehnman & Herlitz, 2006; Rhodes & Anastasi, 2012). Indeed the influences of such variables may interact in complex ways with sex, as expected on a dynamic understanding of person perception (Freeman & Ambady, 2011).

14.3 Open questions

The preceding account relies in part on studies of face perception, raising the obvious implication that we should expect to find a similar search asymmetry favouring female faces over male faces. In work in progress, we have observed this pattern (either in RT slopes or d-prime sensitivity) in visual search with three different kinds of face stimuli. We might also, on similar logic, expect differential sensitivity to characteristic patterns of male and female body movement, e.g. as captured in “point-light” animations of walking. Indeed, adults show a male bias in sex judgments from such stimuli (Troje et al., 2006) and human biological motion is a powerful driver of infants’ attention from birth (Falck-Ytter et al., 2011; Fox and McDaniel, 1982; Simion et al., 2008). Our account depends no less on assumptions about the statistics of early visual experience in our sample of participants. An obvious key test would be to recruit participants with a gender-balanced or male-predominant experience of caregivers in early infancy and childhood (cf. Rennels et al., 2017).

Will the asymmetric representation of females be evident in other tasks? One observation (from Experiments 6 and 8), is that it appears neither necessary nor sufficient that participants adopt a search target template for a specific sex for a search asymmetry to occur. That is, we did not find this effect for inverted icons when participants searched for female or male targets in different blocks; yet we did find a search asymmetry (in d-prime measures) for an “odd-one-out” task in which target sex was unknown from trial to trial. A further way to disentangle top-down influences (such as expectations about target type) from bottom-up stimulus factors would be to test whether sex from body shape influences detection efficiency before the stimulus reaches awareness. That is, are female bodies more readily detected than males in inattentional blindness or continuous flash suppression tasks (Downing et al., 2004; Mack & Rock, 1998; Stein et al., 2012)? Similarly, in a visual search task the target-defining property could be manipulated orthogonally to the sex of the body (cf. Theeuwes, 1994). Would female body targets be found more rapidly than male targets, in a task that required (for example) detecting the presence of a body expressing a specific emotion? Finally, the present proposal makes a novel prediction about the effects of visual adaptation to bodies. If the representation of the female form includes and extends that of male bodies, then the effects of male and female adaptors on sex judgments of ambiguous bodies should not be symmetric.

15. Conclusions

The present findings expose the structure of mental representations that relate sex and body shape. In doing so, they improve our understanding of how observers efficiently use body cues to make inferences about others. More broadly, a better description of body perception will support direct comparisons to well-developed models of how we perceive faces (Duchaine & Yovel, 2015) and voices (Latinus & Belin, 2011). In turn, drawing together such efforts can facilitate the development of frameworks to describe person perception and categorisation in general (Freeman & Ambady, 2011; Hu et al., 2020; Yovel & Belin, 2013).

Author contributions

Both authors developed the concept and design of the studies. Data collection was performed by MG with assistance as noted below. Both authors analysed and interpreted the data and wrote the manuscript.

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Supplementary Material

Appendix A.

Additional methods for Experiment 3 and 4.

Appendix B.

Supplementary analysis with Bayesian paired-sample t-tests.

Appendix C.

Raw Data for experiment 1-10.

References

Adams, R. B., Ambady, N., Nakayama, K., & Shimojo, S. (Eds.). (2010). The Science of Social Vision. Oxford, UK: Oxford University Press.

Alexander, G. M., Hawkins, L. B., Wilcox, T., & Hirshkowitz, A. (2016). Infants prefer female body phenotypes; Infant girls prefer they have an hourglass shape. Frontiers in psychology, 7, 804.

Alexi, J., Cleary, D., Dommisse, K., Palermo, R., Kloth, N., Burr, D., & Bell, J. (2018). Past visual experiences weigh in on body size estimation. Scientific reports, 8(1), 1-8.

Anzures, G., Quinn, P. C., Pascalis, O., Slater, A. M., & Lee, K. (2013). Development of own-race biases. *Visual cognition*, *21*(9-10), 1165-1182.

Arizpe, J. M., McKean, D. L., Tsao, J. W., & Chan, A. W.-Y. (2017). Where You Look Matters for Body Perception: Preferred Gaze Location Contributes to the Body Inversion Effect. PLOS ONE, 12(1), e0169148.

Armann, R., & Bülthoff, I. (2012). Male and female faces are only perceived categorically when linked to familiar identities – And when in doubt, he is a male. Vision Research, 63, 69-80.

Aviezer, H., Trope, Y., & Todorov, A. (2012). Body Cues, Not Facial Expressions, Discriminate Between Intense Positive and Negative Emotions. Science, 338(6111), 1225-1229.

Barthelmé, S., & Tschumperlé, D. (2019). imager: an R package for image processing based on CImg. Journal of Open Source Software, 4(38), 1012.

Baudouin, J. Y., & Humphreys, G. W. (2006). Configural information in gender categorisation. Perception, 35(4), 531-540.

Becker, D. V., & Rheem, H. (2020). Searching for a face in the crowd: Pitfalls and unexplored possibilities. Attention, Perception, & Psychophysics, 1-11.

Becker, D. V., Anderson, U. S., Mortensen, C. R., Neufeld, S. L., & Neel, R. (2011). The face in the crowd effect unconfounded: Happy faces, not angry faces, are more efficiently detected in single- and multiple-target visual search tasks. Journal of Experimental Psychology: General, 140(4), 637-659.

Bell, C., Kirkpatrick, S. W., & Rinn, R. C. (1986). Body image of anorexic, obese, and normal females. Journal of Clinical Psychology, 42(3), 431-439.

Berry, D. S. (1991). Child and Adult Sensitivity to Gender Information in Patterns of Facial Motion. Ecological Psychology, 3(4), 349-366.

Bhatt, R. S., Hock, A., White, H., Jubran, R., & Galati, A. (2016). The development of body structure knowledge in infancy. Child development perspectives, 10(1), 45-52.

Bindemann, M., Scheepers, C., Ferguson, H. J., & Burton, A. M. (2010). Face, body, and center of gravity mediate person detection in natural scenes. Journal of Experimental Psychology: Human Perception and Performance, 36(6), 1477.

Brainard, D. H. (1997). The psychophysics toolbox. *Spatial vision*, *10*(4), 433-436.

Brandman, T., & Yovel, G. (2012). A face inversion effect without a face. Cognition, 125(3), 365-372.

Brooks, K. R., Baldry, E., Mond, J., Stevenson, R. J., Mitchison, D., & Stephen, I. D. (2019). Gender and the Body Size and Shape Aftereffect: Implications for neural processing. Frontiers in neuroscience, 13, 1100.

Brooks, K. R., Clifford, C. W., Stevenson, R. J., Mond, J., & Stephen, I. D. (2018). The high-level basis of body adaptation. Royal Society open science, 5(6), 172103.

Brown, E., & Perrett, D. I. (1993). What gives a face its gender. Perception, 22(7), 829-840.

Bruce, V., & Langton, S. (1994). The use of pigmentation and shading information in recognising the sex and identities of faces. Perception, 23(7), 803-822.

Bruce, V., & Young, A. (2013). Face perception. Psychology Press.

Burton, A. M., Bruce, V., & Dench, N. (1993). What's the difference between men and women? Evidence from facial measurement. Perception, 22(2), 153-176.

Cass, J., Giltrap, G., & Talbot, D. (2019). Female body dissatisfaction and attentional bias to body images evaluated using visual search. Frontiers in Psychology, 10, 2821.

Christie, J., & Klein, R. (1995). Familiarity and attention: Does what we know affect what we notice. Memory & cognition, 23(5), 547-550.

Chronicle, E. P., Chan, M. Y., Hawkings, C., Mason, K., Smethurst, K., Stallybrass, K., ... & Wright, K. (1995). You can tell by the nose—Judging sex from an isolated facial feature. *Perception*, *24*(8), 969-973.

Clifford, C. W. G., Mareschal, I., Otsuka, Y., & Watson, T. L. (2015). A Bayesian approach to person perception. Consciousness and cognition, 36, 406-413.

Cohen, M. A., Alvarez, G. A., Nakayama, K., & Konkle, T. (2016). Visual search for object categories is predicted by the representational architecture of high-level visual cortex. Journal of neurophysiology, 117(1), 388-402.

Cutting, J. E. (1978). Generation of synthetic male and female walkers through manipulation of a biomechanical invariant. Perception, 7(4), 393-405.

Cutting, J. E., Proffitt, D. R., & Kozlowski, L. T. (1978). A biomechanical invariant for gait perception. J Exp Psychol Hum Percept Perform, 4(3), 357-372.

D'Argenio, G., Finisguerra, A., & Urgesi, C. (2020). Motion and gender-typing features interact in the perception of human bodies. *Frontiers in Neuroscience*, *14*, 277.

Davidenko, N. (2007). Silhouetted face profiles: a new methodology for face perception research. J Vis, 7(4), 6.

Davidenko, N., Remus, D. A., & Grill-Spector, K. (2012). Face-likeness and image variability drive responses in human face-selective ventral regions. Human brain mapping, 33(10), 2334-2349.

de Gelder, B. (2009). Why bodies? Twelve reasons for including bodily expressions in affective neuroscience. Philos Trans R Soc Lond B Biol Sci, 364(1535), 3475-3484.

DeGutis, J., Chatterjee, G., Mercado, R. J., & Nakayama, K. (2012). Face gender recognition in developmental prosopagnosia: evidence for holistic processing and use of configural information. Visual Cognition, 20(10), 1242-1253.

Downing, P. E., Bray, D., Rogers, J., & Childs, C. (2004). Bodies capture attention when nothing is expected. Cognition, 93(1), B27-38.

Downing, P. E., Jiang, Y., Shuman, M., & Kanwisher, N. (2001). A cortical area selective for visual processing of the human body. Science, 293(5539), 2470-2473.

Downing, P. E., & Peelen, M. V. (2011). The role of occipitotemporal body-selective regions in person perception. *Cognitive neuroscience*, *2*(3-4), 186-203.

Duchaine, B., & Yovel, G. (2015). A Revised Neural Framework for Face Processing. Annu Rev Vis Sci, 1, 393-416.

Duncan, J., & Humphreys, G. W. (1989). Visual search and stimulus similarity. Psychological review, 96(3), 433.

Dupuis-Roy, N., Fortin, I., Fiset, D., & Gosselin, F. (2009). Uncovering gender discrimination cues in a realistic setting. *Journal of vision*, *9*(2), 10-10.

Enns, J. T., & Rensink, R. A. (1990). Influence of scene-based properties on visual search. Science, 247(4943), 721-723.

Enns, J. T., & Rensink, R. A. (1991). Preattentive recovery of three-dimensional orientation from line drawings. Psychological Review, 98(3), 335.

Faghel-Soubeyrand, S., Dupuis-Roy, N., & Gosselin, F. (2019). Inducing the use of right eye enhances face-sex categorization performance. J Exp Psychol Gen, 148(10), 1834-1841.

Falck-Ytter, T., Bakker, M., & von Hofsten, C. (2011). Human infants orient to biological motion rather than audiovisual synchrony. Neuropsychologia, 49(7), 2131-2135.

Fischer, B. J., & Peña, J. L. (2011). Owl's behavior and neural representation predicted by Bayesian inference. *Nature neuroscience*, *14*(8), 1061.

Fiske, S. T., Gilbert, D. T., & Lindzey, G. (Eds.). (2010). Perceiving People. Hoboken, NJ, USA: John Wiley & Sons, Inc.

Flowers, J. H., & Lohr, D. J. (1985). How does familiarity affect visual search for letter strings? Perception & Psychophysics, 37(6), 557-567.

Fox, R., & McDaniel, C. (1982). The perception of biological motion by human infants. Science, 218(4571), 486-487.

Fletcher-Watson, S., Findlay, J. M., Leekam, S. R., & Benson, V. (2008). Rapid detection of person information in a naturalistic scene. Perception, 37(4), 571-583.

Freeman, J. B., & Ambady, N. (2011). A dynamic interactive theory of person construal. Psychol Rev, 118(2), 247-279.

French, R. M., Mareschal, D., Mermillod, M., & Quinn, P. C. (2004). The role of bottom-up processing in perceptual categorization by 3-to 4-month-old infants: Simulations and data. Journal of experimental psychology: General, 133(3), 382.

Friedman-Hill, S., & Wolfe, J. M. (1995). Second-order parallel processing: Visual search for the odd item in a subset. *Journal of Experimental Psychology: Human Perception and Performance*, *21*(3), 531.

Gaetano, J., Brooks, A., & van der Zwan, R. (2012). Discriminating sex from representations of the human hand: Evidence of a pan-stimulus male bias. Front Hum Neurosci; Australasian Cognitive Neuroscience Conference, Brisbane, Australia

Gaetano, J., van der Zwan, R., Blair, D., & Brooks, A. (2014). Hands as sex cues: sensitivity measures, male bias measures, and implications for sex perception mechanisms. PLoS One, 9(3), e91032.

Gaetano, J., van der Zwan, R., Oxner, M., Hayward, W. G., Doring, N., Blair, D. et al. (2016). Converging Evidence of Ubiquitous Male Bias in Human Sex Perception. PLoS One, 11(2), e0148623.

Gandolfo, M., & Downing, P. E. (2019a). Causal evidence for expression of perceptual expectations in Category-Selective extrastriate regions. *Current Biology*, *29*(15), 2496-2500.

Gandolfo, M., & Downing, P. E. (2019b). Perceiving emotion and sex from the body: evidence from the Garner task for independent processes. Cognition and Emotion, 1-11.

Ganguli, D., & Simoncelli, E. P. (2014). Efficient sensory encoding and Bayesian inference with heterogeneous neural populations. *Neural computation*, *26*(10), 2103-2134.

Gilani, S. Z., Rooney, K., Shafait, F., Walters, M., & Mian, A. (2014). Geometric facial gender scoring: objectivity of perception. PloS one, 9(6).

Gliga, T., & Dehaene-Lambertz, G. (2005). Structural encoding of body and face in human infants and adults. Journal of Cognitive Neuroscience, 17(8), 1328-1340.

Golan, T., Bentin, S., DeGutis, J. M., Robertson, L. C., & Harel, A. (2014). Association and dissociation between detection and discrimination of objects of expertise: Evidence from visual search. Atten Percept Psychophys, 76(2), 391-406.

Grossman, E., Donnelly, M., Price, R., Pickens, D., Morgan, V., Neighbor, G. et al. (2000). Brain areas involved in perception of biological motion. Journal of cognitive neuroscience, 12(5), 711-720.

Gurnsey, R., Humphrey, G. K., & Kapitan, P. (1992). Parallel discrimination of subjective contours defined by offset gratings. Perception & Psychophysics, 52(3), 263-276.

Hall, J. A., Horgan, T. G., & Murphy, N. A. (2019). Nonverbal communication. Annual review of psychology, 70, 271-294.

Haselton, M. G., & Buss, D. M. (2000). Error management theory: A new perspective on biases in cross-sex mind reading. Journal of personality and social psychology, 78(1), 81.

Haselton, M. G., & Nettle, D. (2006). The paranoid optimist: an integrative evolutionary model of cognitive biases. Pers Soc Psychol Rev, 10(1), 47-66.

Hautus, M. J. (1995). Corrections for extreme proportions and their biasing effects on estimated values ofd′. *Behavior Research Methods, Instruments, & Computers*, *27*(1), 46-51.

Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. Trends in cognitive sciences, 4(6), 223-233.

Herlitz, A., & Lovén, J. (2013). Sex differences and the own-gender bias in face recognition: A meta-analytic review. *Visual Cognition*, *21*(9-10), 1306-1336.

Heron-Delaney, M., Wirth, S., & Pascalis, O. (2011). Infants' knowledge of their own species. Philosophical Transactions of the Royal Society B: Biological Sciences, 366(1571), 1753-1763.

Hershler, O., & Hochstein, S. (2009). The importance of being expert: top-down attentional control in visual search with photographs. Atten Percept Psychophys, 71(7), 1478-1486.

Hewig, J., Trippe, R. H., Hecht, H., Straube, T., & Miltner, W. H. (2008). Gender differences for specific body regions when looking at men and women. Journal of Nonverbal Behavior, 32(2), 67-78.

Hill, H., Bruce, V., & Akamatsu, S. (1995). Perceiving the sex and race of faces: the role of shape and colour. Proc Biol Sci, 261(1362), 367-373.

Hill, M. Q., Streuber, S., Hahn, C. A., Black, M. J., & O'Toole, A. J. (2016). Creating body shapes from verbal descriptions by linking similarity spaces. *Psychological science*, *27*(11), 1486-1497.

Hock, A., Kangas, A., Zieber, N., & Bhatt, R. S. (2015). The development of sex category representation in infancy: Matching of faces and bodies. Developmental psychology, 51(3), 346.

Hock, A., White, H., Jubran, R., & Bhatt, R. S. (2016). The whole picture: Holistic body posture recognition in infancy. Psychonomic bulletin & review, 23(2), 426-431.

Horstmann, G., & Bauland, A. (2006). Search asymmetries with real faces: testing the anger-superiority effect. Emotion, 6(2), 193.

Hu, Y., Parde, C. J., Hill, M. Q., Mahmood, N., & O'Toole, A. J. (2018). First Impressions of Personality Traits From Body Shapes. Psychol Sci, 956797618799300.

Hu, Y., Baragchizadeh, A., & O'Toole, A. J. (2020). Integrating faces and bodies: Psychological and neural perspectives on whole person perception. Neuroscience & Biobehavioral Reviews.

Hulleman, J., Te Winkel, W., & Boselie, F. (2000). Concavities as basic features in visual search: Evidence from search asymmetries. Perception & Psychophysics, 62(1), 162-174.

JASP Team (2020). JASP (Version 0.13)[Computer software].

Jeffreys, H. (1961). Theory of probability, Clarendon Press.

Johnson, K. L., & Tassinary, L. G. (2005). Perceiving sex directly and indirectly: meaning in motion and morphology. Psychol Sci, 16(11), 890-897.

Johnson, K. L., Iida, M., & Tassinary, L. G. (2012). Person (mis)perception: functionally biased sex categorization of bodies. Proc Biol Sci, 279(1749), 4982-4989.

Johnson, K. L., McKay, L. S., & Pollick, F. E. (2011). He throws like a girl (but only when he’s sad): Emotion affects sex-decoding of biological motion displays. Cognition, 119(2), 265-280.

Johnson, K., & Shiffrar, M. (2012). People watching: Social, perceptual, and neurophysiological studies of body perception. Oxford: Oxford University Press.

Johnson, M. H., Dziurawiec, S., Ellis, H., & Morton, J. (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. Cognition, 40(1-2), 1-19.

Johnstone, L. T., & Downing, P. E. (2017). Dissecting the visual perception of body shape with the Garner selective attention paradigm. Visual Cognition, 25(4-6), 507-523.

Juvrud, J., Rennels, J. L., Kayl, A. J., Gredebäck, G., & Herlitz, A. (2019). Attention during Visual Preference Tasks: Relation to Caregiving and Face Recognition. Infancy, 24(3), 356-367.

Kana, R. K., & Travers, B. G. (2012). Neural substrates of interpreting actions and emotions from body postures. Social Cognitive and Affective Neuroscience, 7(4), 446-456.

Knoblich, G. E., Thornton, I. M., Grosjean, M. E., & Shiffrar, M. E. (2006). Human body perception from the inside out: Advances in visual cognition. Oxford University Press.

Kozlowski, L. T., & Cutting, J. E. (1977). Recognizing the sex of a walker from a dynamic point-light display. Perception & Psychophysics, 21(6), 575-580.

Kristjánsson, Á., & Tse, P. U. (2001). Curvature discontinuities are cues for rapid shape analysis. Perception & Psychophysics, 63(3), 390-403.

Kumar, S., & Vogels, R. (2019). Body Patches in Inferior Temporal Cortex Encode Categories with Different Temporal Dynamics. *Journal of cognitive neuroscience*, *31*(11), 1699-1709.

Kumar, S., Popivanov, I. D., & Vogels, R. (2019). Transformation of visual representations across ventral stream body-selective patches. *Cerebral Cortex*, *29*(1), 215-229.

Larson, C. L., Aronoff, J., & Stearns, J. J. (2007). The shape of threat: Simple geometric forms evoke rapid and sustained capture of attention. Emotion, 7(3), 526-534.

Latinus, M., & Belin, P. (2011). Human voice perception. Current Biology, 21(4), R143-R145.

Lawson, R. P., Clifford, C. W. G., & Calder, A. J. (2009). About turn: The visual representation of human body orientation revealed by adaptation. Psychological Science, 20(3), 363-371.

Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. P. (2001). Neuroperception: Early visual experience and face processing. Nature, 410(6831), 890.

Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. P. (2004). Impairment in holistic face processing following early visual deprivation. Psychological Science, 15(11), 762-768.

Lee, M. D., & Wagenmakers, E. J. (2014). *Bayesian cognitive modeling: A practical course*. Cambridge University Press.

Levin, D. T. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition deficit. Journal of Experimental Psychology: General, 129(4), 559-574.

Li, X., Cave, K. R., & Wolfe, J. M. (2008). Kanizsa-type subjective contours do not guide attentional deployment in visual search but line termination contours do. Perception & Psychophysics, 70(3), 477-488.

Loffler, G., Yourganov, G., Wilkinson, F., & Wilson, H. R. (2005). fMRI evidence for the neural representation of faces. Nature neuroscience, 8(10), 1386.

Mack, A., & Rock, I. (1998). *Inattentional blindness*. MIT press.

Macmillan, N. A., & Creelman, C. D. (2004). *Detection theory: A user's guide*. Psychology press.

Macrae, C. N., & Martin, D. (2007). A boy primed Sue: Feature-based processing and person construal. European Journal of Social Psychology, 37(5), 793-805.

Makowski, D. (2018). The psycho package: An efficient and publishing-oriented workflow for psychological science. *Journal of Open Source Software*, *3*(22), 470.

Maljkovic, V., & Nakayama, K. (1994). Priming of pop-out: I. Role of features. Memory & cognition, 22(6), 657-672.

Mather, G., & Murdoch, L. (1994). Gender discrimination in biological motion displays based on dynamic cues. Proceedings of the Royal Society of London. Series B: Biological Sciences, 258(1353), 273-279.

Matsumoto, R., Yoshimura, H., Nishiyama, M., & Iwai, Y. (2017). Feature extraction using gaze of participants for classifying gender of pedestrians in images. IEEE International Conference on Image Processing, 3545-3549.

Matsuno, T., & Fujita, K. (2018). Body inversion effect in monkeys. PLOS ONE, 13(10), e0204353.

Maurer, D. (2017). Critical periods re-examined: Evidence from children treated for dense cataracts. Cognitive Development, 42, 27-36.Minnebusch, D. A., & Daum, I. (2009). Neuropsychological mechanisms of visual face and body perception. Neuroscience & Biobehavioral Reviews, 33(7), 1133-1144.

Minnebusch, D. A., Keune, P. M., Suchan, B., & Daum, I. (2010). Gradual inversion affects the processing of human body shapes. NeuroImage, 49(3), 2746-2755.

Minnebusch, D. A., Suchan, B., & Daum, I. (2009). Losing your Head: Behavioral and Electrophysiological Effects of Body Inversion. Journal of Cognitive Neuroscience, 21(5), 865-874.

Neisser, U. (1963). Decision-Time without Reaction-Time: Experiments in Visual Scanning. The American Journal of Psychology, 76(3), 376.

Nestor, A., & Tarr, M. J. (2008). Gender recognition of human faces using color. Psychol Sci, 19(12), 1242-1246.

Nummenmaa, L., Hietanen, J. K., Santtila, P., & Hyönä, J. (2012). Gender and visibility of sexual cues influence eye movements while viewing faces and bodies. Archives of sexual behavior, 41(6), 1439-1451.

Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: a threat advantage with schematic stimuli. Journal of personality and social psychology, 80(3), 381.

Oliva, A., & Torralba, A. (2001). Modeling the shape of the scene: A holistic representation of the spatial envelope. International journal of computer vision, 42(3), 145-175.

Oosterhof, N. N., & Todorov, A. (2008). The functional basis of face evaluation. Proceedings of the National Academy of Sciences, 105(32), 11087-11092.

Pallier, C. (2002). Computing discriminability and bias with the R software. *URL: http://www. pallier. org/ressources/aprime/aprime (Last viewed June 12, 2015)*.

Palumbo, R., Laeng, B., & Tommasi, L. (2013). Gender-specific aftereffects following adaptation to silhouettes of human bodies. Visual Cognition, 21(1), 1-12.

Papeo, L., Goupil, N., & Soto-Faraco, S. (2019). Visual search for people among people. Psychological science, 30(10), 1483-1496.

Peelen, M. V., & Downing, P. E. (2005). Selectivity for the Human Body in the Fusiform Gyrus. Journal of Neurophysiology, 93(1), 603-608.

Peelen, M. V., & Downing, P. E. (2007). The neural basis of visual body perception. Nature reviews neuroscience, 8, 636-648.

Peelen, M. V., Wiggett, A. J., & Downing, P. E. (2006). Patterns of fMRI Activity Dissociate Overlapping Functional Brain Areas that Respond to Biological Motion. Neuron, 49(6), 815-822.

Pelli, D. G. (1997). The VideoToolbox software for visual psychophysics: Transforming numbers into movies. *Spatial vision*, *10*(4), 437-442.

Picci, G., & Scherf, K. S. (2016). From caregivers to peers: Puberty shapes human face perception. Psychological Science, 27(11), 1461-1473.

Popivanov, I. D., Schyns, P. G., & Vogels, R. (2016). Stimulus features coded by single neurons of a macaque body category selective patch. *Proceedings of the National Academy of Sciences*, *113*(17), E2450-E2459.

Popivanov, I. D., Jastorff, J., Vanduffel, W., & Vogels, R. (2014). Heterogeneous single-unit selectivity in an fMRI-defined body-selective patch. *Journal of Neuroscience*, *34*(1), 95-111.

Qin, X. A., Koutstaal, W., & Engel, S. A. (2014). The hard-won benefits of familiarity in visual search: naturally familiar brand logos are found faster. Attention, Perception, & Psychophysics, 76(4), 914-930.

Quinn, P. C., & Eimas, P. D. (1998). Evidence for a global categorical representation of humans by young infants. Journal of Experimental Child Psychology, 69(3), 151-174.

Quinn, P. C., Lee, K., & Pascalis, O. (2019). Face processing in infancy and beyond: The case of social categories. Annual review of psychology, 70, 165-189.

Quinn, P. C., Yahr, J., Kuhn, A., Slater, A. M., & Pascalis, O. (2002). Representation of the gender of human faces by infants: A preference for female. Perception, 31(9), 1109-1121.

Rajsic, J., Carlisle, N. B., & Woodman, G. F. (2020). What not to look for: Electrophysiological evidence that searchers prefer positive templates. Neuropsychologia, 140, 107376.

Ramsey-Rennels, J. L., & Langlois, J. H. (2006). Infants' differential processing of female and male faces. Current Directions in Psychological Science, 15(2), 59-62.

Ramsey, J. L., Langlois, J. H., & Marti, N. C. (2005). Infant categorization of faces: Ladies first. Developmental Review, 25(2), 212-246.

Reed, C. L., Stone, V. E., Bozova, S., & Tanaka, J. (2003). The Body-Inversion Effect. Psychological Science, 14(4), 302-308.

Reed, C. L., Stone, V. E., Grubb, J. D., & McGoldrick, J. E. (2006). Turning configural processing upside down: Part and whole body postures. Journal of Experimental Psychology: Human Perception and Performance, 32(1), 73-87.

Reed, C. L., Bukach, C. M., Garber, M., & McIntosh, D. N. (2018). It's not all about the face: Variability reveals asymmetric obligatory processing of faces and bodies in whole-body contexts. *Perception*, *47*(6), 626-646.

Reed, C. L., Nyberg, A. A., & Grubb, J. D. (2012). Contributions of visual and embodied expertise to body perception. *Perception*, *41*(4), 436-446.

Reeder, R. R., & Peelen, M. V. (2013). The contents of the search template for category-level search in natural scenes. Journal of Vision, 13(3), 13-13.

Reeder, R. R., Stein, T., & Peelen, M. V. (2016). Perceptual expertise improves category detection in natural scenes. Psychonomic Bulletin & Review, 23(1), 172-179.

Reeder, R. R., van Zoest, W., & Peelen, M. V. (2015). Involuntary attentional capture by task-irrelevant objects that match the search template for category detection in natural scenes. Attention, Perception, & Psychophysics, 77(4), 1070-1080.

Rehnman, J., & Herlitz, A. (2006). Higher face recognition ability in girls: Magnified by own-sex and own-ethnicity bias. Memory, 14(3), 289-296.

Rennels, J. L., & Davis, R. E. (2008). Facial experience during the first year. Infant Behavior and Development, 31(4), 665-678.

Rennels, J. L., Juvrud, J., Kayl, A. J., Asperholm, M., Gredebäck, G., & Herlitz, A. (2017). Caregiving experience and its relation to perceptual narrowing of face gender. Developmental psychology, 53(8), 1437.

Rensink, R. A., & Cavanagh, P. (2004). The Influence of Cast Shadows on Visual Search. Perception, 33(11), 1339-1358.

Rensink, R. A., & Enns, J. T. (1995). Preemption effects in visual search: evidence for low-level grouping. Psychological review, 102(1), 101.

Rhodes, M. G., & Anastasi, J. S. (2012). The own-age bias in face recognition: a meta-analytic and theoretical review. *Psychological bulletin*, *138*(1), 146.

Rhodes, G., Brennan, S., & Carey, S. (1987). Identification and ratings of caricatures: Implications for mental representations of faces. Cognitive psychology, 19(4), 473-497.

Rhodes, G., Jeffery, L., Boeing, A., & Calder, A. J. (2013). Visual coding of human bodies: perceptual aftereffects reveal norm-based, opponent coding of body identity. Journal of Experimental Psychology: Human Perception and Performance, 39(2), 313.

Rhodes, G., Sumich, A., & Byatt, G. (1999). Are average facial configurations attractive only because of their symmetry?. Psychological science, 10(1), 52-58.

Rice, A., Phillips, P. J., Natu, V., An, X., & O'Toole, A. J. (2013). Unaware Person Recognition From the Body When Face Identification Fails. Psychological Science, 24(11), 2235-2243.

Righi, G., Westerlund, A., Congdon, E. L., Troller-Renfree, S., & Nelson, C. A. (2014). Infants' experience-dependent processing of male and female faces: insights from eye tracking and event-related potentials. Developmental cognitive neuroscience, 8, 144-152.

Ro, T., Friggel, A., & Lavie, N. (2007). Attentional biases for faces and body parts. Visual Cognition, 15(3), 322-348.

Robbins, R. A., & Coltheart, M. (2012). The effects of inversion and familiarity on face versus body cues to person recognition. Journal of Experimental Psychology: Human Perception and Performance, 38(5), 1098-1104.

Robbins, R. A., Nishimura, M., Mondloch, C. J., Lewis, T. L., & Maurer, D. (2010). Deficits in sensitivity to spacing after early visual deprivation in humans: A comparison of human faces, monkey faces, and houses. Developmental psychobiology, 52(8), 775-781.

Rosenholtz, R. (2001). Search asymmetries? What search asymmetries. Perception & Psychophysics, 63(3), 476-489.

Rosenthal, R., Archer, D., Hall, J. A., DiMatteo, M. R., & Rogers, P. L. (1979). Measuring sensitivity to nonverbal communication: the PONS test. In Nonverbal Behavior (pp. 67-98). Elsevier.

Rossion, B., & Gauthier, I. (2002). How Does the Brain Process Upright and Inverted Faces. Behavioral and Cognitive Neuroscience Reviews, 1, 63-75.

Runeson, S., & Frykholm, G. (1983). Kinematic specification of dynamics as an informational basis for person-and-action perception: Expectation, gender recognition, and deceptive intention. Journal of Experimental Psychology: General, 112(4), 585–615. https://doi.org/10.1037/0096-3445.112.4.585

Russell, R. (2009). A sex difference in facial contrast and its exaggeration by cosmetics. Perception, 38(8), 1211-1219.

Sadeh, B., Pitcher, D., Brandman, T., Eisen, A., Thaler, A., & Yovel, G. (2011). Stimulation of category-selective brain areas modulates ERP to their preferred categories. Current Biology, 21(22), 1894-1899.

Schupp, H. T., & Renner, B. (2011). The Implicit Nature of the Anti-Fat Bias. Frontiers in Human Neuroscience, 5.

Schyns, P. G., & Oliva, A. (1999). Dr. Angry and Mr. Smile: When categorization flexibly modifies the perception of faces in rapid visual presentations. Cognition, 69(3), 243-265.

Schyns, P. G., Bonnar, L., & Gosselin, F. (2002). Show me the features! Understanding recognition from the use of visual information. Psychological science, 13(5), 402-409.

Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., & Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. Proceedings of the Royal Society B: Biological Sciences, 276(1656), 575-584.

Simion, F., Regolin, L., & Bulf, H. (2008). A predisposition for biological motion in the newborn baby. Proceedings of the National Academy of Sciences, 105(2), 809-813.

Singh, D. (1993). Adaptive significance of female physical attractiveness: Role of waist-to-hip ratio. Journal of Personality and Social Psychology, 65(2), 293-307.

Slaughter, V., Heron, M., Jenkins, L., Tilse, E., Müller, U., & Liebermann, D. (2004). Origins and early development of human body knowledge. Monographs of the Society for Research in Child Development, i-113.

Stein, T., Sterzer, P., & Peelen, M. V. (2012). Privileged detection of conspecifics: Evidence from inversion effects during continuous flash suppression. Cognition, 125(1), 64-79.

Stekelenburg, J. J., & Gelder, B. D. (2004). The neural correlates of perceiving human bodies: an ERP study on the body-inversion effect. NeuroReport, 15(5), 777-780.

Sturman, D., Stephen, I. D., Mond, J., Stevenson, R. J., & Brooks, K. R. (2017). Independent Aftereffects of Fat and Muscle: Implications for neural encoding, body space representation, and body image disturbance. Scientific reports, 7(1), 1-8.

Sugden, N. A., Mohamed-Ali, M. I., & Moulson, M. C. (2014). I spy with my little eye: Typical, daily exposure to faces documented from a first-person infant perspective. Developmental psychobiology, 56(2), 249-261.

Sumi, S. (1984). Upside-down Presentation of the Johansson Moving Light-Spot Pattern. Perception, 13(3), 283-286.

Sun, J. Y., & Perona, P. (1996a). Preattentive Perception of Elementary Three-dimensional Shapes. Vision Research, 36(16), 2515-2529.

Sun, J., & Perona, P. (1996b). Early computation of shape and reflectance in the visual system. Nature, 379(6561), 165-168.

Suzuki, S., & Cavanagh, P. (1995). Facial organization blocks access to low-level features: An object inferiority effect. Journal of Experimental Psychology: Human Perception and Performance, 21(4), 901-913.

Talbot, D., Smith, E., & Cass, J. (2019). Male body dissatisfaction, eating disorder symptoms, body composition, and attentional bias to body stimuli evaluated using visual search. Journal of Experimental Psychopathology, 10(2), 2043808719848292.

Theeuwes, J. (1994). Stimulus-driven capture and attentional set: selective search for color and visual abrupt onsets. *Journal of Experimental Psychology: Human perception and performance*, *20*(4), 799.

Thierry, G., Pegna, A. J., Dodds, C., Roberts, M., Basan, S., & Downing, P. (2006). An event-related potential component sensitive to images of the human body. Neuroimage, 32(2), 871-879.

Todorov, A. (2017). Face value: The irresistible influence of first impressions. Princeton University Press.

Tong, F., & Nakayama, K. (1999). Robust representations for faces: evidence from visual search. Journal of Experimental Psychology: Human Perception and Performance, 25(4), 1016.

Tong, F., Nakayama, K., Moscovitch, M., Weinrib, O., & Kanwisher, N. (2000). Response properties of the human fusiform face area. Cognitive Neuropsychology, 17(1-3), 257-280.

Treisman, A., & Gormican, S. (1988). Feature analysis in early vision: evidence from search asymmetries. Psychological review, 95(1), 15.

Treisman, A., & Souther, J. (1985). Search asymmetry: A diagnostic for preattentive processing of separable features. Journal of Experimental Psychology: General, 114(3), 285.

Troje, N. F., & Szabo, S. (2006). Why is the average walker male?. Journal of Vision, 6(6), 1034-1034.

Troje, N. F., Sadr, J., Geyer, H., & Nakayama, K. (2006). Adaptation aftereffects in the perception of gender from biological motion. J Vis, 6(8), 850-857.

Tskhay, K. O., & Rule, N. O. (2016). People automatically extract infants' sex from faces. Journal of Nonverbal Behavior, 40(4), 247-254.

Uher, R., Murphy, T., Friederich, H. C., Dalgleish, T., Brammer, M. J., Giampietro, V. et al. (2005). Functional neuroanatomy of body shape perception in healthy and eating-disordered women. Biol Psychiatry, 58(12), 990-997.

United Kingdom Survey of Childcare and Early Years Providers (2018). https://www.gov.uk/government/statistics/childcare-and-early-years-providers-survey-2018

Urgesi, C., Calvo-Merino, B., Haggard, P., & Aglioti, S. M. (2007). Transcranial magnetic stimulation reveals two cortical pathways for visual body processing. J Neurosci, 27(30), 8023-8030.

van Koningsbruggen, M. G., Peelen, M. V., & Downing, P. E. (2013). A causal role for the extrastriate body area in detecting people in real-world scenes. Journal of Neuroscience, 33(16), 7003-7010.

Vestner, T., Tipper, S. P., Hartley, T., Over, H., & Rueschemeyer, S. A. (2019). Bound together: Social binding leads to faster processing, spatial distortion, and enhanced memory of interacting partners. Journal of Experimental Psychology: General.

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. Journal of Statistical Software, 36(3), 1–48. http://www.jstatsoft.org/v36/i03/.

Wagemans, J., De Winter, J., de Beeck, H. O., Ploeger, A., Beckers, T., & Vanroose, P. (2008). Identification of everyday objects on the basis of silhouette and outline versions. Perception, 37(2), 207-244.

Wang, D., Kristjansson, A., & Nakayama, K. (2005). Efficient visual search without top-down or bottom-up guidance. *Perception & Psychophysics*, *67*(2), 239-253.

Watson, T. L., Otsuka, Y., & Clifford, C. W. (2016). Who are you expecting? Biases in face perception reveal prior expectations for sex and age. J Vis, 16(3), 5.

Weisstein, N., & Harris, C. S. (1974). Visual detection of line segments: An object-superiority effect. Science, 186(4165), 752-755.

White, H., Hock, A., Jubran, R., Heck, A., & Bhatt, R. S. (2018). Visual scanning of male and female bodies in infancy. Journal of experimental child psychology, 166, 79-95.

Wild, H. A., Barrett, S. E., Spence, M. J., O'Toole, A. J., Cheng, Y. D., & Brooke, J. (2000). Recognition and sex categorization of adults' and children's faces: Examining performance in the absence of sex-stereotyped cues. *Journal of experimental child psychology*, *77*(4), 269-291.

Willenbockel, V., Sadr, J., Fiset, D., Horne, G. O., Gosselin, F., & Tanaka, J. W. (2010). Controlling low-level image properties: the SHINE toolbox. Behavior research methods, 42(3), 671-684.

Wolfe, J. M., & Horowitz, T. S. (2017). Five factors that guide attention in visual search. Nature Human Behaviour, 1(3), 0058.

Wolfe, J. M. (1998). What can 1 million trials tell us about visual search. Psychological Science, 9(1), 33-39.

Wolfe, J. M. (2001). Asymmetries in visual search: An introduction. Perception & psychophysics, 63(3), 381-389.

Yamaguchi, M. K., Hirukawa, T., & Kanazawa, S. (2013). Judgment of gender through facial parts. Perception, 42(11), 1253-1265.

Yin, R. K. (1969). Looking at upside-down faces. Journal of experimental psychology, 81(1), 141.

Young, A. W., Hellawell, D., & Hay, D. C. (1987). Configurational information in face perception. Perception*, 16*(6), 747–759.

Yovel, G., & Belin, P. (2013). A unified coding strategy for processing faces and voices. Trends Cogn Sci, 17(6), 263-271.

Yovel, G., & Kanwisher, N. (2005). The neural basis of the behavioral face-inversion effect. Curr Biol, 15(24), 2256-2262.

Yovel, G., Pelc, T., & Lubetzky, I. (2010). It’s all in your head: why is the body inversion effect abolished for headless bodies. J Exp Psychol Hum Percept Perform, 36(3), 759-767.

Zhao, M., & Hayward, W. G. (2010). Holistic processing underlies gender judgments of faces. Attention, Perception, & Psychophysics, 72(3), 591-596.

Zieber, N., Bhatt, R. S., Hayden, A., Kangas, A., Collins, R., & Bada, H. (2010). Body representation in the first year of life. Infancy, 15(5), 534-544.

Zieber, N., Kangas, A., Hock, A., & Bhatt, R. S. (2015). Body structure perception in infancy. Infancy, 20(1), 1-17.

Figure legends

Figure 1. *Example stimuli from all experiments. Search set sizes included 1, 2, 4, or 8 items, except Experiments 9 and 10 which comprised 1, 2, 4, or 6 items. A) silhouetted side views of bodies; B) frontal silhouettes; C) and D) as A and B, with use of GIST matching and other measures to better equate male and female bodies on physical properties; E) body icons; F) inverted body icons; G) isolated trapezia (the "torsos" from body icons); H) upright body photographs; I) inverted body photographs.*

Figure 2. *Summary of response time slopes from Experiments 1-10. The efficiency of visual search for male targets amongst female distractors, and vice versa, is shown in terms of ms/item derived by fitting a linear function to search times in accurate, target-present trials. Error bars represent +/- 1 SEM, *$p < 0.05$. Search for females is more efficient across side and frontal views (Experiments 1-4) and also in iconic figures that lack curvature (Experiment 5). In contrast, search for the inverted iconic figures (Experiment 6) does not show a significant difference in efficiency. Search for the individual shape elements that distinguished male from female in Experiment 5 showed the opposite pattern (Experiment 7). Search efficiency measured by slopes did not differ in an odd-one-out version of the icon search task (Experiment 8). Finally, female targets were detected more efficiently than male targets for normalised photographic body images presented either upright (Experiment 9) or inverted (Experiment 10).*

Figure 3. *The efficiency of visual search for male targets amongst female distractors, and vice versa, is shown in terms of d-dprime, which measures sensitivity to target presence independently of decision criterion. In Experiments 1-5, sensitivity to detect female targets was greater than for male targets. With icon stimuli, this advantage did not persist for inverted items (Experiment 6). For the central "torso" elements of such icons presented in isolation (Experiment 7), the sensitivity advantage was reversed, in favour of males. Sensitivity was greater for female targets in an odd-one-out version of the icon search task*

(Experiment 8). Sensitivity did not differ between target types for photographic body images presented either upright or inverted (Experiments 9 and 10).

Figure 4. *Mean response times from target-present (solid line) and target-absent (dashed line) trials, in which either male (circle marker, green line) or female (triangle marker, orange line) body shapes were the search targets for Experiments 1-10.*

Figure 5. *The forest plot shows the mean RT/item search slope advantage for female bodies with respect to male bodies and the 95% confidence interval. The size of the square represents the inverse of the variance of the study. The larger the square, the more the influence the study has on the pooled result of the metanalysis. The bottom diamond represents the estimated effect size of the metanalytical model and its confidence intervals. Across the 7 studies examined here the model estimates that search for female bodies is approximately 19 ms/item faster than search for male bodies.*

Figure 6. *Forest plot showing mean sensitivity advantage for female bodies with respect to male bodies and the 95% confidence interval as measured by d-prime. The size of the square represents the inverse of the variance of the study. The larger the square, the more the influence the study has on the pooled result of the metanalysis. The bottom diamond represents the estimated effect size of the metanalytical model and its confidence intervals. Across the 7 studies examined the model estimates that female body targets are 0.3 d-prime points more discriminable than male body targets.*

Tables

Experiment	Target	*M*	*M* 95% CI [LL, UL]	*SD*
Experiment 1	Female	0.91	[0.88, 0.93]	0.07
	Male	0.90	[0.88, 0.92]	0.06
Experiment 2	Female	0.92	[0.90, 0.94]	0.05

	Male	0.89	[0.87, 0.92]	0.06
Experiment 3	Female	0.92	[0.90, 0.95]	0.06
	Male	0.91	[0.89, 0.94]	0.06
Experiment 4	Female	0.90	[0.87, 0.93]	0.07
	Male	0.89	[0.86, 0.91]	0.07
Experiment 5	Female	0.93	[0.93, 0.97]	0.06
	Male	0.92	[0.90, 0.95]	0.07
Experiment 6	Female	0.93	[0.91, 0.94]	0.04
	Male	0.94	[0.93, 0.95]	0.04
Experiment 7	Female	0.94	[0.92, 0.95]	0.04
	Male	0.95	[0.94, 0.97]	0.04
Experiment 8	Female	0.89	[0.87, 0.91]	0.05
	Male	0.86	[0.83, 0.88]	0.07
Experiment 9	Female	0.92	[0.91, 0.94]	0.04
	Male	0.91	[0.89, 0.93]	0.05
Experiment 10	Female	0.78	[0.75, 0.82]	0.10
	Male	0.77	[0.74, 0.81]	0.10

Table 1. *Descripti*

Method of stimulus creation and homogeneity matching for Experiments 3 and 4.

A script was used to generate 1040 random virtual characters for each sex in the MakeHuman package. In that software, the sex of the body is described with a value ranging from 0 (female) to 1 (male). For both profile and frontal viewpoints, 130 male silhouettes were generated for each of four “male” sex values (0.7 – 1, in steps of 0.1), for a total of 520 male silhouettes for each viewpoint. Similarly, 130 female silhouettes for each of four “female” values (0 - 0.3, in steps of 0.1) were generated for a total of 520 female silhouettes for each viewpoint. For each generated character we also constrained hips, shoulders, and waist-to-hip ratio to assume values consistent with the selected sex (e.g. low waist-to-hip ratio for females and high waist-to-hip ratio for males). These characteristics are described in the software on a scale from -1 and 1. Each of these variables was randomly varied (at intervals of 0.1) as follows: hips -0.6 to -0.1 for males, 0 to 0.5 for females; waist-to-hip ratio 0.1 to 0.6 for males, -0.6 to -0.1 for females (NB these are ranges on the MakeHuman scales rather than actual WHR values). For males, the shoulders were constrained to assume values between 0.1 to 0.8 in the profile views, and from 0.1 to 0.9 in the frontal views. For females, the variable corresponding to breast size was constrained so that it could assume one of five different steps from 0.6 to 1. Finally, to ensure further variation amongst the characters in each set of silhouettes, we randomly varied the variables of “body proportions”, muscularity, and weight, (which can range from 0 to 1; these were sampled at intervals of 0.1, from 0.1 to 0.9). The generated virtual characters were exported in PNG format. The resulting images were then greyscaled, cropped, resized to 180x180, and thresholded to form silhouettes using the R “imager” package (Barthelmé and Tschumperlé, 2019).

Twenty-four male and female silhouettes were then selected randomly from the full set (separately for profile and frontal views). This selection was repeated iteratively until the proportion of black:white pixels was matched (to within 1%) between the two sets. Next, each image in the two selected sets was converted to a GIST descriptor using LMGist (Oliva & Torralba, 2001; https://people.csail.mit.edu/torralba/code/spatialenvelope/), with 36 image sub-blocks (6x6 matrix) and 8 edge orientations measured at each of 4 scales. The result was a vector of length 1152 describing each image. Separately for male and female stimuli, the Euclidean distance between each unique pair of stimuli was measured over this space. The difference between the mean of these distances for males and for females was calculated. The desired outcome was that this difference of distances should approach zero – in other words, an equal “spread”, on average, of male and of female images in GIST space. A Monte Carlo bootstrap procedure was used to test the observed difference between the two sets of stimuli against the null hypothesis of no difference. A distribution of 1000 null differences was created by randomly selecting (with replacement) two shuffled sets of “male” and “female” distance measures from the actually measured GIST vectors. If the actual difference of the male and female GIST distances fell within the center of this null distribution (between 0.45 to 0.55, where 0.5 is the center) then the 24 selected images were accepted. If not, then the entire process was restarted with a new randomly chosen subset of 24 male and female exemplars. These procedures were repeated twice for profile silhouettes, and twice for frontal silhouettes, providing two balanced sets of each type of stimulus. In each experiment, half of the participants were tested with the 48 images of the first set and the other half with images from the second set.

As a further test of heterogeneity, the variances of the observed distributions of inter-item GIST distances were compared statistically between the male and female image sets. This comparison tests to what extent the variance in between-item distances is (in GIST space) similar between sexes. A comparison of variances was tested for each stimulus set with the Brown-Forsythe test, which does not depend on an assumption of normally-distributed observations. For Experiment 3, the within-class variance of GIST distances was greater for male images than female images, which if anything would be expected (importantly, against our hypothesis) to make search for females more difficult; B-F(1, 550) = 13.96 (set 1) and 41.15 (set 2), $p < 0.0005$ for both sets. For Experiment 4, the within-class variances in GIST distances of male and female items were not significantly different; B-F(1, 550) = 1.61 (set 1) and 0.047 (set 1), $p = 0.2$ and $p = 0.83$, respectively.

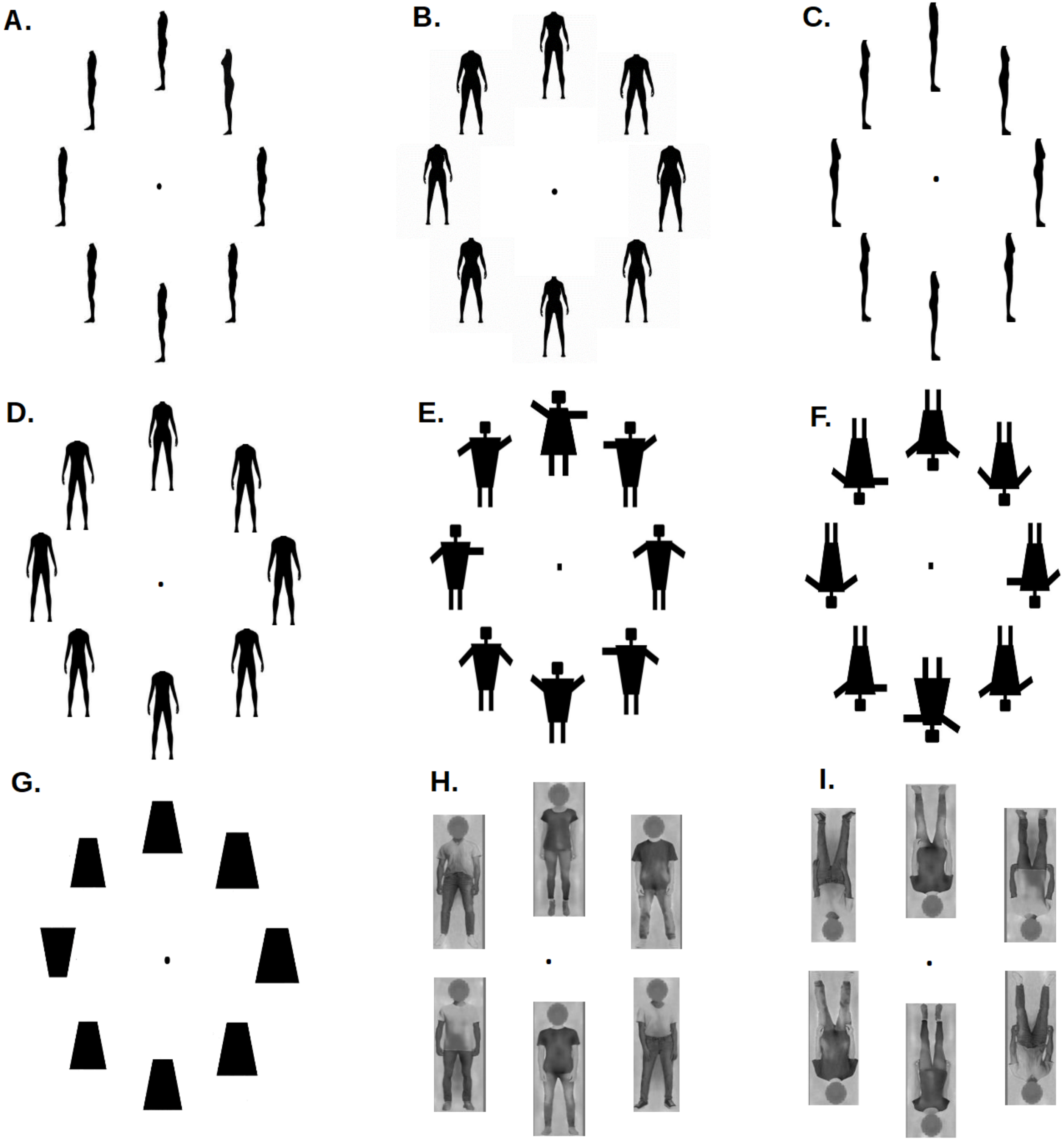
Bayesian analyses of primary results

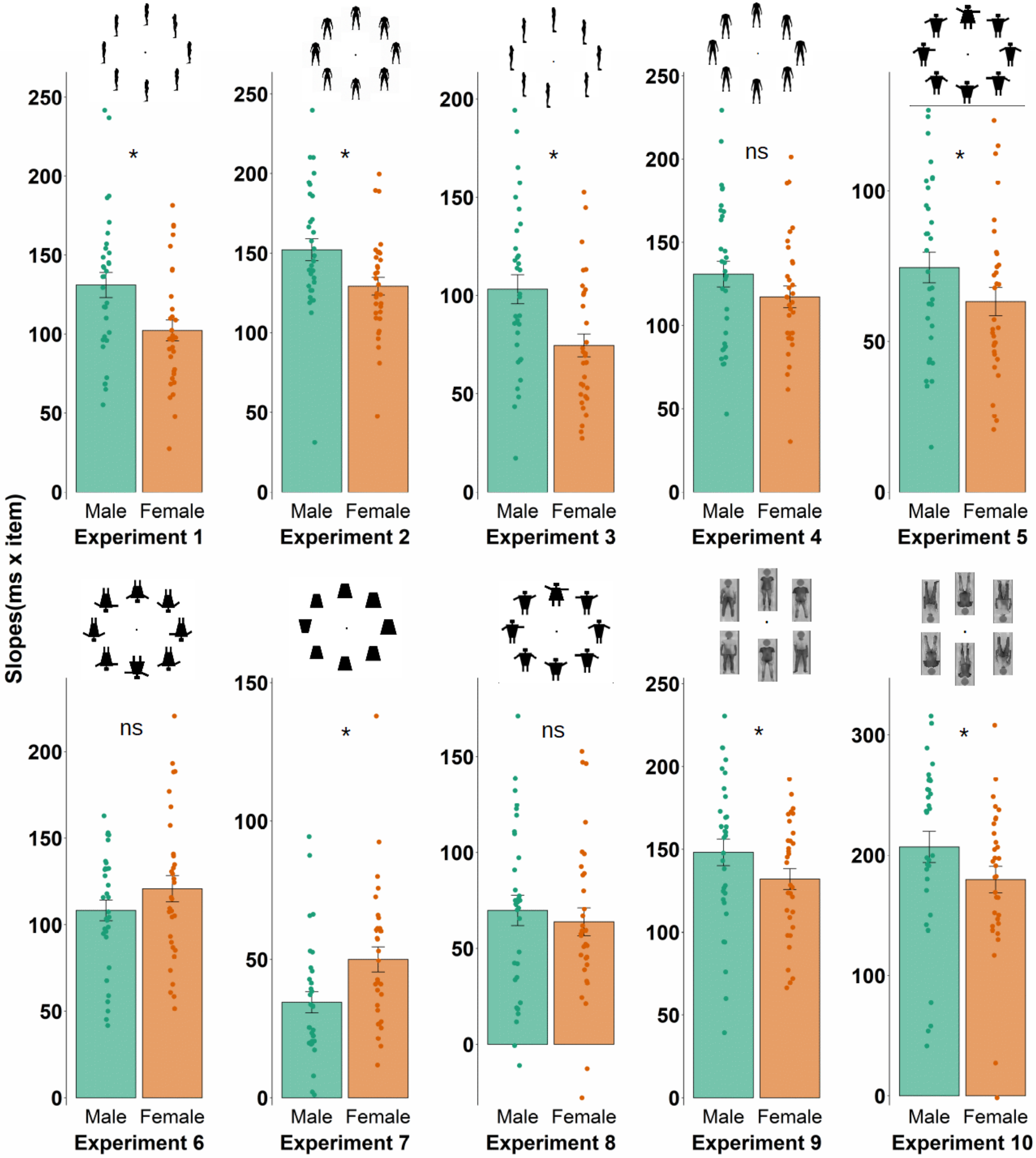
Bayes factors (BF10) were computed using Jasp (Version 0.13) and default, uninformative priors (cauchy distribution, scale = 0.707). BF10 above 3 are usually interpreted as evidence for the alternative hypothesis, in that the observed data are at least three times more likely to arise under the alternative. Conversely, BF10 under 0.30 are usually taken to indicate that the data are better described by the null hypothesis. BF10 between 0.30 and 3 are usually interpreted as “inconclusive”, supporting neither the null nor the alternative hypothesis (Jeffreys, 1961; Lee and Wagenmakers, 2014). The resulting BF10 from each experiment are reported below in Table S1, separately for response time slopes on correct responses to target-present trials, and for d-prime measures of detection sensitivity.

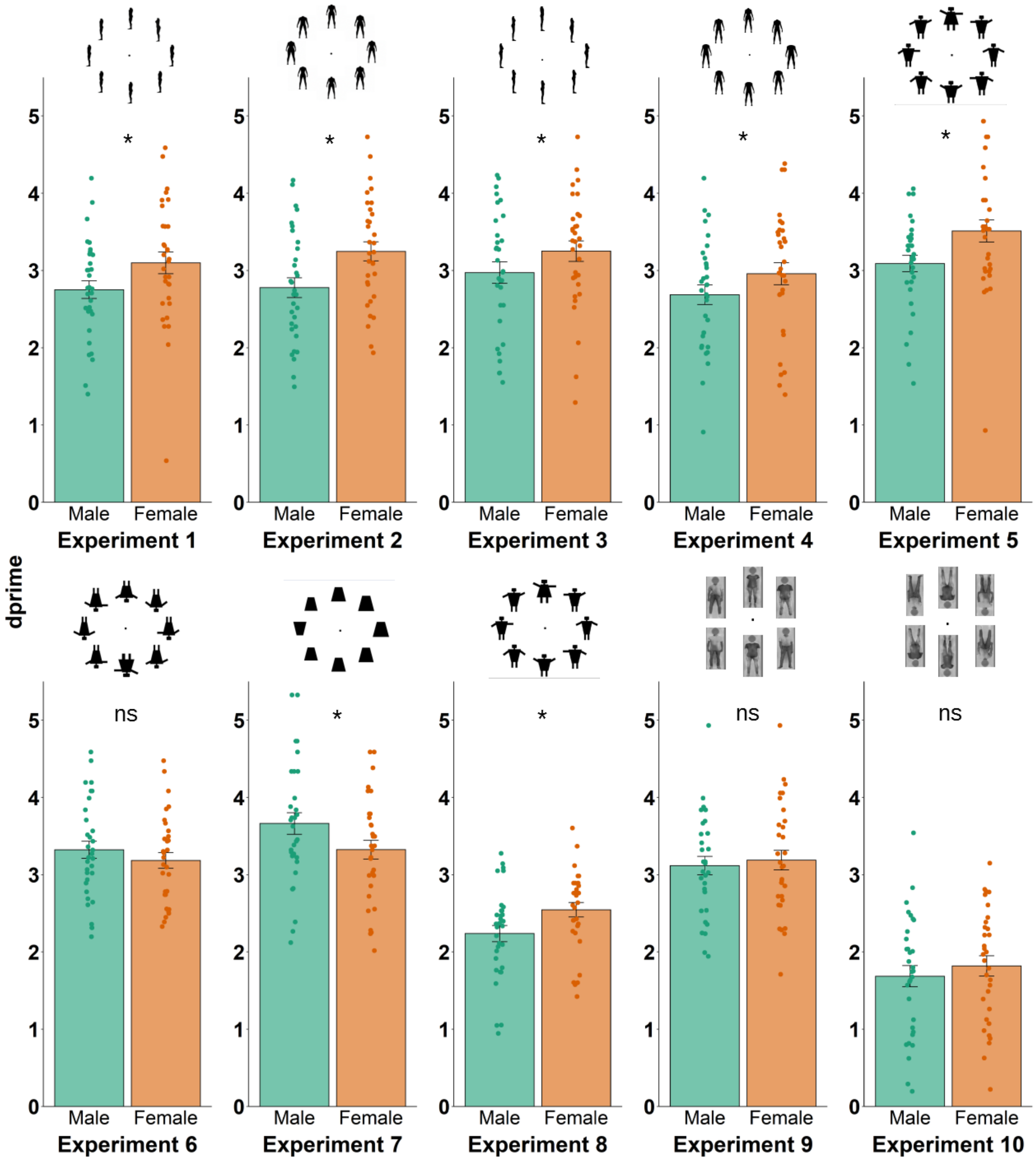
Experiment	*RT slopes* BF10	*d-prime* BF10
Experiment 1	1707.5	4
Experiment 2	169.3	476.9
Experiment 3	3428.2	1.4
Experiment 4	0.9	2.1
Experiment 5	1.7	136.6
Experiment 6	0.7	0.4
Experiment 7	30.9	20.8
Experiment 8	0.2	188
Experiment 9	7.0	0.2

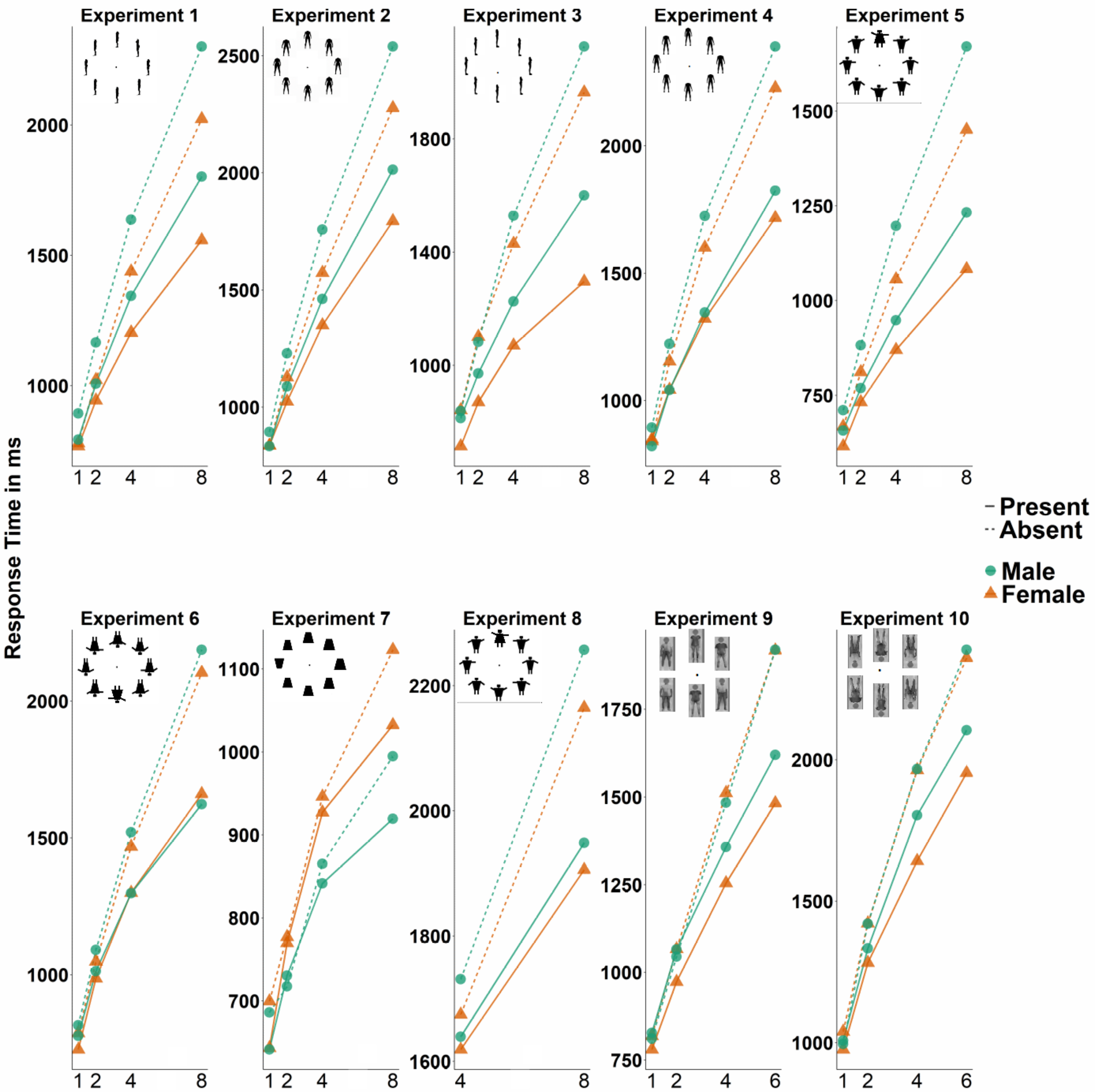
Experiment 10	4.4	0.6

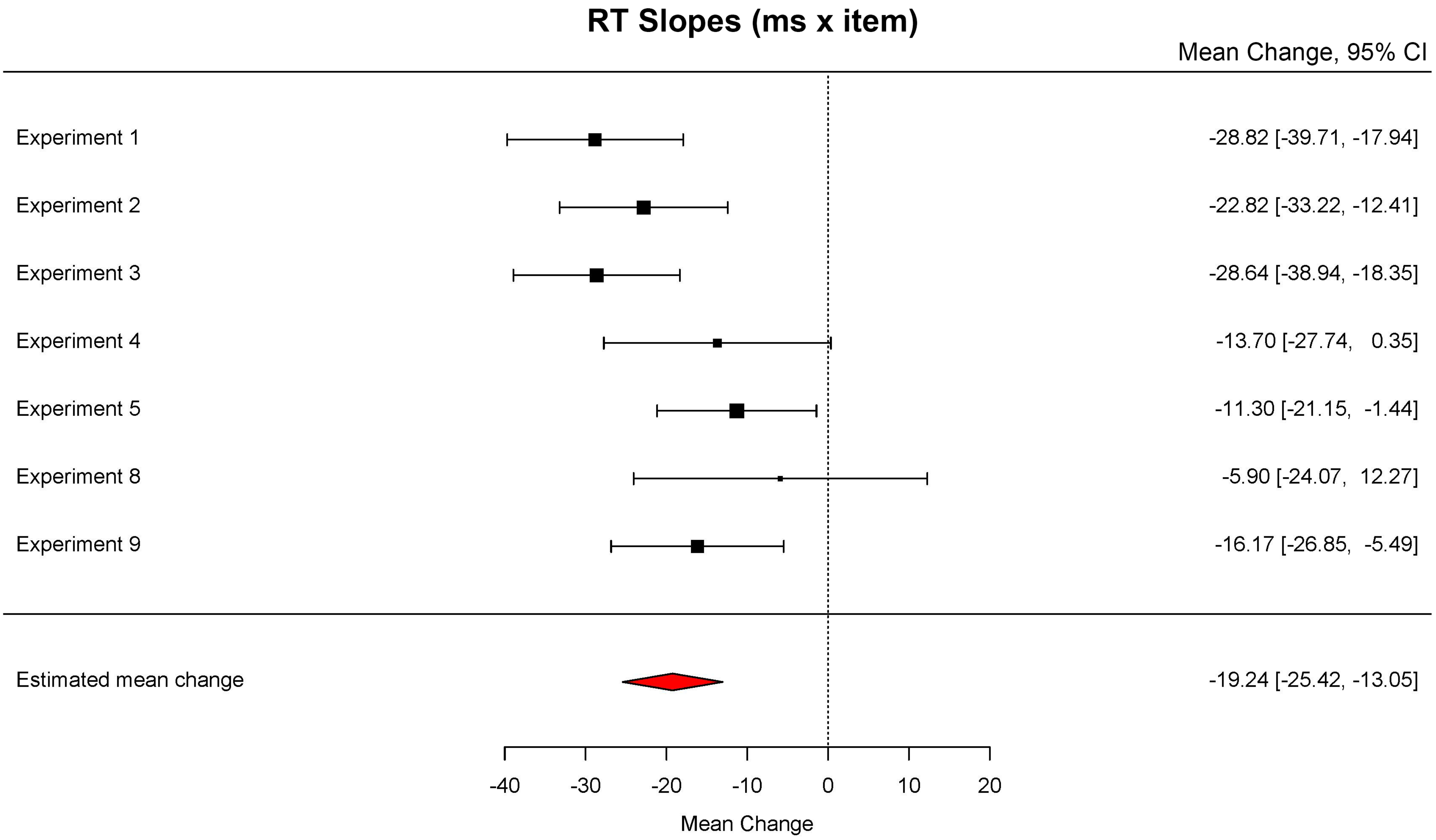
Table S1. Results of Bayesian paired-sample t-tests comparing performance for male and female targets on search slopes and on d-prime measures in each experiment.

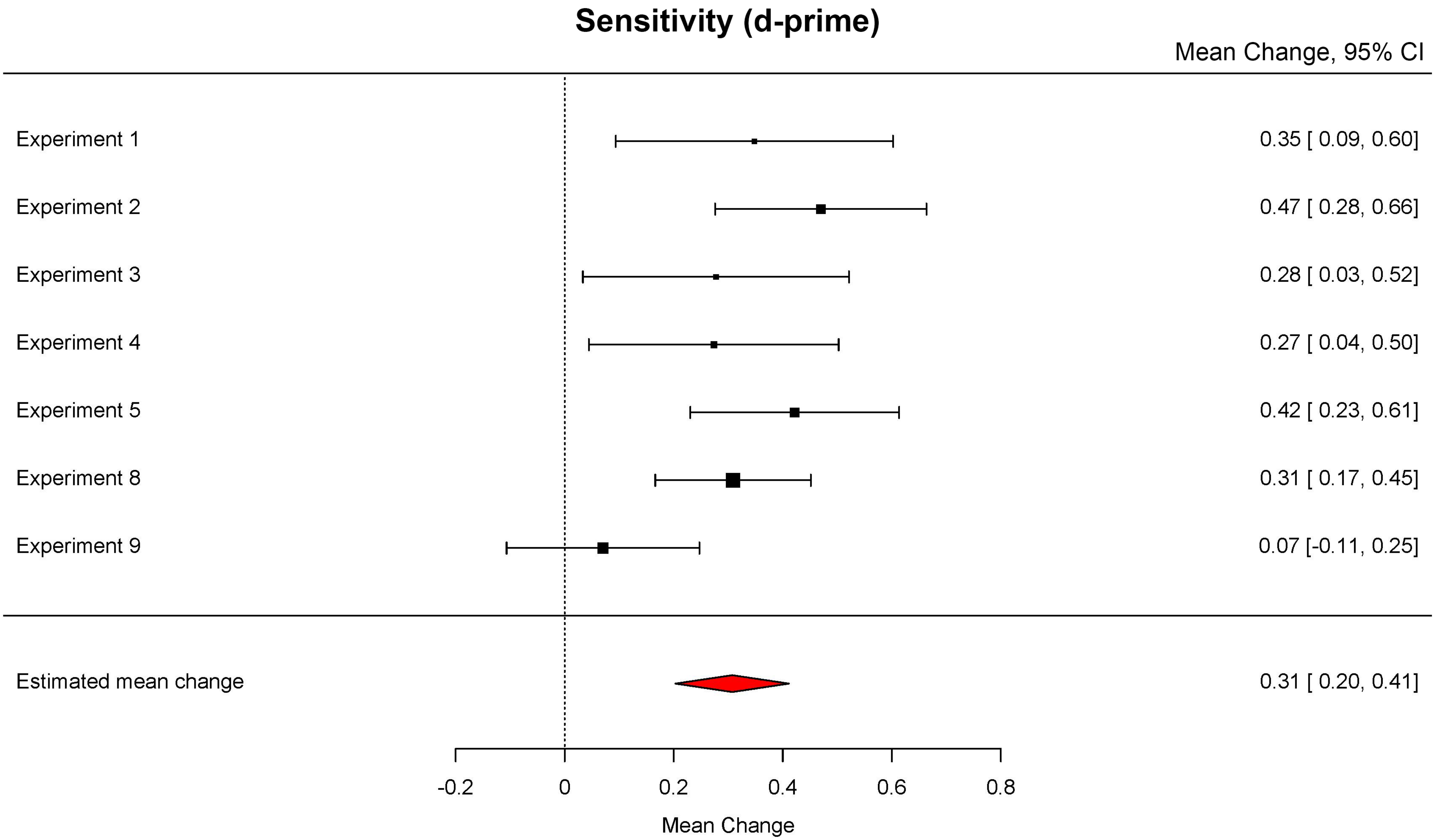

A.
B.
C.
D.
E.
F.
G.
H.
I.


Slopes(ms x item)
250
200
150
100
50
0
*
Male
Female
Experiment 1
250
200
150
100
50
0
*
Male
Female
Experiment 2
200
150
100
50
0
*
Male
Female
Experiment 3
250
200
150
100
50
0
ns
Male
Female
Experiment 4
100
50
0
*
Male
Female
Experiment 5
200
150
100
50
0
ns
Male
Female
Experiment 6
150
100
50
0
*
Male
Female
Experiment 7
150
100
50
0
ns
Male
Female
Experiment 8
250
200
150
100
50
0
*
Male
Female
Experiment 9
300
200
100
0
*
Male
Female
Experiment 10


dprime
0
1
2
3
4
5
*
ns
Male
Female
Experiment 1
Experiment 2
Experiment 3
Experiment 4
Experiment 5
Experiment 6
Experiment 7
Experiment 8
Experiment 9
Experiment 10


Response Time in ms
Experiment 1
2000
1500
1000
1 2 4 8
Experiment 2
2500
2000
1500
1000
1 2 4 8
Experiment 3
1800
1400
1000
1 2 4 8
Experiment 4
2000
1500
1000
1 2 4 8
Experiment 5
1500
1250
1000
750
1 2 4 8
Experiment 6
2000
1500
1000
1 2 4 8
Experiment 7
1100
1000
900
800
700
1 2 4 8
Experiment 8
2200
2000
1800
1600
4 8
Experiment 9
1750
1500
1250
1000
750
1 2 4 6
Experiment 10
2000
1500
1000
1 2 4 6
Present
Absent
Male
Female


RT Slopes (ms x item)
Mean Change, 95% CI
Experiment 1
-28.82 [-39.71, -17.94]
Experiment 2
-22.82 [-33.22, -12.41]
Experiment 3
-28.64 [-38.94, -18.35]
Experiment 4
-13.70 [-27.74, 0.35]
Experiment 5
-11.30 [-21.15, -1.44]
Experiment 8
-5.90 [-24.07, 12.27]
Experiment 9
-16.17 [-26.85, -5.49]
Estimated mean change
-19.24 [-25.42, -13.05]
-40
-30
-20
-10
0
10
20
Mean Change


Sensitivity (d-prime)
Mean Change, 95% CI
Experiment 1
0.35 [0.09, 0.60]
Experiment 2
0.47 [0.28, 0.66]
Experiment 3
0.28 [0.03, 0.52]
Experiment 4
0.27 [0.04, 0.50]
Experiment 5
0.42 [0.23, 0.61]
Experiment 8
0.31 [0.17, 0.45]
Experiment 9
0.07 [-0.11, 0.25]
Estimated mean change
0.31 [0.20, 0.41]
-0.2
0
0.2
0.4
0.6
0.8
Mean Change