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# Development of a Cued Pro- and Antisaccade Paradigm:

# An Indirect Measure to Explore Automatic Components of Sexual Interest

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## Abstract

We developed a cued pro- and antisaccade paradigm (CPAP) to explore automatic components of sexual interest. Heterosexual participants ($n$ = 32 women, $n$ = 25 men) had to perform fast eye movements towards and away from sexually relevant or irrelevant stimuli across a congruent (i.e. prosaccade towards sexually relevant stimuli, antisaccade away from sexually irrelevant stimuli) and an incongruent condition (i.e. prosaccade towards sexually irrelevant stimuli, antisaccade away from sexually relevant stimuli). We hypothesized that pro- and antisaccade performance would be influenced by the sexual interest-specific relevance of the presented stimulus (i.e., nude female or male stimulus) and the instructed task (i.e., pro- or antisaccade) and, thus, differ meaningfully between conditions. Results for prosaccades towards sexually relevant stimuli in the congruent condition showed that error rates were lower and latencies were shorter compared with prosaccades towards sexually irrelevant stimuli in the incongruent condition, but only for male participants. In addition, error rates for antisaccades away from sexually irrelevant stimuli in the congruent condition were lower than for antisaccades away from sexually relevant stimuli in the incongruent condition, for both female and male participants. Latencies of antisaccades, however, did not differ between conditions. In comparison with established indirect sexual interest paradigms, the CPAP benefits from measuring highly automated processes less prone to deliberate control. To this end, the CPAP could be applied to explore the interplay of early automatic and deliberate components of sexual information processing.


*Keywords*: sexual interest; sexual orientation; indirect measurement; pro- and antisaccade paradigm; eye tracking

Sexual interest acts as a filter that influences our perception of sexual information and, based on this, promotes our behavior to encourage or inhibit intimacy (Krupp, 2008; Prause, Janssen, & Hetrick, 2008). For example, Both, Spiering, Everaerd, and Laan (2004) showed that the presentation of sexually relevant film excerpts increased actual sexual behavior of heterosexual participants within 24 hours after stimulus exposure. This corroborates the idea that sexual interest affects human behavior in a motivational manner – at least in a longer-term perspective. Similarly, but with a focus on acute sexual arousal effects, Imhoff and Schmidt (2014) reported that participants who had listened to an erotic story showed higher sexual disinhibition than participants who had listened to a non-erotic story. In the present study, we sought to explore immediate behavioral responses to sexual information at an initial level of attentional allocation – saccadic eye movements.

Recent results of eye tracking studies indicate that the motivational impact of sexual interest on behavior – operationalized as allocation of attentional resources towards sexually relevant information – is already reflected at an early stage of visual processing. For instance, Bolmont, Cacioppo, and Cacioppo (2014) showed that participants' gaze pattern differed depending on the experimentally manipulated rating task whether male and female stimuli were either love- or lust-eliciting. While participants predominately looked at the face of stimuli rated in the love-eliciting condition, they fixated comparatively more often body parts of stimuli in the lust-eliciting condition. In addition, other eye tracking studies revealed that eye movement data, for example on pupil dilation or gaze time, differed between sexually relevant and irrelevant stimulus material (e.g., Attard-Johnson, Bindemann, & Ciardha, 2016; Bradley, Costa, & Lang, 2015; Dawson & Chivers, 2016; Fromberger et al., 2012; 2013). Dawson and Chivers (2016) suggested that these findings imply sexual interest-specific allocation of attention that influences

sexual information processing as well as behavioral reactions both at an automatic and an intentional level. Compared with the impact of deliberate processes, automatic information processing is largely independent of cognitive resources and may affect behavior even unconsciously (e.g., Strack & Deutsch, 2004). Therefore, automatic influences on behavior formation are difficult to verbalize and, thus, cannot be fully explored by self-report. To this end, indirect measures have been used to elucidate the behavioral impact of automatic information processing. Indirect measures assess underlying constructs by their effect on behavioral reactions such as, for example, physiological parameters or response latency. Therefore, indirect measures are not affected by limited introspection (De Houwer & Moors, 2010). Accordingly, behavioral response times to sexually relevant or irrelevant stimuli are often regarded as an indicator of sexual interest (e.g., Rönspies et al, 2015; Snowden & Gray, 2013).

In this research, we sought to develop a novel cued pro- and antisaccade paradigm (CPAP) as an indirect measure to explore initial processes of behavior formation based on sexual interest. Saccadic eye movements can be performed both in an automatic and a controlled manner (Findlay & Walker, 1999). Specifically, we wanted to explore saccades towards (prosaccades) or away from (antisaccades) sexually relevant or irrelevant targets as indicators of early attentional sexual information processing.

## Processing of Sexual Information

Numerous studies have shown preferred processing of emotional over neutral content (e.g., Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Morris, De Gelder, Weiskrantz, & Dolan, 2001). This has been generally interpreted as an adaptive reaction to significant environmental events to satisfy fundamental needs, maximize pleasure, and minimize harm. In

the listed studies, favored processing of emotional information was neither intentional nor limited by cognitive capacity, suggesting that processing was automatic. According to emotion theories (e.g., LeDoux, 1995; Öhman, 1986), automatic detection of emotional significance activates physiological responses and, thus, facilitates conscious awareness.

According to Everaerd (1988), the behavioral influence of sexual information processing is defined as emotional response. Thus, processing characteristics of emotional content should also apply for sexual information. For instance, in an eye tracking study by Fromberger and colleagues (2012) heterosexual men had to compare the sexual attractiveness of female and male stimuli while the number of first fixations and the relative fixation length were recorded. It was shown that already at an initial stage of attention sexually preferred stimuli were fixated more often and longer than sexually non-preferred pictures (Experiment 2). In a similar study, Dawson and Chivers (2016) investigated sexual interest-specific influences on eye movements at early (number of first fixations, time to first fixation) and controlled stages of attention (total fixation duration, total fixation count). Male participants showed increased initial and controlled attention towards female compared with male stimuli. Female participants, however, initially responded non-specifically to male stimuli but demonstrated preference for male stimuli in controlled processing. Furthermore, Attard-Johnson and colleagues (2016) investigated pupillary response of heterosexual participants to images of different aged males and females as indicator of sexual arousal. Their eye tracking results provided first evidence that sexual interest could be measured by pupil dilation with sexual orientation- and sexual maturity-specific dilation for males and a target gender non-specific but maturity-specific pattern for females.

The above-mentioned oculomotoric findings corroborate that behavior formation based on automatic processing of sexual information should differ with regard to sexual interest-specific

relevance. According to general dual-process models (e.g., Reflective-Impulsive Model, Strack and Deutsch; 2004), perceptual input is associatively linked to behavioral schemata that occur automatically when information is processed. Hence, behavioral reactions controlled by the impulsive system occur irrespective of actual intentions and cognitive resources. The reflective system, on the other hand, enables intentional reactions to processed information. Parallel processing of the two systems could result in behavioral conflicts as they can not only activate the same but also different behavioral scripts. Based on the characteristics of both operating principles, the executed behavior should be a function of automatically and deliberately activated intentions and a function of cognitive capacity. Similarly, but specifically tailored to sexual information processing, Janssen, Everaerd, Spiering, and Janssen (2000) suppose that automatic processing of information with "sexual meaning" (p. 9) evokes sexual arousal that facilitates the triggering of conscious processing mechanisms. Both levels could either operate in a concordant manner (e.g., information is appraised as sexually meaningful at automatic *and* conscious processing level) and intensify sexual arousal or in a discordant manner (e.g., information is appraised as sexually meaningful at one *but not at* the other processing level) and weaken the genital response. To validate their model, Janssen and colleagues (2000) showed that reactions of male participants to sexually primed targets were faster compared with neutrally primed ones. They concluded that their results underpinned a preattentive impact of automatic information processing on sexual arousal.

In line with Janssen and colleagues (2000), we suggest that automatic processing of sexual information should activate sexually motivated approach or avoidance behavior that could be subsequently enforced or downregulated by conscious mechanisms. It is likely that the sexual interest-specific relevance of information as well as individual intentions play a central role in

this context increasing or decreasing sexually motivated approach or avoidance (Figure 1A). For instance, automatically induced approach tendencies towards an attractive woman could be complemented by an equivalent deliberate intention of a heterosexual man. However, a heterosexual man could also intend to avoid an attractive woman, although, she automatically attracts him.

## Saccade Generation in the Context of Attentional Shifts

The visual system enables the processing of relevant environmental events including sexual information. As the visual acuity decreases markedly with increasing distance to the fovea centralis, eye movements (e.g., saccades) ensure the orientation of the visual apparatus. Therefore, the oculomotoric system plays a crucial role in the direction of information processing (Land & Tatler, 2009).

Saccades are fast and conjugated eye movements abruptly changing the point of fixation. They can be generated exogenously or endogenously. Changes in the peripheral field of vision support exogenous triggering resulting in automatic saccades, while internal states support endogenous triggering resulting in intentional saccades (Liversedge, Gilchrist, & Everling, 2011). Findlay and Walker (1999) suggested that the simultaneous occurrence of exogenous and endogenous mechanisms might result in conflicts if working in opposite directions. Findings from Massen (2004) support the assumption of a parallel automatic and intentional generation of saccades, whereby only saccades with competitive advantages are performed. Moreover, neuronal networks that are activated through saccade generation overlap with the system of visual attentional control (Land & Tatler, 2009). Accordingly, visual orientation by saccades is intimately connected to the allocation of attentional resources (Deubel & Schneider, 1996;

Liversedge et al., 2011). In comparison with studies measuring first fixations as indicator of attention towards sexual information (e.g. Fromberger et al., 2012), saccades should indicate even earlier stages of attention allocation as they precede a first fixation.

## Pro- and Antisaccade Paradigm

The pro- and antisaccade paradigm is a reliable and valid procedure to investigate the conflict between automatic and intentional processes of saccade generation (Hutton & Ettinger, 2006). The antisaccade task was developed by Hallett (1978) instructing intentionally generated saccades away from peripheral stimuli that are in conflict with automatically triggered saccades towards appearing stimuli. Hence, exogenous generation processes must be inhibited, requiring cognitive resources (Abegg, Sharma, & Barton, 2012) and executive control mechanisms (Munoz & Everling, 2004). Antisaccade performance is typically contrasted with instructed prosaccades towards appearing stimuli. The instruction to look at stimuli does not provoke any direction conflict between an exogenous and endogenous generation processes. The performance of pro- and antisaccades is measured by different saccadic parameters, of which the latency of correct responses and the rate of direction errors are the most important (Leigh & Zee, 1999).

Apart from studies in clinical populations that demonstrated disorder-specific biased emotional information processing within pro- and antisaccade paradigms (e.g., Aichert et al., 2013; Derakshan, Ansari, Hansard, Shoker, & Eysenck, 2009; Mueller et al., 2012) there are hitherto no studies on pro- and antisaccade performance as a reaction to sexual information.

## The Present Study

The mechanisms of saccade generation can be illustrated in the processing model of sexual information. Automatic processing of sexual information facilitates exogenous saccade

generation, while intentional regulation that intensifies or weakens automatic approach or avoidance responses to sexual information corresponds to endogenous saccade generation. Both processing levels could either work conjointly or in opposition and, consequently, increase or decrease sexually motivated allocation of attention. Based on these assumptions, we developed the CPAP to explore the interplay of automatic and intentional processing components of sexual interest at the level of saccade generation. The above-mentioned results of previous eye tracking studies corroborate the notion that processing of sexual information might indeed influence saccade generation.

We suggest that processing of sexual information–and, accordingly, pro- and antisaccade performance–varies in dependence of the sexual relevance of the stimuli and the sexual intentions of the observer (Figure 1B). In the present study, relevance of sexual information was operationalized by the interaction of the sex of participants and of the stimuli (i.e., female stimuli are sexually relevant for heterosexual male participants; male stimuli are sexually relevant for heterosexual female participants). As we included only heterosexual women and men, sex of participants was a proxy for sexual orientation that in turn indicated the specific sexual interest of participants. Participants' intention was manipulated through the instruction by a sexual cue to perform pro- or antisaccades in reaction to sexual targets, resulting in *congruent* and *incongruent* experimental conditions. In the *congruent condition*, participants were asked to perform prosaccades towards sexually relevant targets instructed by a sexually relevant cue and antisaccades away from sexually irrelevant targets instructed by a sexually irrelevant cue. In the *incongruent condition*, participants performed prosaccades towards sexually irrelevant targets instructed by a sexually irrelevant cue and antisaccades away from sexually relevant targets instructed by a sexually relevant cue. We expected that (1) prosaccade error rates would be lower

and prosaccade latencies shorter in congruent vs. incongruent conditions. Instructed and, thus, endogenously generated prosaccades towards sexually relevant stimuli in the congruent condition should complement exogenous generation processes towards significant sexual information. Conversely, in the incongruent condition, where prosaccades should be performed towards sexually irrelevant stimuli, exogenous generation processes towards sexually irrelevant information should be weaker and, therefore, not complementing endogenous processing due to the instruction. The same was supposed for (2) antisaccade error rates and latencies: These should be lower and shorter in the congruent than in the incongruent condition. Endogenous generation processes in the congruent condition should not interfere with exogenous processing, as stimuli are not sexually relevant. In turn, in the incongruent condition, instructed antisaccades away from sexually relevant information should be in conflict with exogenous generation processes towards significant information. Although previous studies point to sexual non-specificity in sexual information processing in women that occurs independent from assessment methods (e.g., Attard-Johnson et al., 2016; Chivers, Rieger, Latty, & Bailey, 2004; Dawson & Chivers, 2016; Lippa, 2006), we included male and female participants. However, it is an empirical question whether men and women show sexual-interest specific differences in the performance of pro- and antisaccades in the CPAP.

[Insert Figure 1 around here]

In addition, we statistically controlled for the potential influence of several variables: As supposed in Figure 1, different states of sexual motivation should influence information processing. To this end, we measured participants' sexual desire and elapsed time since their last sexual activity. Moreover, we assessed executive functions of participants as several studies showed that pro- and antisaccade performance varies in dependence of working memory

capacity (e.g., Munoz & Everling, 2004). Finally, we controlled for neuroticism as findings revealed differences in processing of emotional information for participants with high or low neuroticism (e.g., Fathi, Elahi, & Hasani, 2014).

## Method

### Participants

Initially, we recruited 88 individuals ($n$ = 44 women, $n$ = 44 men). Participants who were not exclusively heterosexual[1] ($n$ = 6 woman, $n$ = 4 men) as well as participants who performed less than 10 valid out of 60 trials in the CPAP ($n$ = 6 women, $n$ = 15 men) were excluded from the analysis. Age of the final sample ($n$ = 32 women, $n$ = 25 men) ranged from 18 to 44 years ($M$ = 24.68, $SD$ = 4.37) and was independent of sex, $t(55) = 1.54$, $p = .129$. The majority of participants was in a relationship (64.9%) and had no university degree (58.9%). All participants reported that they did not have any eye disease nor had undergone eye surgery in the past. Participants received 6 € (approximately 8 US $) as compensation.

### Procedure and Measures

Upon their arrival to the laboratory, participants were informed about the alleged study aim (assessment of sexual attractiveness) and the procedures of the experiment. The study was divided into two blocks described in their order of appearance: After giving their informed consent, in the first block participants were asked to complete a series of questionnaires

[1] Sexual orientation was assessed with the Kinsey-scale (Kinsey, Pomeroy, & Martin, 1948; Kinsey, Pomeroy, Martin, & Gebhard, 1953). Only participants with scores ≤ 1 were included as *exclusively heterosexual* (score = 0) or *predominantly heterosexual* (score = 1).

assessing their sexual orientation, time since last sexual activity, sexual desire, and neuroticism as well as a standard Stroop color-interference task to measure executive functions and an indirect latency-based viewing time (VT) measure of sexual orientation. These measures served as control variables and were recorded in the following order: Neuroticism scale of the Big Five Inventory (Rammstedt & John, 2005; $\alpha = .67$), Stroop color-interference task (Stroop, 1935), Kinsey-scale (Kinsey et al., 1948; Kinsey et al., 1953), time since last sexual activity (Likert scale from 1 “some hours before” to 5 “more than one week”), total sexual outlets per week (TSO; Kinsey et al., 1948), German translation of sexual desire inventory-2 (SDI-2; Spector, Carey, & Steinberg, 1996; translation by Kistemaker, 2013), the sexual preoccupation scale of the sexuality scale (Wiedermann & Allgeier, 1993; German translation by Brenk-Franz & Strauß, 2011), and a VT task assessing sexual orientation (Imhoff, Schmidt, Nordsiek, Young, & Banse, 2010).

For the Stroop task, overall error rates and response latencies served as dependent variables (i.e., a difference measure of the mean aggregated response times across 40 incongruent and 40 congruent color-naming trials, positive values depicting longer response latencies in incongruent trials; $\alpha = .35$ for difference measure of latencies). The 80 Stroop trials were presented in a prefixed random order to maximize between-person effects.

For the VT task, sexual attractiveness ratings of nude women and men on a Likert scale (1 = “sexually not attractive” to 5 = “sexually very attractive”) and response latencies for attractiveness ratings were the dependent variables (i.e., difference measures of mean aggregated ratings and response times across each 20 pictures of nude women and men, positive values depicting higher attractiveness ratings and longer response latencies for female over male stimuli; $\alpha = .97$ for difference measure of attractiveness ratings; $\alpha = .76$ for difference measure of

latencies). VT stimuli stemmed from the same database as CPAP stimuli but non-overlapping stimuli sets were used (see Figure 2 for exemplary CPAP stimuli). Again, VT trials were presented in a prefixed random order.

In order to minimize measurement error, all measures of sex drive (SDI-2 subscales solitary sexual desire [$\alpha = .89$] and dyadic sexual desire [$\alpha = .81$], Spector et al., 1996; sexual preoccupation scale of the sexuality scale [$\alpha = .89$], Wiedermann & Allgeier, 1993) were aggregated into a composite sex drive measure ($\alpha = .73$). TSO was treated as separate variable to measure a behavioral component of sexual desire. Three participants with TSO values three or more interquartile distances from the median of the distribution were excluded as outliers for analyses referring to TSO (Field, 2013).

**Cued Pro- and Antisaccade Paradigm**

The CPAP was performed in the second block of the experiment. Movements of the dominant eye were recorded using a video-based combined pupil and corneal reflection tracker (EyeLink 1000, SR Research Ltd., Ottawa, Ontario, Canada). The system had a minimal spatial resolution of 0.01° and an average accuracy of 0.25° to 0.5°. Centroid pupil-tracking algorithms were used to detect pupil and corneal reflection. A five-point calibration procedure was performed before each experimental condition. Monocular sampling rate was 1000 Hz. Stimuli were presented on a 17-inch monitor with a display resolution of 1024 x 768 pixels. Head movements were reduced using a chinrest.

The CPAP was divided into two experimental conditions that were either congruent or incongruent with participants' sexual interest. In order to set up these experimental conditions, participants had to carry out either pro- or antisaccades in reaction to targets' sex (picture of

either a naked man or women). The task was instructed by a preceding cue (generic picture of either a naked man or women that was kept constant throughout the CPAP and was different from the target stimuli) that had always the same sex as the target.

In the incongruent condition (Figure 2; perspective of heterosexual female participants), prosaccades were instructed by a cue that had the same sex as the participant and had to be performed in reaction to a following same-sex target, whereas antisaccades were instructed by an opposite-sex cue and had to be performed in reaction to a following opposite-sex target. In the congruent condition (Figure 2; perspective from heterosexual male participants), prosaccades were instructed by an opposite-sex cue and had to be performed in reaction to a following opposite-sex target; whereby antisaccades were instructed by a same-sex cue and had to be performed in reaction to a following same-sex target.

The cue was presented at the center of the screen for 1,500 ms, followed by a fixation point that was displayed for 500–1,000 ms (variation of time slices: 50 ms) at the same location before the target item appeared at the right or left side of the screen (±12° visual angle) for 2,000 ms. Target sex was counterbalanced for side of presentation (left, right), task (pro- vs. antisaccade), and fixation duration (500–1,000 ms). Each condition included 60 trials consisting of 30 male and female targets announced by a single generic male or female cue, presented in a prefixed random order. Targets included pictures of nude males and females (30 each). The single generic cues did not match with any target. Each condition was preceded by four practice trials that were discarded from the statistical analysis. To maximize intraindividual variance, all participants performed the incongruent condition first followed by the congruent condition. Overall, this resulted in a 2 (Participant Sex) x 2 (Condition) mixed-model design with the first factor varying

between subjects and the second within subjects. At the end of the experiment, participants were debriefed, paid or granted course credits, and thanked.

[Insert Figure 2 around here]

For the pro- and antisaccade paradigm, directionally correct saccades and direction errors were identified using DataViewer (SR Research Ltd.). Criteria for the detection of saccades were minimum amplitude of 1° and minimum velocity of 30°/s. Pro- or antisaccades were included if they started within a defined horizontal window around the central screen position (512 px ± 112 px), had a latency to target onset of at least 80 ms (Wenban-Smith & Findlay, 1991), and were in the instructed direction (prosaccade: towards target; antisaccade: away from target). Trials with a saccade or blink between 100 ms before target onset and 80 ms after target onset were excluded. Error saccades were included if they met the same inclusion criteria concerning start position and latency, but instead were performed opposite to the instructed direction.

Error rates and response latencies served as dependent variables. For correlation analyses we computed a difference score of the mean aggregated error rates and a difference score of response latencies across the 30 incongruent and 30 congruent prosaccade trials as well as a difference score of the mean aggregated error rates and a difference score of the response latencies across the 30 incongruent and 30 congruent antisaccade trials. Thereby, positive values depict higher error rates and longer response latencies in incongruent than in congruent trials.

**Statistical Analysis**

Participants whose difference scores of pro- or antisaccade error rates or latencies were larger than three or more interquartile distances from the median of the distribution were excluded as outliers (Field, 2013). Thus, one participant was removed from all analyses of

prosaccade latencies and another participant had to be excluded from all analyses of antisaccade latencies.

For the analysis of the experimental effects, we performed a series of univariate mixed-model ANOVAs to investigate the sexual orientation-specific influence on error rates of pro- and antisaccades and latencies of correct pro-and antisaccades. To validate the cued pro- and antisaccade paradigm as a potential indirect measure of sexual orientation, results of the VT were used as criterion. First, the sexual orientation-specific influence on sexual attractiveness ratings and latencies in the VT was examined in two univariate mixed-model ANOVAs. Then, difference values of sexual attractiveness ratings and latencies in the VT were correlated with difference scores of error rates and latencies of pro- and antisaccades. To control possibly confounding effects of sexual activity, neuroticism, and executive capacities (Stroop task), mixed-model ANCOVAs were carried out for each parameter of pro- and antisaccades. Moreover, correlations were carried out to examine the relation of pro- and antisaccade parameters and variables of sexual desire as supposed in the processing model of sexual information.

## Results

### Sexual Orientation-Specific Influences on Pro- and Antisaccades

Mean error rates and mean latencies of pro- and antisaccades are displayed in Table 1[2]. All CPAP parameters showed acceptable to good reliability (Cronbach's α ranging from .77 to .86, with the exception of Cronbach's α for antisaccade latencies of .55; Table 1).

***Prosaccade errors.*** The 2 (Participant Sex) x 2 (Condition) mixed-model ANOVA for error rates of prosaccades revealed no significant main effect of Condition, $F(1, 55) = 1.22$, $p = .274$, $\eta^2 = .02$, or Participant Sex, $F(1, 55) = 1.05$, $p = .311$, $\eta^2 = .02$. However, there was a significant interaction between Participant Sex and Condition, $F(1, 55) = 8.64$, $p = .005$, $\eta^2 = .14$. Post hoc *t*-tests for dependent data revealed that men performed significantly better in the congruent condition than in the incongruent condition (Table 1), $t(24) = 2.33$, $p = .028$, $d = 0.67$. In contrast, women did not show a significant difference between congruent and incongruent conditions (Table 1), $t(31) = 1.61$, $p = .117$, $d = 0.29$. Therefore, only men showed a sexual orientation-specific influence on error rates of prosaccades that was expected in hypothesis 1.

***Prosaccade latencies***[3]**.** The 2 (Participant Sex) x 2 (Condition) mixed-model ANOVA for latencies of correct prosaccades revealed a significant main effect of Condition, $F(1, 54) = 7.62$, $p = .008$, $\eta^2 = .12$, meaning that latencies in the incongruent condition were longer than latencies

[2] Effects of sexual activity, neuroticism, and executive capacities (five participants had to be excluded as outliers) were examined in ANCOVAs for each model, but revealed no significant effects of the control variables (*p*s > .07). Thus, control variables were dropped from all further analyses for reasons of parsimony.

[3] Effects of prosaccade latencies left the reported results virtually unaltered by excluding outliers.

in the congruent condition. No significant main effect of Participant Sex emerged, $F < 1$. However, there was a significant interaction between Participant Sex and Condition, $F(1, 54) = 17.78$, $p < .001$, $\eta^2 = .25$. Again, post hoc analyses showed significant differences for men, who had shorter reaction times in the congruent condition than in the incongruent condition (Table 1), $t(23) = 3.92$, $p = .001$, $d = 0.55$, whereas women did not show this effect (Table 1), $t(31) = 1.32$, $p = .198$, $d = 0.17$. Therefore, only men showed a sexual orientation-specific influence on latencies of correct prosaccades that was expected in hypothesis (1).

***Antisaccade errors.*** The 2 (Participant Sex) x 2 (Condition) mixed-model ANOVA for error rates of antisaccades revealed a significant main effect of Condition, $F(1, 55) = 6.25$, $p = .015$, $\eta^2 = .10$, with lower error rates in the congruent condition than in the incongruent condition. Neither a significant main effect of Participant Sex, $F(1, 55) = 1.16$, $p = .287$, $\eta^2 = .02$, nor a significant interaction between Participant Sex and Condition, $F(1, 55) = 1.66$, $p = .203$, $\eta^2 = .03$, was revealed. Therefore, women and men showed a sexual orientation-specific effect on error rates (Table 1) of antisaccades as postulated in in hypothesis (2).

***Antisaccade latencies[4].*** The 2 (Participant Sex) x 2 (Condition) mixed-model ANOVA for latencies of correct antisaccades revealed no significant main effects of Condition, $F(1, 54) = 2.97$, $p = .090$, $\eta^2 = .05$, or Participant Sex, $F < 1$, and no significant interaction between Participant Sex and Condition, $F(1, 54) = 2.36$, $p = .130$, $\eta^2 = .04$. Therefore, contrary to

[4] The inclusion of the outlier for antisaccade latencies revealed a significant main effect of Condition, $F(1, 55) = 4.38$, $p = .041$, $\eta^2 = .07$, resulting in longer latencies for incongruent trials. This corroborates sexual orientation-specific effects also on antisaccade latencies in case the outlier was kept in the analysis.

hypothesis 2, neither women nor men showed a sexual orientation-specific effect on latencies of correct antisaccades (Table 1).

[Insert Table 1 around here]

**Convergent Validity**

**Viewing time ratings.** The 2 (Participant Sex) x 2 (Stimulus Sex) mixed-model ANOVA for explicit sexual attractiveness ratings in the VT showed a significant main effect of Stimulus Sex, $F(1, 55) = 147.86$, $p < .001$, $\eta^2 = .73$, ratings of female stimuli being higher than ratings for male stimuli. Furthermore, men rated stimuli as more attractive than women did, $F(1, 55) = 10.57$, $p = .002$, $\eta^2 = .16$. This effect was further qualified by a significant interaction between Participant Sex and Stimulus Sex, $F(1, 55) = 127.21$, $p < .001$, $\eta^2 = .70$. Post hoc analyses showed that men significantly differed in their ratings of female vs. male stimuli, $t(24) = 15.66$, $p < .001$, $d = 4.37$, whereas women did not, $t < 1$, $d = 0.14$ (Table 1). Therefore, only men showed a sexual orientation-specific influence on sexual attractiveness ratings.

**Viewing time latencies.** The 2 (Participant Sex) x 2 (Stimulus Sex) mixed-model ANOVA for latencies of sexual attractiveness ratings in the VT showed no significant main effect of Stimulus Sex, $F < 1$. However, it revealed a significant main effect of Participant Sex, $F(1, 55) = 4.58$, $p = .037$, $\eta^2 = .08$. In general, men showed shorter latencies than women. Moreover, there was a significant interaction between Participant Sex and Stimulus Sex, $F(1, 55) = 30.29$, $p < .001$, $\eta^2 = .36$. Post hoc analyses showed that men significantly differed in latencies for ratings of female vs. male stimuli (Table 1), $t(24) = 3.94$, $p = .001$, $d = 0.72$. Furthermore, women also significantly differed in latencies for ratings of female vs. male stimuli (Table 1), $t(31) = 3.77$, $p$

=.001, $d$ = 0.46. Therefore, women and men showed a sexual orientation-specific influence on latencies of sexual attractiveness rating.

**Intercorrelations.** The hypothesized positive correlation for difference values of sexual attractiveness ratings in the VT and difference values of CPAP parameters only emerged for latencies of correct prosaccades ($r$ = .44, $p$ = .001), whereas the correlations with the other CPAP differences values were nonsignificant ($r$s < .18, $p$s > .19). Moreover, correlations between difference values of VT latencies and CPAP difference values for pro- or antisaccade parameters were all nonsignificant ($r$s < .20, $p$s > .13). In addition, the correlation between the difference score of prosaccade latencies and the sex drive aggregate was significant ($r$ = .29, $p$ = .03). All other correlations of CPAP parameters and the sex drive aggregate as well as TSO were nonsignificant ($r$s < .19, $p$s > .20).

## Discussion

We developed the CPAP as an indirect measure to explore early stages of behavior formation based on sexual interest. In view of the assumption that processing of sexual information varies as a function of sexual relevance and intention, we expected sexual interest-specific differences in pro- and antisaccade performance in reaction to sexual information.

In line with hypothesis (1) that error rates and latencies of correct prosaccades would be shorter in the congruent than in the incongruent condition, results showed that the prosaccade performance of male participants differed with regard to stimulus sex. More precisely, heterosexual men made fewer mistakes and were faster when they had to look towards female targets compared with male targets. This effect cannot be explained by general differences in performance of women and men (i.e., no significant main effect of Participant Sex). Hence,

hypothesis (1) was confirmed for male participants only. Furthermore, hypothesis (2) that error rates would be lower and latencies of antisaccades would be shorter in the congruent compared with the incongruent condition was partly confirmed, meaning that error rates but not latencies of antisaccades varied depending on sexual relevance. More precisely, error rates of both women and men were lower in the congruent condition, when participants were tasked with looking away from sexually irrelevant stimuli. Moreover, we did not observe any influence of executive control, neuroticism, sexual activity, or sexual desire. Therefore, the cued pro- and antisaccade paradigm appears to be largely insensitive to individual difference variables.

With regard to the psychometric quality of the saccadic parameters, reliability analysis showed satisfying to good coefficients (Cronbach's α .77-.86; with the exception of Cronbach's α for antisaccade latencies of .55), especially in comparison with other commonly used attitudinal indirect measures (e.g., Cronbach's α .53-.88 in a large overview by Bar-Anan & Nosek, 2014). The validity check revealed convergence with attractiveness ratings of the VT, at least for prosaccade latencies. However, pro- and antisaccade parameter did not correlate with corresponding VT response latencies. The absence of significant correlations between saccadic parameters on the one hand and attractiveness ratings and VT response latencies on the other hand might be a result of the different underlying processes. VT performance is associated with rather "cold" cognitive processes concerning the task structure, because interfering attentional adhesion accounts due to the sexually attractive nature of relevant target stimuli have been ruled out (Imhoff et al., 2010).It has been demonstrated that by far the greatest share of variance of VT effect is dependent on features of the task (i.e., more stimulus features have to be scrutinized for sexually relevant vs. irrelevant target categories resulting in longer latencies for sexually relevant target categories) but not on individual target characteristics (Imhoff, Schmidt, Weiß, Young, &

Banse, 2012). Individuals are simply faster to reject a target as sexually irrelevant if already one crucial feature for sexual relevance is incongruent (e.g., correct sex, age, attractiveness). The more crucial features are congruent, the longer it takes to scrutinize the target. These process differences are reflected in the substantially longer VT latencies representing much less automatic and more controlled information processing. In contrast, the performance in the CPAP could be associated with relatively "hotter" motivational processes impacting the actual allocation of attention as a function of the subjectively perceived sexual relevance of the specific target as discussed below.

**Prosaccadic Results of Men**

Regarding instructed prosaccades, men made fewer direction errors and performed faster in reaction to female targets than to male targets. The results suggest that programming prosaccadic parameters was influenced by the compatibility of the relevance of sexual information and the task instruction in male participants.

Processing of sexually relevant cues could have facilitated exogenous triggering of prosaccades by the corresponding target. In addition, with regard to the task-relevant role of the cue, conscious processing of subsequent sexual targets must be taken into account. Consequently, exogenous and endogenous generation processes of instructed prosaccades towards female targets could have worked conjointly in enhancing sexually motivated approach behavior. Notably, in this context, approach behavior is not considered spatially, but as an allocation of cognitive resources that might precede corresponding bodily reactions (Land & Tatler, 2009).

In contrast, prosaccades towards sexually irrelevant stimuli could be understood as sexually non-motivated allocation of attention. The instructed task of looking towards nude male targets should have been incompatible with regard to male participants' heterosexual orientation and, consequently, not automatically linked to approach behavior–at least not as strong as towards nude female stimuli–or even automatically associated with avoidance behavior. Eye movement data from different studies substantiate the preferred processing of female over male stimuli (e.g. Bradley et al., 2015; Dawson & Chivers, 2016; Fromberger et al., 2012) that might have resulted in a motivational benefit for prosaccades towards female stimuli in the CPAP. In addition, intentional mechanisms might have further hampered saccade generation. Such intentional regulation may have resulted from the fact that participants may have avoided reactions indicating homosexual orientation. The salient study context "assessment of sexual attractiveness" could have encouraged homophobic behavior of male participants (Jellison, McConell, & Gabriel, 2004). It should be noted that these regulatory mechanisms might have required cognitive resources (Lavie, Hirst, Fockert, & Viding, 2004), so that task monitoring and performance could have been compounded. This might have been a reason for men's comparatively high prosaccadic error rates while viewing male stimuli.

The difference in regards to the motivational significance of female vs. male stimuli can be further corroborated by the results of the VT task. Men explicitly rated female stimuli as much more sexually attractive than male stimuli, resulting in an extremely large effect size of $d = 4.37$ for men.

**Prosaccadic Results of Women**

Contrary to hypothesis (1) women did not show any significant differences in prosaccadic parameters as a function of experimental conditions. Hence, sexual interest-specific influences on prosaccade generation might have been different from what was expected. In this context, again, results of the VT may contain useful information. Women rated male stimuli as relatively sexually unattractive. Additionally, their ratings for men's sexual attractiveness did not differ from female stimuli resulting in a very small effect size of $d = 0.14$. This corroborates that male stimuli might not have been sexually salient enough to trigger exogenous saccade generation and enhance endogenous processing; the operationalization of sexual relevance might have failed. Relatedly, in an extensive analysis of internet search terms, Ogas and Gaddam (2011) showed that heterosexual women prefer verbal over pictorial sexual stimuli. Hence, the present stimulus material might have been far less sexually attractive for women than for men. Consequently, the benefit of complementing exogenous processes might have been lacking. Such sexually non-motivated approach towards male stimuli can be interpreted in the context of robust results showing female non-specificity for sexual cues (e.g., Chivers et al., 2004; Lippa, 2006). Rieger and colleagues (2015) recently confirmed this effect in the oculomotoric context. They investigated the congruence of physical and subjective sexual arousal to sexual stimuli. Results showed that pupil dilation and genital arousal of heterosexual women were only weakly related to their sexual orientation compared with these responses in men. Eye movement data from Bradley and colleagues (2015) even revealed that the preference for sexual information reversed for women over time. In a selective looking paradigm, gaze duration on affective (e.g., food, threat, nude women, nude men) and neutral pictures was compared within six time intervals of three seconds. In the first (0–0.5 s) and second time interval (0.5–1 s), gaze duration was

significantly longer for any affective compared with neutral stimuli. However, during the third time interval (1–1.5 s), the preferred processing of nude male stimuli disappeared. While other affective content was still favored over neutral content, gaze duration for nude male stimuli did no longer differ from neutral control pictures. In the last two time intervals (2–2.5 s, 2.5–3 s), only nude female stimuli were preferably processed over neutral content, and only by male participants.

**Antisaccadic Results**

In accordance with hypothesis (2), antisaccade error rates of female and male participants were lower in the congruent than in the incongruent condition. As expected, processing of sexually relevant information might have been strongly linked with automatically elicited approach behavior and, thus, more strongly hampered intentional re-orientation in form of successful antisaccades than for sexually irrelevant information. Cognitive resources that would have been needed to intentionally look away might not have been strong enough to win the battle against exogenously triggered antisaccades.

Interestingly, compared to prosaccade results, we found sexual interest-specific differences not only for male but also for female participants. Although findings for prosaccade performance lead to the assumption that male stimuli might not have been sexually meaningful for women, female participants made more errors when instructed to look away from male than from female targets. Hence, for female participants the influence of stimulus material on saccade generation differed between conditions. Possibly, this effect for females might be a result of the order of experimental conditions: First, female participants had to perform antisaccades away from male targets in the incongruent condition before being instructed to look towards male targets in the

congruent condition. This means that female participants had no information on the sexually attractiveness of the male targets while performing antisaccades in the first condition (or at least it was more difficult to concentrate on the actual features of the male stimuli presented in the antisaccade task). Consequently, sexual interest-specific influence on antisaccade performance in terms of automatically elicited approach might have been solely based on the cued information about target sex.

On the other hand, in the second condition, when female participants had to look towards male targets, stimulus information might have been more easily elaborated and evaluated as sexually non-attractive and, thus, exogenous processes did not facilitate intentional prosaccade performance. The above-mentioned study results of Bradley et al. (2015) support our findings. For women, preferred processing of sexual information reversed over time. Hence, motivational disadvantages of antisaccades away from sexually (less) salient information in the CPAP might be caused by early, very crude stimulus processing, whereas missing motivational benefits of prosaccades could be the result of the more elaborate information processing when women had relatively increased possibilities to actually look at male stimuli. This post-hoc explanation should be tested in future research by counterbalancing the order of conditions.

Latencies of successful antisaccades did not differ between experimental conditions as expected in hypothesis (2); at least when outliers were excluded from analyses. In line with Findlay and Walker (1999), it is suggestive that antisaccade generation resulted from intentional processes. In case of successful antisaccades endogenous generation might have overridden automatically activated and exogenously triggered influences by sexually relevant or irrelevant information. However, antisaccade latencies were shorter in the congruent than in the incongruent condition–as expected in hypothesis (2)–when outliers were included. This finding

must be replicated in future studies, as it is dependent on the behavior of a single empirical outlier.

**Limitations**

One obvious limitation of the CPAP is the inherent difficulty in precisely differentiating between automatic and intentional processing at the level of saccade generation. Processing of the sex of the stimuli, however, needs to be implemented if one seeks to manipulate the sexual interest-specific relevance of the stimuli. To this end, cues were introduced to serve the purpose of indicating whether the pro- or antisaccade was to be performed and to announce the sex of the target. In addition, we cannot rule out order effects. To minimize interindividual differences all participants first performed the incongruent and subsequently the congruent condition. This limitation should be addressed in future research by counterbalancing study designs.

Furthermore, in line with the well-documented female non-specificity for sexual cues (e.g., Chivers et al., 2004; Lippa, 2006), it must be noted that the expected attractiveness of male stimuli might have been limited for women. Results of the VT showed that women did not rate male stimuli as particularly sexually attractive nor did their ratings differ from that of female stimuli. Therefore, the success of our operationalization of sexual interest-specific relevance is questionable for female participants, at least for the prosaccade performance. Future studies should respond to this problem and increase the sexual attractiveness of stimuli for women. Another possibility would be to validate this paradigm with gay and heterosexual men exclusively, as their sexual orientation is highly specific and pictorial stimuli are well validated to elicit corresponding sexual information processing. However, this will miss out on the chance of elucidating differential sexual information processing between men and women.

## Conclusions and Outlook

The measurement of saccades as an indicator of sexual interest is of particular interest in fundamental research as these early responses (< 250 ms) point to highly automated information processing. Therefore, using the CPAP could offer new insights, as previous oculomotoric approaches refer to later, supposedly more controllable processes (e.g., time to first fixation > 800 ms, Fromberger et al., 2013; time to first fixation > 700 ms, Dawson & Chivers, 2016). Especially, with regard to the often reported female non-specificity (e.g., Bouchard, Timmers, & Chivers, 2015; Dawson & Chivers, 2016) the CPAP is a promising approach–as at least antisaccade errors showed female sexual specificity in our study–to investigate interest-specific processing at an automatic level. Most importantly, however, future studies should confirm reliability and validity of the CPAP and replicate findings in larger and more strictly defined samples in terms of sexual interest specificity.

Ultimately, this novel paradigm might be applied in practice. For example, diagnostics of paraphilic interests in forensic contexts request for methods that are neither limited by restricted introspection nor fakeable (Schmidt, Banse, & Imhoff, 2015). Of course, it must be considered that the measurement of saccades is somewhat demanding on the technical side, is very sensitive to sabotage, and requires high levels of cooperation from participants. However, this is true for most indirect physiological measurements, and sabotaged data should be identifiable by uncommonly high error rates. Therefore, the decisive issue is rather that this cognitively particularly demanding procedure should hamper faking that is subsequently not recognizable as such.

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Informed Consent: The study protocol adhered to the criteria of informed consent through all stages of the present research for all participants.

## References

Abegg, M., Sharma, N., & Barton, J. J. S. (2012). Antisaccades generate two types of saccadic inhibition. *Biological Psychology, 89*, 191–194. doi: 10.1016/j.visres.2013.11.008

Aichert, D. S., Derntl, B., Wöstmann, N. M., Groß, J. K., Dehning, S., Cerovecki. A., Möller, H. J., Habel, U., Riedel, M., & Ettinger, U. (2013). Intact emotion-cognition interaction in schizophrenia patients and first-degree relatives: Evidence from an emotional antisaccade task. *Brain and Cognition, 82*, 329–336. doi: 10.1016/j.bandc.2013.05.007

Anderson, A. K., Christoff, K., Panitz, D. A., De Rosa, E., & Gabrieli, J. D. E. (2003). Neural correlates of the automatic processing of threat facial signals. *Journal of Neuroscience, 23*, 5627–5633.

Attard-Johnson, J., Bindemann, M., & Ó Ciardha, C. (2016). Pupillary response as an age specific measure of sexual interest: An exploratory study. *Archives of Sexual Behavior, 45*, 885–870.doi: 10.1007/s10508-015-0681-3.

Bar-Anan, Y., & Nosek, B. A. (2014). A comparative investigation of seven implicit measures of social cognition. *Behavior Research Methods, 46*, 668–688. doi: 0.3758/s13428-013 0410-6

Bolmont, M., Cacioppo, J. T., & Cacioppo, S. (2014). Love is in the gaze: An eye-tracking study of love and sexual desire. *Psychological Science, 25*, 1748–1756.

Both, S., Spiering, M., Everaerd, W., & Laan, E. (2004). Sexual behavior and responsiveness to sexual stimuli following laboratory-induced sexual arousal. *Journal of Sex Research, 41*, 242–258. doi: 10.1080/00224490409552232

Bouchard, K. N., Timmers, A. D., & Chivers, M. L. (2015). Gender-specificity of genital response and self-reported sexual arousal in women endorsing facets of bisexuality. *Journal of Bisexuality*, *15*, 180–203. doi: 10.1080/15299716.2015.1023389

Bradley, M. M., Costa, V. D., & Lang, P. J. (2015). Selective looking at natural scenes: Hedonic content and gender. *International Journal of Psychophysiology*, *98*, 54–58. doi: 10.1016/j.ijpsycho.2015.06.008

Brenk-Franz, K., & Strauß, B. (2011). Der multidimensionale Fragebogen zur Sexualität (MFS) Erste Evaluation der deutschsprachigen Version des Multidimensional Sexuality Questionnaires [Multidimensional questionnaire on sexuality – First evaluation of the German version of the Multidimensional Sexuality Questionnaire (MSQ)]. *Zeitschrift für Sexualforschung*, *24*, 256–271. doi:10.1055/s-0031-128706

Chivers, M. L., Rieger, G., Latty, E., & Bailey, J. M. (2004). A sex difference in the specificity of sexual arousal. *Psychological Science*, *15*, 736–744. doi: 10.1111/j.0956-7976.2004.00750.x

Dawson, S. J., & Chivers, M. L. (2016). Gender-specificity of initial and controlled visual attention to sexual stimuli in androphilic women and gynephilic men. *PLOS One*, *11*. doi: 10.1371/journal.pone.0152785.

De Houwer, J., & Moors, A. (2010). Implicit measures: Similarities and differences. In B. Gawronski, & B. K. Payne (Eds.), *Handbook of implicit social cognition: Measurement, theory, and applications* (pp. 176–193). New York, NY: Guilford Press.

Deubel, H., & Schneider, W. X. (1996). Saccade target selection and object recognition: Evidence for a common attentional mechanism. *Vision Research*, *36*, 1827–1837. doi: 10.1016/0042-6989(95)00294-4

Derakshan, N., Ansari, T. L., Hansard, M., Shoker, L., & Eysenck, M. W. (2009). Anxiety, inhibition, efficiency, and effectiveness: An investigation using the antisaccade task. *Experimental Psychology*, *56*, 48–55. doi: 10.1027/1618-3169.56.1.48

Everaerd, W. (1988). Commentary on sex research: Sex as an emotion. *Journal of Psychology and Human Sexuality*, *1*, 3–15.

Fathi, A., Elahi, T., & Hasani, J. (2014). Recognition of the facial emotional states in extraversion/ neuroticism personality dimensions: The modulatory role of working memory. *Advances in Cognitive Science*, *16*, 57–68.

Field, A. (2013). *Discovering statistics using IBM SPSS Statistics*. Thousand Oaks, CA: Sage Publishers.

Findlay, J. M., & Walker, R. (1999). A model of saccade generation based on parallel processing and competitive inhibition. *Behavioral and Brain Sciences*, *22*, 661–721.

Fromberger, P., Jordan, K., Steinkrauss, H., von Herder, J., Stolpmann, G., Kroner-Herwig, B., & Müller, J. L. (2013). Eye movements in pedophiles: Automatic and controlled attentional processes while viewing prepubescent stimuli. *Journal of Abnormal Psychology*, *122*, 587–599. doi: 10.1037/a0030659

Fromberger, P., Jordan, K., von Herder, J., Steinkrauss, H., Nemetschek, R., Stolpmann, G., & Müller, J. L. (2012). Initial orienting towards sexually relevant stimuli: Preliminary evidence from eye movement measure. *Archives of Sexual Behavior*, *41*, 919–928. doi: 10.1007/s10508-011-9816-3

Hallett, P. E. (1978). Primary and secondary saccades to goals defined by instructions. *Vision Research*, *18*, 1279–1296.

Hutton, S. B., & Ettinger, U. (2006). The antisaccade task as a research tool in psychopathology: A critical review. *Psychophysiology, 43*, 302–313. doi: 10.1111/j.1469-8986.2006.00403.x

Imhoff, R., & Schmidt, A. F. (2014). Sexual disinhibition under sexual arousal: Evidence for domain specificity in men and women. *Archives of Sexual Behavior, 43*, 1123–1136. doi: 10.1007/s10508-014-0329-8

Imhoff, R., Schmidt, A. F., Nordsiek, C. L., Young, A. W., & Banse, R. (2010). Viewing time effects revisited: Prolonged response latencies for sexually attractive targets under restricted task conditions. *Archives of Sexual Behavior, 39*, 1275–1288. doi: 10.1007/s10508-009-9595-2

Imhoff, R., Schmidt, A. F., Weiß, S., Young, A. W., & Banse, R. (2012). Vicarious viewing time: Prolonged response latencies for sexually attractive targets as a function of task- or stimulus-specific processing. *Archives of Sexual Behavior, 41*, 1389–1401. doi: 10.1007/s10508-011-9879-1

Janssen, E., Everaerd, W., Spiering, M., & Janssen, J. (2000). Automatic processes and the appraisal of sexual stimuli: Towards an information processing model of sexual arousal. *Journal of Sex Research, 37*, 8–23.

Jellison, W. A., McConnell, A. R., & Gabriel, S. (2004). Implicit and explicit measures of sexual orientation attitudes: Ingroup preferences and related behaviors and beliefs among gay and straight men. *Personality and Social Psychology Bulletin, 30*, 629–642. doi: 10.1177/0146167203262076

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). *Sexual behavior in the human male*. Philadelphia, Pa: W. B. Saunders.

Kinsey, A. C., Pomeroy, W. B., Martin, C. E., & Gebhard, P. H. (1953). *Sexual behavior in the human female*. Philadelphia, Pa: W. B. Saunders.

Kistemaker, L. (2013). *Sexuelle Objektifizierung. Valider Effekt oder Methodenartefakt? [Sexual objectifaction. Valid effect of methodical artefact?]* (unpublished master thesis). University of Bonn, Bonn.

Krupp, D. B. (2008). Through evolution's eyes: Extracting mate preferences by linking visual attention to adaptive design. *Archives of Sexual Behavior*, *37*, 57–63.

Land, M. F., & Tatler, B. W. (2009). *Looking and acting: vision and eye movements in natural behaviour*. Oxford: Oxford University Press.

Lavie, N., Hirst, A., De Fockert, J. W., & Viding, E. (2004). Load theory of selective attention and cognitive control. *Journal of Experimental Psychology: General, 133*, 339–354. doi: 10.1037/0096-3445.133.3.339

LeDoux, J. E. (1995). Emotion: Clues from the brain. *Annual Review of Psychology, 46*, 209–235.

Leigh, R. J., & Zee, D. S. (1999). *The neurology of eye movements*. USA: Oxford University Press.

Lippa, R. (2006). Is high sex drive associated with increased sexual attraction to both sexes? *Psychological Science*, *17*, 46–52. doi: 10.1111/j.1467-9280.2005.01663.x

Liversedge, S. P., Gilchrist, I. D., & Everling, S. (2011*). The Oxford Handbook of Eye Movements*. New York, NY: Oxford University Press.

Massen, C. (2004). Parallel programming of exogenous and endogenous components in the antisaccade task. *Quarterly Journal of Experimental Psychology*, *57*, 475–498.

Morris, J. S., De Gelder, B., Weiskrantz, L., & Dolan, R. J. (2001). Differential extrageniculostriate and amygdala responses to presentation of emotional faces in a cortically blind field. *Brain, 124*, 1241–1251. doi: 10.1093/brain/124.6.1241

Mueller, S. C., Hardin, M. G., Mogg, K., Benson, V., Bradley, B. P., Reinholdt-Dunne, M. L., Liversedge, S. P., Pine, D. S., & Ernst, M. (2012). The influence of emotional stimuli on attention orienting and inhibitory control in pediatric anxiety. *Journal of Child, Psychology and Psychiatry, 53*, 856–863. doi: 10.1111/j.1469-7610.2012.02541.x.

Munoz, D. P., & Everling, S. (2004) Look away: The anti-saccade task and the voluntary control of eye movement. *Nature Review Neuroscience, 5*, 218–228. doi: 10.1038/nrn1345

Ogas, O., & Gaddam, S. (2011). *A billion wicked thoughts: What the internet tells us about sexual relationships*. USA: Penguin Group.

Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology, 23*, 123–145.

Prause, N., Janssen, E., & Hetrick, W. P. (2008). Attention and emotional response to sexual stimuli and their relationship to sexual desire. *Archives of Sexual Behavior, 37*, 934–949. doi: 10.1007/s10508-007-9236-6

Rammstedt, B., & John, O. P. (2005). Kurzversion des Big Five Inventory (BFI-K): Entwicklung und Validierung eines ökonomischen Inventars zur Erfassung der fünf Faktoren der Persönlichkeit [Short version of the Big Five Inventory (BFI-K): Development and validation of an economical inventory to assess the five factors of personality]. *Diagnostica, 51*, 195–206.

Rieger, G., Cash, B. M., Merrill, S. M., Jones-Rounds, J., Dharmavaram, M., & Savin-Williams, R. C. (2015). Sexual arousal: The correspondence of eyes and genitals. *Biological Psychology, 104*, 56–64. doi: 10.1016/j.biopsycho.2014.11.009

Rönspies, J., Schmidt, A. F., Melnikova, A., Krumova, R., Zolfagari, A., & Banse, R. (2015). Indirect measurement of sexual orientation: Comparison of the Implicit Relational Assessment Procedure, Viewing Time, and Choice Reaction Time Tasks. *Archives of Sexual Behavior, 44*, 1483–1492. doi: 10.1007/s10508-014-0473-1

Schmidt, A. F., Banse, R., & Imhoff, R. (2015). Indirect measures in forensic contexts. In F. J. R. van de Vijver, & T. Ortner (Eds.), *Behavior Based Assessment in Personality, Social, and Applied Psychology* (pp. 173–194). Göttingen, Germany: Hogrefe

Snowden, R. J., & Gray, N. S. (2013). Implicit sexual associations in heterosexual and homosexual women and men. *Archives of Sexual Behavior, 42*, 475–485. doi: 10.1007/s10508-012-9920-z

Spector, I. P., Carey, M. P., & Steinberg, L. (1996). The sexual desire inventory: Development, factor structure, and evidence of reliability. *Journal of Sex and Marital Therapy, 22*, 175–190.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*, 220–247.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643–662.

Wenban-Smith, M. G., & Findlay, J. M. (1991). Expresssaccades: Is there a separate population in humans? *Experimental Brain Research, 87*, 218–222.

Wiedermann, M. W., & Allgeier, E. R. (1993). The measurement of sexual-esteem: Investigation of Snell and Papini's (1989) Sexuality Scale. *Journal of Research in Personality, 27,* 88–102.

Table 1

*Descriptive Statistics of Error Rates and Latencies of Pro- and Antisaccades as well as Viewing Time Sexual Attractiveness Ratings and Latencies*

| | | Women | | Men | |
|---|---|---|---|---|---|
| | *α* | *M* | *SD* | *M* | *SD* |
| Error rates of prosaccades (%, *n* = 57) | .82[b] | | | | |
| Congruent | | 4.3 | 4.2 | 3.2 | 5.5 |
| Incongruent | | 2.9 | 2.9 | 6.2 | 6.8 |
| Latencies of correct prosaccades (ms, *n* = 56) | .86[b] | | | | |
| Congruent | | 163 | 39 | 152 | 36 |
| Incongruent | | 157 | 34 | 181 | 56 |
| Error rates of antisaccades (%, *n* = 57) | .77[b] | | | | |
| Congruent | | 16.2 | 10.9 | 17.1 | 9.2 |
| Incongruent | | 18.4 | 14.2 | 23.7 | 15.3 |
| Latencies of correct antisaccades (ms, *n* = 56) | .55[b] | | | | |
| Congruent | | 243 | 36 | 237 | 43 |
| Incongruent | | 244 | 35 | 253 | 65 |
| Viewing time sexual attractiveness ratings[a] (*n* = 57) | .97[b] | | | | |
| Female stimuli | | 2.0 | 0.7 | 3.4 | 0.6 |
| Male stimuli | | 1.9 | 0.5 | 1.2 | 0.4 |
| Viewing time latencies (ms, *n* = 57) | .76[b] | | | | |
| Female stimuli | | 3,318 | 1,403 | 3,398 | 993 |
| Male stimuli | | 3,998 | 1,518 | 2,498 | 1,383 |

*Note.* [a]Likert scale ratings (1 = “sexually not attractive” to 5 = ”sexually very attractive”); [b]Cronbach’s α was calculated using difference scores of latencies and error rates from two task blocks (i.e., test halves).

*Figure 1.* Processing of Sexual Information (A) and Saccade Generation as Reaction to Sexual Information (B).

Figure 1

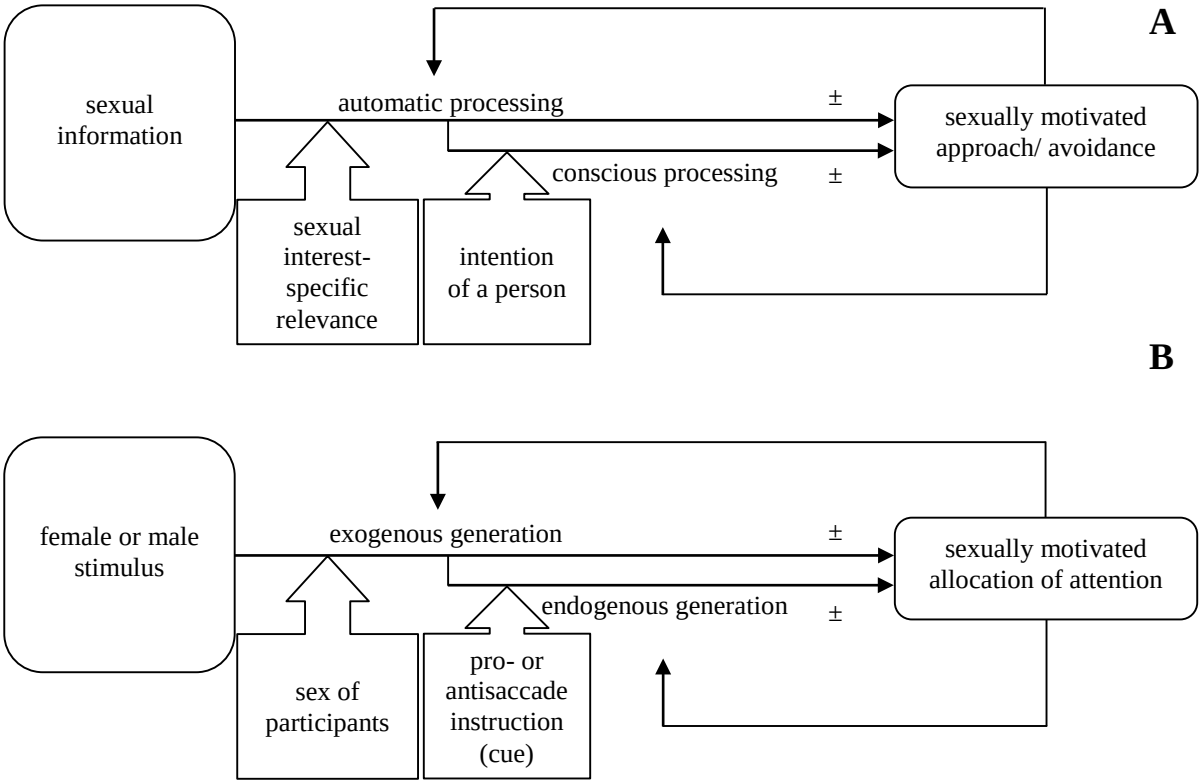
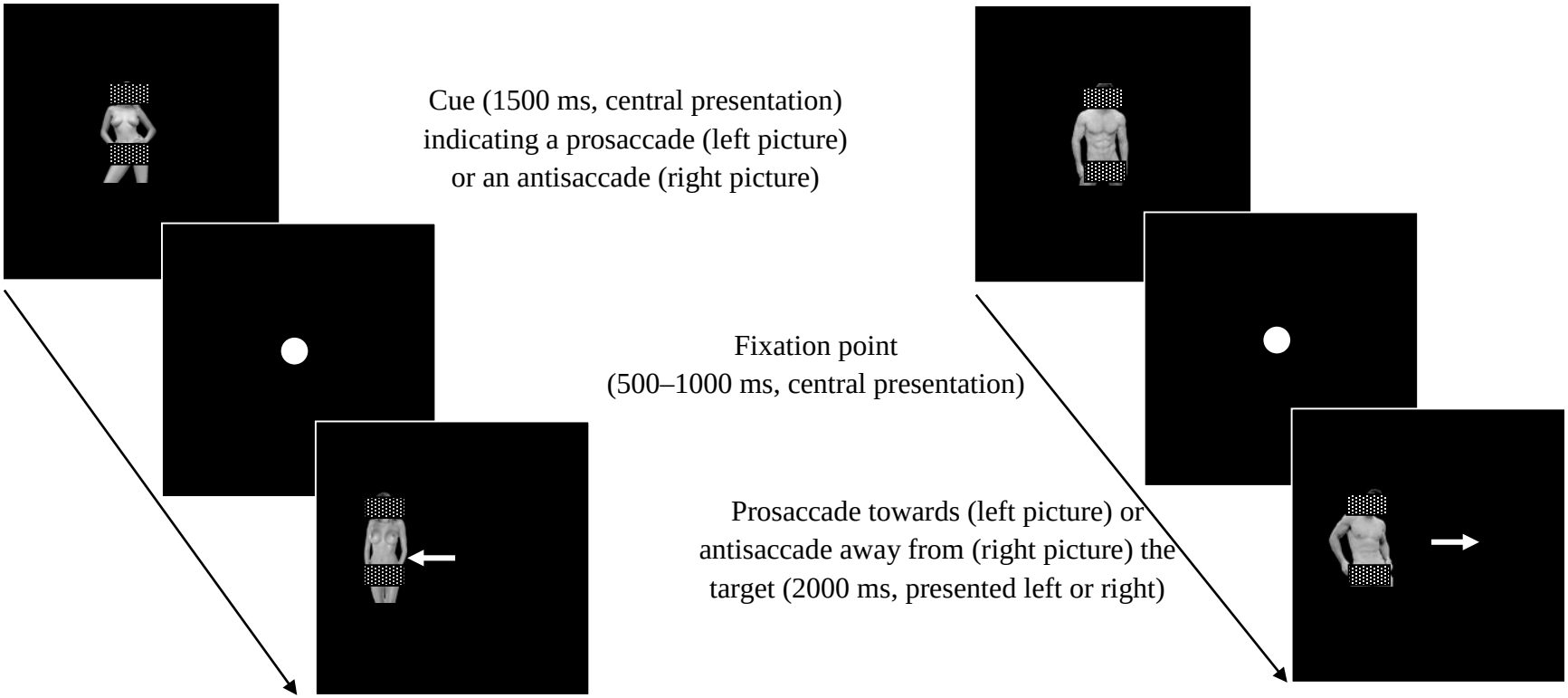

A
sexual information
automatic processing
±
sexually motivated approach/ avoidance
conscious processing
±
sexual interest-specific relevance
intention of a person
B
female or male stimulus
exogenous generation
±
sexually motivated allocation of attention
endogenous generation
±
sex of participants
pro- or antisaccade instruction (cue)

*Figure 2.* Congruent Experimental Condition for Male Participants and Incongruent Experimental Condition for Female Participants (Stimuli Are Not to Scale, Faces and Genitals Are Censored)

Figure 2


Cue (1500 ms, central presentation)
indicating a prosaccade (left picture)
or an antisaccade (right picture)
Fixation point
(500–1000 ms, central presentation)
Prosaccade towards (left picture) or
antisaccade away from (right picture) the
target (2000 ms, presented left or right)