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# Developing a Causally Valid Picture-Story Measure of Sexual Motivation: I. Effects of Priming

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Sexual motivation plays a crucial role in both normal sexual functioning as well as sexual dysfunctions. Although many self-report questionnaires exist to assess sexual motivation, their validity is restricted in that their sensitivity to experimental manipulation has not been tested and that they are subject to self-report limitations (e.g., self-representational issues). The aim of the current research is to develop and validate through experimental means a measure of sexual motivation based on the content analysis of imaginative stories that participants write about socially ambiguous pictures. In two studies (Study 1: $N = 86$; Study 2: $N = 113$), participants were randomly allocated to an erotic prime or control prime condition and took a picture-story test before and after the presentation of the primes. Subjective affect was assessed in both studies; physiological measures of affect (pupillometry and facial electromyography) and a criterion measure of sexual motivation (key-pressing for longer exposure to sexual vs. control pictures) only in Study 2. In both studies, erotically primed participants showed an increase of sexual imagery in picture stories, whereas participants presented with control primes did not. In Study 2, this effect was mediated by subjective and physiological arousal. Sexual imagery changes also mediated the effect on the behavioral criterion (viewing time for sexual pictures). We additionally report evidence for the discriminant validity of the sexual motive arousal procedure.

*Keywords:* sexual motivation, causal validation, picture-story exercise, priming

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Sexual motivation is a fundamental motivational system and has elicited a substantial amount of research (Agmo & Laan, 2022). There is general agreement among researchers that sexual motivation is incentive-based and that it is a dynamic process (Agmo, 1999; Berridge, 2001; Bindra, 1978; Toates, 1986, 2009). According to Bindra (1978) and Agmo (1999), both a central motive state and incentives (i.e., affectively charged stimuli that elicit goal-directed, motivated behavior) generate motivation. More specifically, the central motive state and the mental representation of characteristics of incentive stimuli have a mutually exciting relationship. The central motive state is influenced by internal states (such as previous exposures to sexual incentives, past and current hormonal milieu, and inhibiting factors such as fear) that are not motivating themselves but that have a gating function and influence the central motive state's current level. In other words, the central motive state may have a settling point shaped by internal factors but can also be "pushed up" (or "down") from there via incentives (or disincentives). If the central motive state is low or there are no sexual incentives, no sexual motivation will ensue. Consequently, if sexual incentive cues are held constant, one can determine an individual's central motive state from the degree of her or his response to the cues. In sum, the central motive state makes the individual more sensitive to the stimulus qualities of the incentive and the activation of the representation of the incentive augments the central motive state. Thus, there is a mutually excitatory relationship between the central motive state and the incentive, representing a positive feedback loop.

Although various measures of sexual motivation are available, such as self-reports, psychophysiological and reaction time measures (e.g., Cartagena-Ramos et al., 2018; Hinzmann et al., 2020; Kukkonen, 2015), to our knowledge no measure of sexual motivation has been established yet that is based on the incentive

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motivation model. The aim of the current two studies is therefore to develop a measure of sexual motivation that exposes participants to sexual incentives and assesses individual differences in motivational responses to them, as revealed in participants' thematic apperceptive responses to picture cues.

## Validating Motive Measures

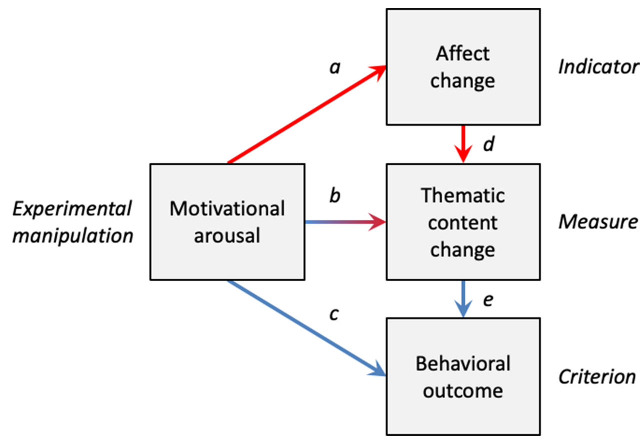
McClelland (1958, 1987) argued that the central requirement of validity is that a measure must be sensitive to experimental manipulation (EM) of the process it aims to capture. Similarly, modern validity theory suggests that a measure is only valid if the attribute it measures exists, and variations in this attribute cause variations in the measure (Borsboom et al., 2004). For example, the thermometer was validated by showing that its immersion in cold water leads to a drop, and in boiling water to an increase of its mercury column (Celsius, 1742). Subsequently, the thermometer was used as a measure of the temperature of substances with unknown heat properties. In the context of sexual motivation, this suggests that a measure should give lower readings under neutral conditions, when no sexual incentives are present ("cold"), and higher readings under sexually arousing conditions when sexual incentives are present ("hot"). In a similar way, a thermometer can be used to determine the characteristic temperature of substances, coding motive themes in the picture-story exercise (PSE; McClelland et al., 1989) has been used to measure individual differences in motive strength.

The PSE is the most commonly used measure to assess motives. Specifically, the PSE relies on the analysis of written imaginative stories in response to ambiguous pictures of social interactions (Pang, 2010). PSE stories are content-coded with empirically derived coding systems which were developed based on systematic differences in stories written by individuals who were either experimentally aroused in a given motive or not (Winter, 1998). For example, Winter (1973) used film clips to develop a coding system for the need for power (nPower). Generally, experimental arousal of a motivational state results in greater imagery indicative of this specific state in PSE stories (Schultheiss et al., 2004), suggesting that the PSE is sensitive to variations in motivation.[1] Using this approach, researchers have used PSE-based motive measures to predict a broad range of outcomes, from physiological processes to societal changes (McClelland, 1987; Schultheiss & Köllner, 2021). We will use a similar approach to develop a content-coding system that assesses sexual motivation, which we term the need for sex (nSex) following the nomenclature established by Murray (1938).

In the present research, we extended the validation approach suggested by McClelland (1958) and Borsboom et al. (2004) into an Experimental Manipulation, Measure, Indicator, Criterion (EMMIC) framework (Schultheiss et al., 2022), retaining the central role of *experimental manipulation* to derive a *measure*, but augmenting it with an *indicator* to verify the intended effect of the experimental manipulation on the targeted process and a *criterion* to demonstrate the measure's ability to predict a relevant outcome (see Figure 1).

**Figure 1**

*EMMIC (Experimental Manipulation, Measure, Indicator, Criterion) Validation Model*




*Note.* Experimental manipulation of a motivational state has a significant effect on the affect-change indicator (a), the thematic content of the picture-story measure (b), and a relevant behavioral criterion (c). The affect mediation triangulation (red arrows) uses affect change as an indicator to verify that motivation was aroused by the experimental manipulation; affect change should therefore mediate the effect of arousal on the measure, and controlling for $a \times d$ should render $b' < b$. The measure-criterion triangulation (blue arrows) aims to document that the measure's variance portion that is sensitive to causal effects of motivation arousal is also the one that accounts for variance in a relevant behavioral outcome, and controlling for $b \times e$ should therefore render $c' < c$. From Schultheiss et al. (2022) and CC-By Attribution 4.0 International (https://osf.io/nz2fr/). See the online article for the color version of this figure.

## Core Indicator: Affect

Importantly, not all forms of experimentally manipulated thematic content changes may reflect motivation and likewise, not all forms of goal-directed behavior are due to motivation; only those that are guided by hedonic mechanisms (i.e., increase of pleasure and reduction of displeasure) do (Berridge, 2001; Bindra, 1978; Hardy, 1964; Schultheiss, 2021). Incentives and incentive motivation are affective at their core, and both respond to and pursue incentives that are intrinsically guided by affective processes. Importantly, the effects of experimental arousal on story content are necessary, but not sufficient for documenting an instrument's validity as a motive measure, as story content variations may be due to nonmotivational factors such as attention, memory, or narrative complexity. We therefore argue for a triangulation between EM, measure, and indicator. Specifically, affect indicates whether the manipulation succeeded in changing the targeted attribute (i.e., motivation) and should mediate the effect of the EM on the measure.

In the present research, we assess affect via self-report (Studies 1 and 2) and psychophysiology (Study 2). In Study 1, subjective affect is assessed as experimentally elicited changes in general state

[1] We acknowledge that PSE-based motive measures are typically classified as implicit measures and contrasted with explicit, declarative motive measures such as questionnaire scales (see McClelland et al., 1989; Schultheiss, 2008). However, as pointed out by Schultheiss & Köllner (2021), PSE-based motive measures were originally developed with the goal of arriving at procedural motive measures that are sensitive to motivational arousal; their implicitness was a property that subsequently emerged but should not be taken to be their most relevant feature. Therefore, our goal in the present research was to develop a *causally valid* procedural measure of sexual motivation, not necessarily an *implicit* one.

measures of approach motivation, avoidance motivation, and hedonic tone. In Study 2, arousal and valence are assessed as specific responses to erotic versus control stimuli. The psychophysiological affect of these stimuli is assessed with facial electromyography (EMG), as was done in previous sexuality research (e.g., Sullivan & Brender, 1986). Particularly, changes in the corrugator muscle—the muscle located at the medial end of the eyebrow—show a bipolar continuum, ranging from negative affective valuation of stimuli (maximally activated corrugator) through a neutral midpoint (slightly activated corrugator) to positive affective valuation of stimuli (maximally relaxed corrugator; Larsen et al., 2003). Corrugator assessment is often complemented by an assessment of the zygomaticus muscle—the muscle that lifts the lip corners in a smile. The zygomaticus muscle has been shown to be active when a person is presented with pleasurable stimuli but stays deactivated in response to neutral or negative stimuli (e.g., Lang et al., 1993). These facial indicators of affect are sensitive to the affective valence of visual and other types of stimuli and change in predictable ways as a function of motivational states (Hoefling et al., 2009). Similarly, pupil diameter increases when people are presented with emotionally engaging stimuli, albeit regardless of hedonic direction. Specifically, pupils widen when participants view pleasant or unpleasant, compared to neutral stimuli, if luminance, which also affects pupil diameter, is held constant (e.g., Bradley et al., 2008). Likewise, pupil dilation has been used as an indicator of automatic responses, including sexual arousal (e.g., Laeng et al., 2012; Lick et al., 2016). Subjective and psychophysiological responses to sexual (vs. neutral) stimuli will serve as indicators of the activation of a motivational state due to the EM and as a mediator in analytical models of the effect of the manipulation on changes in picture-story content.

## Criterion Validity

For a measure of nSex to be valid not just in the sense of measuring the targeted attribute (verified via the indicator) but also in terms of pragmatic usefulness, it needs to predict relevant behavior. For sexual motivation, central real-world criteria would be the frequency of sexual activity and orgasm as well as the affective correlates accompanying these events. Ultimately, it needs to be documented that nSex predicts such outcomes. However, in the context of the present research, which was experimental and conducted in a laboratory, we used as a criterion how much effort (i.e., "wanting;" Berridge, 1996) participants invested into having access to sexual stimuli relative to neutral stimuli and the resulting differences in exposure times to these types of stimuli. Specifically, we adapted a key-press task (KPT) that was used successfully in past research on attractivity (e.g., Chelnokova et al., 2014; Parsons et al., 2011) and used it as a behavioral criterion measure in Study 2. In the EMMIC validation model (Figure 1), criterion validity can be determined by triangulating between EM, measure, and behavioral criterion and verifying that the portion of a measure's variance that is sensitive to the manipulation is also the one that predicts the criterion.

## Discriminant and Convergent Validity

We explored discriminant validity in the following ways: First, we tested whether our motivational-arousal manipulation would be *unique* (see McClelland, 1958) by inducing *changes* in nSex only or whether it would also extend to changes of the motivational needs for power, achievement, or affiliation, three frequently studied motives. An absence of motivational arousal effects on these motives, combined with evidence for an arousing effect on nSex, would support the specificity of the motivational arousal manipulation we employed. Second, we also examined the overlap of *dispositional* nSex (i.e., nSex assessed before the EM took place) with dispositional nPower, nAchievement, and nAffiliation. Although motive measures derived from the same PSE rarely correlate exactly zero with each other, correlations below |.20| are usually interpreted as evidence for discriminant validity (e.g., Schönbrodt et al., 2021; Schultheiss & Brunstein, 2001). Third, we examined the overlap between dispositional nSex and self-report measures of the Big Five traits (John & Srivastava, 1999; Rammstedt & John, 2007), with the expectation that the two types of measures would not converge, as has been observed in earlier research on other PSE-assessed motives (Schultheiss & Brunstein, 2001). We examined convergent validity in Study 2 by including two frequently used self-report measures of sexual motivation and behavior, the sexual inhibition scale (SIS) and sexual excitation scale (SES; Carpenter et al., 2011) and the revised sociosexual orientation inventory (SOI-R; Penke & Asendorpf, 2008). We expected dispositional nSex to converge with the global score and all subscales of the SOI-R as well as with the SES of the SIS/SES, as higher scores on these measures are all assumed to reflect stronger approach motivation to sexual incentives. Our analyses were more exploratory with regard to the inhibition scales of the SIS/SES.

## Overview of Studies and Hypotheses

The present research is the first step in a larger research program in which we systematically varied our method of arousing sexual motivation (priming with pictures in the present research, priming with movies and audio stories in subsequent studies) and also, orthogonal to the arousal method, PSE picture set, which was varied between studies for each arousal method. Studies 1 and 2 test whether experimentally induced sexual motivation increases sexual imagery in a PSE. For this, participants were asked to write eight imaginative stories in response to ambiguous pictures of social interactions. First, participants wrote four stories without the presentation of primes (baseline phase) and then four stories with the presentation of primes with backward masking (priming phase). The experimental group was exposed to erotic prime pictures and the control group was exposed to neutral prime pictures presented before each PSE picture. Primes were shown for either 30 or 500 ms to examine to what extent the conscious perception plays a role in motivational arousal as previous research has shown that prime duration can have an effect on cognitive processing (e.g., Framorando & Gendolla, 2018; Schüpbach et al., 2014). Two sets of PSE pictures (A and B) were created for each study to counterbalance the PSE stimuli across participants. Subjective and physiological affect in response to the primes was assessed. Ultimately, the main goal of the current studies is to develop a coding system for nSex in order to measure sexual motivation in a valid manner. The following hypotheses guided our research in both studies, although some could only be tested fully in Study 2:

> *Hypothesis 1*: Themes indicative of nSex will increase in the erotic prime condition as compared to a neutral prime control condition. Specifically, we expect nSex to increase in the erotic prime condition from the baseline to the prime phase (Hypothesis 1a), but not

in the control prime condition (Hypothesis 1b). Erotic prime individuals will therefore also show higher nSex in the priming phase than control prime individuals (Hypothesis 1c); this effect should be absent in the baseline (no-prime) phase (Hypothesis 1d). Overall, these effects constitute an Expected Significant Time (Baseline, Priming) × Condition (Erotic, Neutral) interaction, providing evidence in favor of McClelland's (1958) sensitivity criterion and Borsboom et al.'s (2004) causal effect criterion.

*Hypothesis 2a*: Subjective energetic arousal, tense arousal, and hedonic tone will increase in the erotic prime condition as compared to the control condition, constituting a Significant Time (Baseline, Priming) × Condition (Erotic, Neutral) interaction (Study 1).

*Hypothesis 2b*: Subjective arousal and hedonic responses will be higher in response to erotic prime stimuli than in response to neutral prime stimuli (Study 2).

*Hypothesis 3*: Pupil size will be greater in response to erotic stimuli than to control stimuli.

*Hypothesis 4*: Corrugator muscle activity will be lower in response to erotic stimuli than in response to control stimuli.

*Hypothesis 5*: Zygomatic muscle activity will be greater in response to erotic stimuli than in response to control stimuli. Hypotheses 2 through 5 provide a test of the expected effect of the EM on the affect indicator.

*Hypothesis 6*: Increases in arousal and hedonic responses (Hypothesis 2a and 2b), pupil size, and zygomatic activation (Hypotheses 3 and 5), as well as decreases in corrugator activation (Hypothesis 4), in response to erotic versus neutral stimuli mediate the predicted experimental–arousal effect on nSex. In their combination, Hypotheses 2–6 represent a test of the affect mediation triangulation described above (see the red line triangle in Figure 1).

*Hypothesis 7*: Erotically primed individuals will subsequently show longer viewing time of erotic stimuli, relative to neutral stimuli, than control prime individuals. This tests the effect of the EM on the criterion.

*Hypothesis 8*: nSex on the PSE predicts increased relative viewing time for erotic stimuli.

*Hypothesis 9*: nSex mediates the effect of experimental conditions on relative viewing time for erotic stimuli. In their combination, Hypotheses 7–9 represent a test of the criterion mediation triangulation described above (see the blue line triangle in Figure 1).

These hypotheses (except for Hypothesis 2b) were preregistered for Study 2 (AsPredicted #16735), but already guided our thinking and study design for Study 1.[2] Studies 1 and 2 will also examine the sensitivity of nSex subcategories to the EM as well as their role in the affect and criterion mediation pathways (Figure 1).

## Derivation of a Coding System: An Overview

The main goal of the current studies is to develop a valid coding system for nSex; however, such a coding system can depend substantially on PSE stimuli. Therefore, two different sets of eight PSE pictures each were used across studies to increase the coding system's generalizability. First, using PSE stories of Study 1, thematic differences between PSE stories written under erotic or neutral conditions were identified and articulated as specific coding rules. These coding rules were then fine-honed and expanded after the analysis of systematic differences in PSE stories under the two conditions in Study 2. Then, all PSE stories from both studies were content-coded based on the updated coding system from Study 2, and the research presented here is based on this iteratively revised coding system. The strategy we applied was to initially retain as many coding categories as possible. Only after inspection of each category for (a) sufficient intercoder reliability and (b) sensitivity for motivational arousal effects, combined with predicted associations with affect and criterion measures, we will decide which categories are suitable for a finalized nSex coding system (Boyatzis, 1998). The present research represents a first step in this direction.

# Method

Ethics approval was obtained from the Institutional Review Board of Friedrich-Alexander University, Erlangen, Germany. Power analyses were based on between and within-subjects-based $t$ tests with power = .80 and an α level of .01, two-sided, and suggested a sample size of $n = 50$ per group.

## Participants

### Study 1

Participants were 43 men and 43 women ($N = 86$), aged 18–45 years ($M = 23.43$, $SD = 3.74$). Forty-four participants were assigned to the erotic prime and 42 participants to the control prime condition. Eighty-five participants self-identified as heterosexual and one participant as bisexual. Participants were recruited through social media and postings in the university setting of the Friedrich-Alexander-University Erlangen-Nuremberg. Participation required being at least 18 years old and fluent in German. Participants received 15 Euro for their participation.

### Study 2

Participants were 31 men and 82 women ($N = 113$) aged 18–36 years ($M = 22.61$, $SD = 3.71$). Participants were allocated to erotic

[2] The hypotheses described here deviate from the preregistration in the following ways: First, we have dropped one hypothesis pertaining to an AAT measure of sexual motivation after it became clear to us that such a measure may be unsuitable for testing an association between nSex and behavior (see Janson et al., 2022; Phaf et al., 2014). Second, our wording for the affect-mediation hypothesis in the preregistration erroneously used the word "moderate" instead of mediate. Third, the preregistered hypothesis for testing motivational-arousal effects on subjective arousal and hedonic responses deviated from all other hypotheses concerning affect measures and also from the preregistered actual specification of associated statistical procedures in that it targeted between-subject affect differences in the experimental and control conditions. Although this procedure is suitable for Study 1, it does not fit the focus on within-subject comparisons of affective responses to erotic and neutral stimuli in Study 2. Lastly, we changed corresponding statistical analyses from null hypothesis significance testing to equivalent Bayesian statistics as it became apparent to be a more suitable statistical approach for our analyses.

prime ($n = 56$) and control conditions ($n = 57$). Seventy-four participants self-identified as exclusively heterosexual, 31 participants as mostly heterosexual, five participants as bisexual, and three participants as mostly homosexual. Recruitment and inclusion criteria were the same as in Study 1. Participants received 20 Euro for their participation.

## Design

Both studies featured a 2 (Experimental Condition: Erotic vs. Control Primes) × 2 (Prime Duration: 30 vs. 500 ms) × 2 (PSE Sequence: AB vs. BA) × 2 (Phase: Baseline vs. Priming) design, with the first three factors varied between subjects and the last one varied within subjects. PSE sequence served as a control factor and was intended to balance whatever differences may exist a priori (AP) between PSE picture sets A and B across levels of the other factors. Participants were randomly allocated to the cells resulting from the between-subjects factors. In Study 1, dependent variables were sexual imagery in the PSE and subjective affect. In Study 2, dependent variables were sexual imagery in the PSE, relative viewing time and key presses for erotic (vs. neutral) stimuli on the KPT, and affective responses to erotic versus neutral priming stimuli as assessed via subjective ratings of arousal and valence and EMG assessment of corrugator and zygomatic activation as well as pupil size.

## Materials and Measures

### *Stimuli*

**PSE Pictures.** Eight PSE pictures per study were used and showed heterosexual couples in ambiguous social interactions (https://osf.io/uht9f/?view_only=c90070e0bac54311a1aab629716501bc). They were selected based on their expected "pull" for nSex (Schultheiss & Pang, 2007), which means that they showed events that suggest the start of a social interaction that may lead to sexual behavior but there is nothing overtly sexual about the image. Thus, it is possible but not necessary that one writes a story that contains sexual imagery.

***Study 1.*** Set A consists of the following pictures: *woman blindfolding man* (Schultheiss et al., 2003); *trapeze artists* (Pang & Schultheiss, 2005); *couple in field*, showing a man lying on the ground with his head in the lap of a woman who reads a book; and *man on couch*, showing a man sitting on a couch and looking at a woman standing in front of him. The latter two pictures were used here for the first time and taken from newsmagazines and internet sources. Set B contains the following pictures: *nightclub scene* (Pang & Schultheiss, 2005) and the following three pictures that were used here for the first time: *couple solving crossword*, showing a man looking at a crossword puzzle and a woman leaning over him and pointing her finger on the crossword; *man feeding woman*, showing a man sitting next to a woman and feeding her with spaghetti; and *pillow fight*, showing a man and woman in underwear in bed and the woman throwing a pillow at the man. Within these sets, pictures were presented in randomized order for each participant.

***Study 2.*** Set A consists of the following pictures: *scantily clad couple*, showing a man in underpants with a woman in front of him wearing only a shirt; *flirt*, showing a woman biting her finger and sitting in front of a man; *massage*, showing a woman lying prone and a man massaging her back; and *tango dancers*, showing a man and woman who are on the dancefloor and surrounded by people. Set B contains the following pictures: *(un)dressing*, showing a man standing behind a woman and holding the zipper of her dress; *couple in bathroom*, showing a man and woman standing in front of each other in a bathroom and brushing teeth; *woman in charge*, showing a woman sitting on a couch in underwear and looking at a man standing in front of her; and *billiards*, showing a woman playing billiards and a man leaning over her. Within these sets, pictures were presented in randomized order for each participant. Upon request, we share all PSE pictures used in these studies.

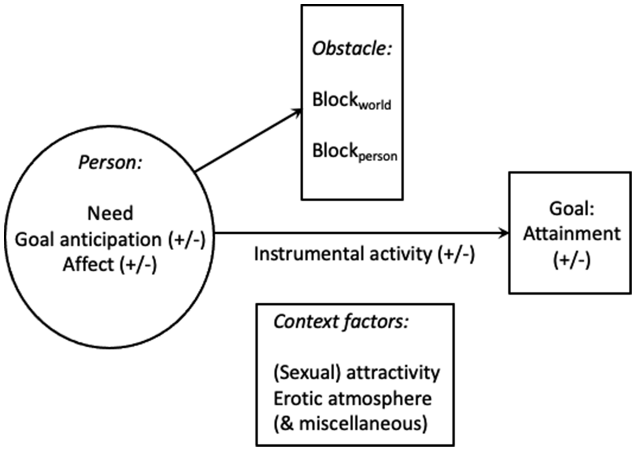
**Prime Pictures.** In both studies, prime pictures were selected from the International Affective Picture System (IAPS; Bradley & Lang, 2007) based on their arousal scores (Lang et al., 2008). For the erotic condition, the following 16 sexually arousing pictures were chosen: 4,608, 4,611, 4,651, 4,652, 4,656, 4,658, 4,659, 4,660, 4,669, 4,670, 4,672, 4,680, 4,690, 4,694, 4,695, and 4,800, with a mean arousal rating of 6.45. For the control condition, the following 16 generally arousing pictures were chosen: 8,030, 8,031, 8,034, 8,116, 8,117, 8,130, 8,160, 8,161, 8,178, 8,179, 8,180, 8,185, 8,210, 8,300, 8,370, and 8,490, with a mean arousal rating of 6.39. The mask that was presented after the prime pictures appeared consisted of snippets of prime pictures where no individuals or objects were identifiable.

### *Experimental Manipulation*

Following standard instructions for computer administration (Schultheiss & Pang, 2007), participants worked on an eight-picture PSE in both studies. Four PSE pictures were presented before the EM (i.e., baseline phase) and four pictures were presented during the EM (i.e., priming phase). On each of the four baseline trials, participants saw a mask for 70 ms, followed by a PSE picture. On each trial of the priming phase, participants saw four randomly selected prime pictures, presented consecutively, that were either displayed for 30 or 500 ms, each followed by a mask shown for 70 ms, and then a PSE picture. Sexually arousing prime pictures were shown in the erotic and generally arousing nonerotic pictures were shown in the nonerotic priming condition. During baseline and priming phases, PSE pictures were shown on a black background for 10 s and then replaced by a screen with writing instructions. Participants were asked to write their stories into a window on the screen, with the guiding questions appearing above the writing space (e.g., "What is happening?" and "Who are the persons?"). In this way, the PSE reflects people's spontaneous thought contents in response to suitable eliciting cues and is assumed to be close to spontaneously emitted behavior. After 4 min, a text appeared in the lower half of the screen asking the participants to finish the story and continue with the next trial.

**nSex Content Coding.** Following the lead of previously developed coding systems for motive assessment (e.g., McClelland et al., 1953), we devised nSex coding categories (see Supplemental 1 in the online supplemental materials) based on a motivational sequence model (see Figure 2). The sequence starts when a person experiences a desire or need. It can be followed by positive and/or negative goal anticipation. The person may then engage in instrumental activity in order to achieve the goal. Sometimes obstacles (i.e., blocks within the person or in the outside world) can prevent goal attainment. When the goal is achieved (or not), associated affective responses can be positive or negative. Accordingly, the following eight

**Figure 2**
*Motivational Sequence*




categories were created: need for sex, positive goal anticipation, negative goal anticipation, instrumental activity, obstacles, goal attainment, goal affect, and a category called "others" that includes themes of sexual imagery that are more contextual and do not easily fit the other categories. These superordinate categories are further split into a total of 35 subcategories with precise definitions (e.g., positive goal anticipation may be expressed as sexual potential, sexual arousal, sexual fantasies, or the general positive expectation that one will soon have sex). These coding rules are described in detail in an instruction manual (https://osf.io/vf8cb/) which contains positive and negative coding examples. In each study, three independent coders content-coded all PSE stories for nSex according to this coding system. According to Nunnally (1978), interrater reliabilities of .70 or better are sufficient in early research stages. Interrater reliabilities for the subcategories were, with very few exceptions, satisfactory (≥.70) to excellent (≥.90; see Supplemental 1 in the online supplemental materials).

**Content Coding of Other Motives.** All PSE stories were additionally coded by two trained coders who had previously reached at least 85% agreement with an expert coder on calibration stories for achievement, power, and affiliation imagery using Winter's (1994) manual for scoring motive imagery in running text. An example for achievement motivation is a unique accomplishment like winning the Nobel Prize. An example for power motivation is a strong, forceful action that inherently has an impact on others such as screaming and making another person cry. An example for affiliation motivation is an affiliative, companionate activity like going for a walk with a partner. In Study 1, intraclass correlations (ICC; 2,*k*) were .75 for achievement, .78 for power, and .86 for affiliation. In Study 2, ICC (2,*k*) were .72, .83, and .87, respectively.

### *Subjective Affect*

**Study 1.** We assessed subjective affective responses to experimental manipulations with the UWIST Mood Adjective Check List (UMACL; Matthews et al., 1990), a self-report questionnaire with 24 adjectives and a four-point Likert rating scale. Participants are asked to mark the response that best reflects their current affective state, with 1 being "definitely" and 4 being "definitely not." Each item starts with the statement "Right now I feel …." The UMACL consists of three subscales: hedonic tone assesses responses to motivational outcomes (i.e., reward, frustration; e.g., "happy" and "sad"), energetic arousal measures positive high activation associated with approach motivation (e.g., "active" and "passive"), and tense arousal assesses feelings of tension associated with avoidance motivation (e.g., "anxious" and "calm"). McDonald's Omega before the PSE baseline and after the PSE priming phase, respectively, were .89 and .91 for hedonic tone, .88 and .91 for energetic arousal, and .88 and.86 for tense arousal. For the statistical analyses, all items were (re)coded to be consistent with their scale name and the sum of the items for each subscale used.

**Study 2.** We used the Self-Assessment Manikin (SAM; Bradley & Lang, 1994), a measure assessing valence and arousal dimensions of individuals' affective responses on 5-point picture scales. The valence scale shows a manikin smiling on the right and a manikin making a sad face on the left end of the scale, with three intermediate expressions including a neutral midpoint in between. The arousal scale shows a strongly excited manikin on the right and a sleeping manikin on the left end of the scale, with three intermediate gradations in between. Participants were asked to rate the erotic and control prime stimuli on the SAM valence and arousal scales by clicking on the manikin version that best expressed how they felt about the stimulus. McDonald's Omega for arousal ratings in response to neutral stimuli was .93 and in response to erotic stimuli .91. McDonald's Omega for valence ratings in response to neutral stimuli of valence was .72 and in response to erotic stimuli .88. For statistical analyses, we used mean item scores for each subscale.

### *Forced-Choice Task*

In both studies, the forced-choice task (FCT) served to test to what extent primes presented for different durations were accessible to conscious awareness. The structure of the FCT was identical to the EM: first, a prime stimulus was presented, and then the mask. However, instead of four priming stimuli, only one masked priming stimulus was presented per trial. An additional difference is that the priming stimulus was followed by a choice screen instead of a PSE stimulus. Thus, participants were presented with an erotic or control prime stimulus for either 30 or 500 ms, depending on the condition participants were assigned to. Subsequently, two stimuli of the *same* category were shown side by side, one of which was the stimulus presented previously (32 trials). Afterward, two stimuli of the two *different* categories were presented side by side (32 trials). Participants then indicated which of the two stimuli they had seen before by mouse click. They were encouraged to just guess if they were not sure. In Study 1, the mean accuracy for the 30 ms condition was 68.01% ($SD = 13.09$) for same-category stimuli and 69.57% ($SD = 22.94$) for different-category stimuli. For the 500 ms condition, mean accuracy was 99.43% ($SD = 1.39$) for same-category stimuli and 99.79% ($SD = 0.80$) for different-category stimuli. In Study 2, the mean accuracy for the 30 ms condition was 70.63% ($SD = 16.01$) for same-category stimuli, and 83.13% ($SD = 17.22$) for different-category stimuli. For the 500 ms condition, mean accuracy was 99.62% ($SD = 1.18$) for same-category stimuli, and 99.95% ($SD = 0.41$) for different-category stimuli.

### *Key-Press Task*

Participants worked on the KPT only in Study 2. They were informed that the overall task duration was fixed at 4 min, regardless of their actions, but that they could control the viewing time of each individual picture by pressing keys to increase or decrease it. Erotic and control stimuli were presented in alternating order for a default time of 4 s each. Forty-eight8 sexually arousing stimuli were selected from a previously validated Portuguese database of sex pictures (EROSimag/UP-UA.pt; Carvalho et al., 2014) and 48 generally arousing nonsexual stimuli were chosen from the IAPS (Bradley & Lang, 2007). By using the up or down button on the keyboard, participants could decide if they wanted to prolong the stimulus presentation up to 8 s maximum or if they wanted to shorten it to a minimum of 1 s. Although the latter value could be realized in principle if pressing of the down button started within the first second of the presentation, a realistic lower-bound minimum was about 2 s. If participants did not use the keyboard buttons at all, a new stimulus would be presented after 4 s had elapsed. This allowed us to assess participants' "wanting" of sexual incentives specifically by measuring the average time they watched sexual pictures and invested key-press effort into this exposure, relative to their efforts to change exposure durations of neutral pictures. Note that how much effort a participant invested into increasing or decreasing viewing time for sexual stimuli on average did not predetermine how much effort she or he invested into increasing or decreasing viewing time for nonsexual stimuli; both effort parameters could thus vary independently. From KPT data we derived measures of average viewing time in milliseconds and average directional (up vs. down) key-press frequency, separately for sexual and nonsexual pictures.

## Pupillometry

In Study 2, pupil diameter (mm) was recorded using a Tobii TX300 eye tracker, at a sampling rate of 300 Hz. Pupil size was recorded when erotic and control prime stimuli (adjusted for equal luminance using Adobe Photoshop) were presented successively for 3 s each before participants were asked to rate them on the SAM. Blinks and other events that caused the device to lose pupil and corneal reflection were cleaned from raw data and the average size of both pupils was used. For baseline-correction, we subtracted pupil diameter responses to control stimuli from pupil diameter responses to erotic stimuli. Because only two of the four testing cubicles were equipped with an eye tracker, pupil size could only be assessed in 54 participants.

## Facial Responses

In Study 2, facial affective responses were assessed with EMG recorded from the skin over the corrugator and zygomaticus muscles during the 3 s when participants viewed a stimulus and before they rated it on the SAM scales. The skin was cleaned with alcohol and rubbed with a conductive EMG-gel (Nuprep), keeping impedances below 10 kΩ. The electrodes were filled with electrode paste (OneStep Cleangel) and then attached to the left side of the face, over the zygomaticus major and the corrugator supercilia muscle regions (Fridlund & Cacioppo, 1986). Ground was placed on the upper half of the forehead. Raw EMG signals were recorded with an MP150 BIOPAC system at a sampling rate of 1,000 Hz. Using AcqKnowledge 5.0, raw EMG data were filtered at a band pass of 28–500 Hz plus a notch filter at 50 Hz, followed by signal rectification. Focus areas were created for the 3 s when stimuli were presented and epoch analysis with an epoch bin width of 200 ms was applied. Finally, we used the mean scores of the 3 s period (stimulus presentation), subtracted the facial affective responses of the control stimuli from the facial affective responses of the erotic stimuli, and used the resulting difference scores in further analyses.

## Questionnaires

### Study 1

***Big Five Inventory.*** The Big Five Inventory (BFI; John & Srivastava, 1999) is a 44-item inventory that aims to assess the five-facet model personality traits of extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. Each item is scored on a 5-point Likert scale ranging from 1=*strongly disagree* to 5=*strongly agree*. Items start with the statement "I see myself as someone who …" and are completed depending on the subscale. In our study, McDonald's Omega for extraversion was .81, for agreeableness .66, for conscientiousness .74, for neuroticism .76, and for openness to experience .83. For the statistical analyses, all items were recoded, and the sum of the items for each subscale used.

### Study 2

***Big Five Inventory-10.*** The Big Five Inventory-10 (BFI-10; Rammstedt & John, 2007) is a self-report measure that includes 10 items to assess the Big Five traits with two items each. Participants were instructed to rate how well statements described them using a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*), with the introduction "I see myself as someone who …" followed by trait-specific endings. In our study, McDonald's Omega for extraversion was .77, for agreeableness .40, for conscientiousness .64, for neuroticism .60, and for openness to experiences .55. For the statistical analyses, the negatively coded items were recoded and the mean score of the items for each subscale was used.

***Sexual Inhibition/Sexual Excitation Scales—Short Form.*** The SIS/SES–Short Form (Carpenter et al., 2011; Turner et al., 2013) is a self-report questionnaire with 14 items that are answered on a 4-point Likert scale ranging from 1=*strongly disagree* to 4=*strongly agree*. It includes three factors: the SES factor involves six items and refers to how different intrapersonal (e.g., fantasies) and interpersonal (e.g., sexual partners) stimuli may enhance sexual arousal (e.g., "When a sexually attractive stranger accidentally touches me, I easily become aroused"); the SIS1 factor includes four items that depict how worries or concerns about sexual functioning may reduce or inhibit sexual arousal (e.g. "I cannot get aroused unless I focus exclusively on sexual stimulation"); and the SIS2 factor consists of four items and refers to sexual inhibition related to potential negative consequences of sexual interactions (e.g., "If I can be seen by others while having sex, I am unlikely to stay sexually aroused"). In our study, McDonald's Omega for SES was .71, for SIS1 .47, and for SIS2 .69. For statistical analyses, we used the sum of the items for each subscale.

***Revised Sociosexual Orientation Inventory.*** The SOI-R (Penke & Asendorpf, 2008) is a nine-item self-report measure that assesses sociosexual behavior, attitudes, and desire. The behavior facet includes questions related to the number of sexual partners (e.g., "With how many different partners have you had sex within the past 12 months?"). The attitude facet involves statements about the engagement in sexual relationships without deeper emotional commitment (e.g., "Sex without love is OK."). The desire facet includes questions related to the frequency of sexual fantasies and arousal with persons with whom there is no deeper emotional commitment (e.g., "How often do you have fantasies about having sex with someone you are not in a committed romantic relationship with?"). Participants are asked to answer the items on a 9-point Likert scale (ranging from 1 = "0" to 9 = "20 or more" for the behavior facet, 1 = *strongly disagree* to 9 = *strongly agree* for the attitude facet, and 1 = *never* to 9 = *at least once a day* for the desire facet). In our study, McDonald's Omega for the behavior facet was .84, for attitude fact .75, for desire facet .84, and for SOI-R overall .71. For statistical analyses, we recoded the negatively coded attitude item and used mean the score for each subscale.

## Procedure

Data collection for Study 1 took place from November to December 2008, and data collection for Study 2 took place from November to December 2018. In both studies, participants were assessed individually in the Human Motivation and Affective Neuroscience laboratory at Friedrich-Alexander-University, Erlangen, Germany. Upon arrival, participants provided written consent for participating in the research and were then seated for all subsequent testing at separate computer workstations, each equipped with a Windows PC, a 60 Hz LCD screen with 24-in. diameter, a keyboard, and a mouse. In Study 1, participants collected a saliva sample for later hormone assaying (not part of this paper) and then provided affect ratings before the baseline PSE (T1), once before (T2), and once after (T3) the priming phase. Then participants completed the FCT in the version that corresponded to their experimental condition (30 or 500 ms, with either erotic or neutral primes) after which they collected a second saliva sample. In Study 2, participants collected a saliva sample for later hormone assaying (not part of this paper) and subsequently worked on the PSE and then the KPT. Participants were then asked to collect the second saliva sample and to call the experimenter. The experimenter then attached the electrodes for facial EMG assessment. The experimenter further informed participants that their pupils would be assessed using the eye tracker and instructed them to move as little as possible. After the experimenter left, participants' responses to all priming stimuli were assessed via SAM scales and facial EMG. Participants then complete an approach-avoidance task (AAT), which we did not analyze (see footnote 2). Next, participants worked on the FCT in the version that corresponded to their experimental condition. In both studies, participants were then asked to fill out questionnaires and provide demographic information. They were debriefed and received monetary compensation.

# Results

All statistical analyses were conducted with Systat 13.00.05 and JASP 0.17.1. For our analyses, we created nSex scores in a way that examines which particular combination of nSex coding categories captures the motivational arousal effect best across both studies, but also in such a way that the mediating effect of affective changes on motive score change is strongest in order to demonstrate that the resulting score is a genuine motivational process. For this, we created the following scores using the notation of logical AND (overlap between two studies) and OR (total of two studies); EM (see Supplemental 1 in the online supplemental materials for an overview):

1. AP: as a benchmark against which we could compare empirically derived scores, we calculated the AP nSex as the sum of all nSex coding categories, excluding negative categories (i.e., negative goal anticipation, negative instrumental activity, block, negative goal attainment, negative affect, and derogation).[3]
2. EM AND: Only categories that were sensitive to EM in both studies. We operationalize sensitivity as the combination of (a) a score increasing by more than one percentage point in the arousal phase compared to the baseline in the experimental group and (b) the increase is at least two percentage points greater than the percentage increase in the control group. This combination of criteria served to ensure that a coding category showed specific sensitivity to arousal manipulations, while excluding general increases unrelated to arousal. Note that this algorithm did not capitalize on *decreases* in the control condition.
3. EM OR: All categories that were sensitive to EM either in Study 1 or in Study 2.
4. Affect: We ranked *r*s (Pearson's correlation of vector and motive score at the priming phase, residualized for baseline and PSE sequence) from Study 2, and selected the top 12 categories, which represented a third of all coding categories.
5. Affect AND EM AND: Overlap between EM AND and Affect.
6. Affect AND EM OR: Overlap between EM OR and Affect.
7. Affect OR EM AND: Total of EM AND and Affect.
8. Affect OR EM OR: Total of EM OR and Affect.

Table 1 shows that there is no evidence of a difference in word count between and within the groups (all $BF_{10} < 1$). Therefore, word count will not be considered in the following analyses.

## Hypotheses

*Hypothesis 1*: To examine whether sexual imagery increased from baseline to priming in the erotic condition (Hypothesis 1a), a Bayesian paired-samples *t* test for AP nSex was conducted (see Table 1) and showed no evidence in favor of our hypothesis in Study 1 and moderate evidence in favor of our hypothesis in Study 2. When multiplying the Bayes factors of both studies for the evidence-updating replication Bayes factor (EU *BF*; Ly et al., 2019), there was some evidence in the anecdotal range in favor of our hypothesis across both studies. For the control condition, results of the EU *BF* support our hypothesis that there is no difference in sexual imagery from baseline to priming (Hypothesis 1b; see Table 1). To test whether the erotic condition shows more sexual imagery compared to the control condition during priming (Hypothesis 1c), a Bayesian independent samples *t* test was conducted and suggested some evidence in the anecdotal range in favor of our hypothesis based on the EU *BF* across both studies (see Table 1). Likewise, the results of the EU *BF* support our hypothesis that there is no difference

[3] Sexual motivation is an affectively charged state that energizes and directs action aimed at the attainment of a reward (e.g., sexual pleasure, orgasm; Agmo & Laan, 2022). Thus, we assume that themes related to approach of sexual stimuli will unfold in the PSE due to the experimental arousal manipulation. Since the negative subcategories include themes related to avoidance of sexual stimuli, we disregard them in the a priori nSex score.

**Table 1**
*Effects of Motivational Arousal Manipulation on the nSex Scores for Study 1* ($n_{erotic}$*: 44;* $n_{control}$*: 42) and Study 2* ($n_{erotic}$*: 56;* $n_{control}$*: 57)*

| | Study 1 | | | | | | Study 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | | | T1 | | T2 | | | | | |
| Experimental condition | *M* | *SD* | *M* | *SD* | *d* | $BF_{10}$ | *M* | *SD* | *M* | *SD* | *d* | $BF_{10}$ | *Meta d* | EU $BF_{10}$ |
| AP nSex | | | | | | | | | | | | | | |
| Erotic | 4.27 | 2.98 | 5.16 | 3.66 | 0.20 | 0.64 | 7.46 | 4.42 | 8.86 | 4.26 | 0.33 | 4.32 | **0.27** | **2.76** |
| Control | 4.17 | 2.91 | 3.83 | 3.21 | −0.08 | 0.19 | 9.22 | 4.46 | 7.71 | 4.16 | −0.32 | 1.96 | **−0.21** | **0.37** |
| *D* | 0.04 | | 0.39 | | | | −0.40 | | 0.27 | | | | | |
| $BF_{10}$ | 0.23 | | 1.73 | | | | 1.44 | | 0.94 | | | | | |
| *Meta d* | | | | | | | **−0.19** | | **0.32** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.33** | | **1.63** | | | | | |
| EM AND | | | | | | | | | | | | | | |
| Erotic | 1.95 | 1.61 | 2.80 | 2.30 | 0.31 | 2.23 | 3.95 | 2.60 | 5.14 | 2.78 | 0.49 | 95.30 | **0.40** | **212.52** |
| Control | 2.36 | 2.09 | 1.83 | 1.69 | −0.23 | 0.47 | 4.94 | 2.19 | 3.87 | 2.72 | −0.39 | 6.26 | **−0.32** | **2.94** |
| *D* | −0.22 | | 0.48 | | | | −0.41 | | 0.46 | | | | | |
| $BF_{10}$ | 0.36 | | 3.56 | | | | 1.68 | | 5.60 | | | | | |
| *Meta d* | | | | | | | **−0.33** | | **0.47** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.60** | | **19.94** | | | | | |
| EM OR | | | | | | | | | | | | | | |
| Erotic | 4.42 | 3.33 | 5.25 | 3.65 | 0.17 | 0.51 | 7.29 | 4.43 | 9.10 | 4.44 | 0.43 | 27.89 | **0.30** | **14.22** |
| Control | 4.17 | 3.19 | 3.64 | 3.07 | −0.12 | 0.22 | 8.96 | 4.35 | 7.69 | 4.16 | −0.29 | 1.40 | **−0.21** | **0.31** |
| *D* | 0.08 | | 0.48 | | | | −0.38 | | 0.35 | | | | | |
| $BF_{10}$ | 0.24 | | 3.60 | | | | 1.24 | | 1.80 | | | | | |
| *Meta d* | | | | | | | **−0.16** | | **0.40** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.30** | | **6.48** | | | | | |
| Affect | | | | | | | | | | | | | | |
| Erotic | 2.44 | 1.95 | 3.48 | 2.69 | 0.33 | 2.62 | 4.33 | 2.81 | 5.49 | 3.36 | 0.45 | 38.19 | **0.36** | **100.06** |
| Control | 2.48 | 2.05 | 2.43 | 2.40 | −0.02 | 0.17 | 5.58 | 2.82 | 4.78 | 3.26 | −0.23 | 0.60 | **−0.14** | **0.10** |
| *D* | −0.02 | | 0.41 | | | | −0.44 | | 0.21 | | | | | |
| $BF_{10}$ | 0.23 | | 2.13 | | | | 2.31 | | 0.61 | | | | | |
| *Meta d* | | | | | | | **−0.24** | | **0.29** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.53** | | **1.30** | | | | | |
| Affect AND (EM AND) | | | | | | | | | | | | | | |
| Erotic | 1.43 | 1.30 | 2.11 | 1.78 | 0.36 | 3.97 | 3.02 | 2.14 | 3.72 | 2.31 | 0.34 | 5.76 | **0.34** | **22.86** |
| Control | 1.70 | 1.52 | 1.51 | 1.58 | −0.11 | 0.21 | 3.83 | 1.74 | 2.94 | 2.23 | −0.39 | 7.19 | **−0.26** | **1.51** |
| *D* | −0.19 | | 0.35 | | | | −0.41 | | 0.35 | | | | | |
| $BF_{10}$ | 0.32 | | 1.36 | | | | 1.71 | | 1.72 | | | | | |
| *Meta d* | | | | | | | **−0.31** | | **0.35** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.55** | | **2.34** | | | | | |
| Affect AND (EM OR) | | | | | | | | | | | | | | |
| Erotic | 2.39 | 1.90 | 3.42 | 2.68 | 0.33 | 2.72 | 4.32 | 2.80 | 5.45 | 3.34 | 0.43 | 28.26 | **0.38** | **76.86** |
| Control | 2.44 | 2.01 | 2.33 | 2.36 | −0.04 | 0.17 | 5.55 | 2.82 | 4.75 | 3.15 | −0.24 | 0.63 | | **0.11** |
| *D* | −0.03 | | 0.43 | | | | −0.44 | | 0.22 | | | | | |
| $BF_{10}$ | 0.23 | | 2.53 | | | | 2.16 | | 0.62 | | | | | |
| ***Meta d*** | | | | | | | **−0.25** | | **0.31** | | | | | |
| **EU $BF_{10}$** | | | | | | | **0.50** | | **1.57** | | | | | |
| Affect OR (EM AND) | | | | | | | | | | | | | | |
| Erotic | 3.09 | 2.41 | 4.23 | 3.23 | 0.28 | 1.55 | 5.32 | 3.27 | 6.95 | 3.73 | 0.56 | 459.78 | **0.42** | **712.66** |
| Control | 3.17 | 2.63 | 2.86 | 2.62 | −0.09 | 0.19 | 6.74 | 3.38 | 5.87 | 3.78 | −0.22 | 0.54 | **−0.16** | **0.10** |
| *D* | −0.03 | | 0.47 | | | | −0.43 | | 0.29 | | | | | |
| $BF_{10}$ | 0.23 | | 3.34 | | | | 1.94 | | 1.04 | | | | | |
| *Meta d* | | | | | | | **−0.24** | | **0.36** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.45** | | **3.47** | | | | | |
| Affect OR (EM OR) | | | | | | | | | | | | | | |
| Erotic | 4.47 | 3.38 | 5.31 | 3.67 | 0.17 | 0.50 | 7.30 | 4.44 | 9.14 | 4.46 | 0.44 | 32.02 | **0.31** | **16.01** |
| Control | 4.20 | 3.25 | 3.75 | 3.14 | −0.10 | 0.21 | 8.99 | 4.34 | 7.63 | 4.27 | −0.29 | 1.32 | **−0.20** | **0.28** |
| *D* | 0.08 | | 0.46 | | | | −0.39 | | 0.35 | | | | | |
| $BF_{10}$ | 0.24 | | 3.07 | | | | 1.29 | | 1.74 | | | | | |
| *Meta d* | | | | | | | **−0.17** | | **0.39** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.31** | | **5.34** | | | | | |

(*table continues*)

**Table 1** (*continued*)

| | Study 1 | | | | | | Study 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | | | T1 | | T2 | | | | | |
| Experimental condition | *M* | *SD* | *M* | *SD* | *d* | $BF_{10}$ | *M* | *SD* | *M* | *SD* | *d* | $BF_{10}$ | *Meta d* | EU $BF_{10}$ |
| Word count | | | | | | | | | | | | | | |
| Erotic | 365.23 | 102.61 | 370.89 | 111.40 | 0.11 | 0.21 | 397.09 | 111.59 | 388.04 | 116.09 | −0.15 | 0.27 | **−0.03** | **0.06** |
| Control | 367.36 | 96.37 | 372.10 | 105.27 | 0.10 | 0.20 | 438.46 | 122.62 | 438.81 | 116.27 | 0.01 | 0.15 | **0.05** | **0.03** |
| *D* | −0.02 | | −0.01 | | | | −0.35 | | −0.44 | | | | | |
| $BF_{10}$ | 0.23 | | 0.22 | | | | 0.96 | | 0.06 | | | | | |
| *Meta d* | | | | | | | **−0.20** | | **−0.24** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.22** | | **0.01** | | | | | |

*Note.* Bold values represent summary effect sizes. AP = a priori; nSex = need for sex; EM = experimental manipulation; $BF_{10}$ = evidence in favor of alternative hypothesis Erotic ≠ Control; *Meta d* = Cumming's unbiased *d*, meta-analytically combined via exploratory software for confidence intervals (Cumming, 2011), using single-group calculation for within-group contrasts and two-group calculations for between-group contrasts; EU $BF_{10}$ = evidence updating replication Bayes factor.



in sexual imagery between the erotic and control condition at baseline (see Table 1).

For Study 1, a Bayesian repeated measures analysis of variance (ANOVA) for the AP nSex score that included phase, experimental condition, prime duration, and PSE sequence as well as terms up to their three-way interactions as factors resulted in $BF_m = 7.73$ for a model that included the interaction terms of phase with an experimental condition, PSE sequence, and prime duration (although this was not the best-fitting model overall) and in Study 2, the best-fitting model was one that included the Phase × Experimental condition and Phase × PSE sequence effects, $BF_m = 52.41$. The analysis of individual effects indicated that in Study 1 there was evidence for the Phase × PSE sequence, $BF_{\text{Inclusion}} > 1{,}000$, but equivocal evidence for the Phase × Experimental condition effect, $BF_{\text{Inclusion}} = 0.99$ (all other $BF_{\text{Inclusion}} < 2$), and in Study 2 there was evidence for the Phase × Experimental condition effect, $BF_{\text{Inclusion}} = 380.54$, and the Phase × PSE sequence effect, $BF_{\text{Inclusion}} > 1{,}000$ (all other $BF_{\text{Inclusion}} < 1$).

Table 1 shows the effect of the motivational arousal manipulation on the other nSex scores and suggests that specifically the EM AND, Affect, as well as Affect OR (EM AND) nSex score, show the strongest arousal manipulation effect across both studies (all EU $BF_{10} > 100$). Particularly the Affect score shows some evidence in the anecdotal range in Study 1 and extreme evidence in Study 2 supporting our hypothesis that there is an increase from the baseline to the priming phase in the erotic condition (Hypothesis 1a). Similarly, the results support our hypothesis that there is no difference in sexual imagery from baseline to priming in the control condition (Hypothesis 1b). Additionally, there is some evidence in the anecdotal range in favor of our hypothesis that the erotic condition shows more sexual imagery compared to the control condition during priming (Hypothesis 1c). Likewise, the results support our hypothesis that there is no difference in sexual imagery between the erotic and control condition at baseline (Hypothesis 1d).

For Study 1, a Bayesian repeated measures ANOVA for the Affect score that included phase, experimental condition, prime duration, and PSE sequence as well as terms up to their three-way interactions as factors resulted in $BF_m = 15.86$ for a model that included the interaction terms of phase with an experimental condition, PSE sequence, and prime duration (although this was not the best-fitting model overall) and in Study 2, the best-fitting model was one that included the phase × experimental condition and Phase × PSE sequence effects, $BF_m = 48.98$. Analyses of individual effects indicated that in Study 1 there was evidence for the Phase × PSE sequence, $BF_{\text{Inclusion}} > 1{,}000$, but equivocal evidence for the phase × experimental condition effect, $BF_{\text{Inclusion}} = 1.93$ (all other $BF_{\text{Inclusion}} < 3$), and in Study 2 there was evidence for the phase × experimental condition effect, $BF_{\text{Inclusion}} = 80.64$, and the Phase × PSE sequence effect, $BF_{\text{Inclusion}} > 1{,}000$ (all other $BF_{\text{Inclusion}} < 2$).

*Hypothesis 2a*: Bayesian repeated measures ANOVA for the UMACL subscales that included phase, experimental condition, and prime duration as well as terms up to their three-way interactions as factors resulted in all $BF_M < 0.03$ for a model that included the interaction terms of phase with the experimental condition and prime duration (although these were not the best-fitting model overall). The best-fitting models were in fact the null models (all $BF_M > 7.40$). These results suggest no evidence of any effect on the UMACL subscales (see Table 2 for means and standard deviations).

Hypotheses 2b–5 examined subjective (arousal and valence) and physiological (corrugator, zygomaticus, and pupillometry) affect

**Table 2**

*Mean Scores (*SD*) of UMACL Subscales as a Function of Experimental Condition, Phase, and Priming Duration for Study 1 (*$n_{erotic,\ 30\ ms}$*: 20;* $n_{erotic,\ 500\ ms}$*: 24;* $n_{control,\ 30\ ms}$*: 22;* $n_{control,\ 500\ ms}$*: 20)*

| | Erotic | | Control | |
|---|---|---|---|---|
| Prime duration | Baseline | Priming | Baseline | Priming |
| Hedonic tone | | | | |
| 30 ms | 24.95 (3.93) | 24.15 (4.11) | 25.18 (5.40) | 25.05 (5.51) |
| 500 ms | 24.58 (4.52) | 24.17 (4.442) | 25.75 (4.18) | 24.75 (4.33) |
| Energetic arousal | | | | |
| 30 ms | 21.65 (4.61) | 21.50 (4.06) | 23.46 (4.979 | 23.73 (4.55) |
| 500 ms | 23.00 (4.09) | 22.92 (4.43) | 22.30 (4.89) | 23.50 (5.97) |
| Tense arousal | | | | |
| 30 ms | 16.15 (4.38) | 17.45 (4.71) | 18.18 (5.22) | 16.14 (4.96) |
| 500 ms | 17.25 (4.47) | 16.13 (3.56) | 16.35 (4.71) | 17.15 (3.88) |

*Note.* UMACL = UWIST Mood Adjective Check List.

in response to erotic versus control stimuli in Study 2. Results are given in Table 3 and indicate that there is extreme evidence for a difference in affective responses to erotic versus control stimuli in all measures except for subjective valence. Therefore, subjective valence will not be considered a mediator in the following analyses. In line with our hypotheses, the data support the notion that pupil dilation and subjective arousal are greater in response to erotic stimuli in comparison to the control stimuli. Unexpectedly, our findings suggest that participants show more corrugator activity and less zygomaticus activity in response to erotic stimuli compared to control stimuli.

We additionally created composite measures over the three measures (corrugator, zygomaticus, and SAM arousal) that both showed EM effects and represented almost the entire sample. To do so, for each measure and each stimulus condition, we first subtracted the separate averaged responses to erotic and control stimuli from each individual's response on that measure and then divided the result by the standard deviation of the averaged responses to erotic and control stimuli on the measure. This yielded, for each measure, two variables that expressed how strongly, in terms of SD units, a person's response to erotic and control stimuli, respectively, deviated from the average of these responses. Next, we averaged these deviation variables across corrugator, zygomatic, and SAM arousal measures for erotic and for control stimuli to arrive at composite variables of affective responses. These composites differed reliably between conditions (see Table 3).

**Table 3**

*Test of Affective Responses to Erotic Versus Control Stimuli for Study 2*

| Stimulus type | *M* | *SD* | *N* |
|---|---|---|---|
| Corrugator | | | |
| Erotic | 0.000077 | 0.00019 | 93 |
| Control | −0.000051 | 0.00016 | 93 |
| *D* | | −0.45 | |
| $BF_{-0}$ | | 0.02 | |
| $BF_{10}$ | | 6,921.08 | |
| Zygomaticus | | | |
| Erotic | −0.00022 | 0.00046 | 91 |
| Control | 0.00012 | 0.00063 | 91 |
| *D* | | 0.40 | |
| $BF_{+0}$ | | 0.02 | |
| $BF_{10}$ | | 533.28 | |
| Pupillometry | | | |
| Erotic | 0.04 | 0.06 | 54 |
| Control | −0.04 | 0.06 | 54 |
| *D* | | −1.46 | |
| $BF_{+0}$ | | >1,000,000.00 | |
| $BF_{10}$ | | >1,000,000.00 | |
| SAM arousal | | | |
| Erotic | 2.86 | 0.79 | 100 |
| Control | 2.25 | 0.85 | 100 |
| *D* | | −0.59 | |
| $BF_{+0}$ | | 410,470.43 | |
| $BF_{10}$ | | 205,235.22 | |
| SAM valence | | | |
| Erotic | 3.36 | 0.64 | 100 |
| Control | 3.45 | 0.48 | 100 |
| *D* | | −0.11 | |
| $BF_{+0}$ | | 0.06 | |
| $BF_{10}$ | | 0.21 | |
| Composite | | | |
| Erotic | −1.00 | 0.46 | 103 |
| Control | −1.24 | 0.38 | 103 |
| *D* | | 0.56 | |
| $BF_{+0}$ | | 181,744.46 | |
| $BF_{10}$ | | 90,872.24 | |

*Note.* Composite = subtraction of the separate averaged responses to erotic and control stimuli for each measure from the individual response and division of the result by the standard deviation of the averaged responses to erotic and control stimuli (for corrugator, zygomaticus, and subjective arousal); $BF_{-0}$ = evidence in favor of alternative hypothesis erotic < control. $BF_{+0}$ = evidence in favor of alternative hypothesis erotic > control; $BF_{10}$ = evidence in favor of alternative hypothesis erotic ≠ control; SAM = Self-Assessment Manikin.

Table 4 shows the correlations between measures of affect and the KPT. Since the correlations between viewing time and key presses of the KPT are alike, we will present results of viewing time only in the following analyses; results of the key presses can be found in Supplemental 2 in the online supplemental materials.

> *Hypothesis 6*: Mediation analyses were conducted in order to test whether changes in affect in response to erotic versus control stimuli (Hypotheses 2–5) mediate the predicted experimental arousal effect on the nSex scores in Study 2 (see Table 5). Because affective responses to the erotic versus control stimuli were tested in a within-subjects design and nSex changes in a between-subjects design, we deviated from typical mediation testing (i.e., because no classical between-subjects $a \times b$ mediation path exists) by conducting simple linear regressions. Table 5 shows that corrugator, zygomaticus, and subjective arousal seem suitable as mediators (although the main effects of corrugator and zygomaticus activity were in the wrong direction, mediation analyses are in the right direction). Therefore, we created a new variable, called total vector, that combines all relevant affect mediators (i.e., we first $z$-standardized the three mediators and then averaged them). Results suggest that the mediation works for all nSex scores and is especially strong for Affect nSex (largest decrement of *sr* from *c* to *c*′).

Taken together, our results indicate that the Affect nSex score is specifically sensitive to the EM and to the affect mediation. For

**Table 4**

*Pearson's ρ for Difference Scores of Erotic and Control Stimuli for Study 2*

| Difference score | 1 | 2 | 3 | 4 | 5 | 6 | *N* |
|---|---|---|---|---|---|---|---|
| 1. Corrugator | — | | | | | | 93 |
| 2. Zygomaticus | −.22 | — | | | | | 91 |
| 3. Pupillometry | .03 | .12 | — | | | | 54 |
| 4. SAM arousal | −.33[a] | .05 | .08 | — | | | 100 |
| 5. SAM valence | −.32[a] | .10 | −.17 | .45[b] | — | | 100 |
| 6. KPT VT | −.31[a] | .08 | .08 | .57[b] | .60[b] | — | 113 |
| 7. KPT KP | −.31[a] | .08 | .08 | .57[b] | .60[b] | 1.00[b] | 113 |

*Note.* SAM=Self-Assessment Manikin; KPT VT = key-press task viewing time; KPT KP = key-press task key presses.
[a] $BF_{10}$ = 10–100. [b] $BF_{10}$ > 100.

**Table 5**
*Mediation of Change in Affect on the Relationship Between EM and Change in PSE for Study 2*

| Mediation path | EM AND | EM OR | Affect | Affect AND (EM AND) | Affect AND (EM OR) | Affect OR (EM AND) | Affect OR (EM OR) |
|---|---|---|---|---|---|---|---|
| Corrugator | | | | | | | |
| *B* | $b = 2{,}963.60$, $SE = 1{,}219.06$, $sr = 0.20$* | $b = 3{,}430.61$, $SE = 1{,}677.41$, $sr = -0.16$* | $b = 2{,}979.47$, $SE = 1{,}378.96$, $sr = 0.17$* | $b = 2{,}467.49$, $SE = 1{,}005.64$, $sr = -0.21$* | $b = 3{,}070.37$, $SE = 1{,}361.62$, $sr = -0.18$* | $b = 3{,}393.27$, $SE = 1{,}520.08$, $sr = -0.18$* | $b = 3{,}349.23$, $SE = 1{,}707.54$, $sr = 0.15$ |
| *C* | $b = 2.27$, $SE = 0.51$, $sr = 0.38$*** | $b = 3.07$, $SE = 0.70$, $sr = 0.34$*** | $b = 1.86$, $SE = 0.58$, $sr = 0.26$** | $b = 1.59$, $SE = 0.42$, $sr = 0.33$*** | $b = 1.81$, $SE = 0.58$, $sr = 0.26$** | $b = 2.42$, $SE = 0.64$, $sr = 0.31$*** | $B = 3.10$, $SE = 0.71$, $sr = 0.34$*** |
| *C′* | $b = 2.05$, $SE = 0.50$, $sr = 0.34$*** | $b = 2.81$, $SE = 0.70$, $sr = 0.31$*** | $b = 1.64$, $SE = 0.58$, $sr = 0.23$** | $b = 1.41$, $SE = 0.42$, $sr = 0.28$** | $b = 1.459$, $SE = 0.57$, $sr = 0.23$** | $B = 2.17$, $SE = 0.63$, $sr = 0.27$*** | $b = 2.85$, $SE = 0.71$, $sr = 0.31$*** |
| Zygomaticus | | | | | | | |
| *B* | $b = 871.92$, $SE = 391.43$, $sr = 0.19$* | $b = 1{,}047.11$, $SE = 535.41$, $sr = 0.16$ | $b = 1{,}205.53$, $SE = 328.92$, $sr = 0.23$** | $b = 1{,}020.50$, $SE = 314.89$, $sr = 0.27$** | $b = 1{,}164.19$, $SE = 423.06$, $sr = 0.23$** | $b = 1{,}106.60$, $SE = 482.42$, $sr = 0.19$* | $b = 1{,}085.34$, $SE = 544.99$, $sr = 0.16$ |
| *C* | $b = 2.29$, $SE = 0.52$, $sr = 0.39$*** | $b = 2.98$, $SE = 0.70$, $sr = 0.34$*** | $b = 1.76$, $SE = 0.58$, $sr = 0.26$** | $b = 1.64$, $SE = 0.43$, $sr = 0.34$*** | $b = 1.72$, $SE = 0.57$, $sr = 0.26$** | $b = 2.32$, $SE = 0.64$, $sr = 0.30$*** | $b = 3.00$, $SE = 0.72$, $sr = 0.34$*** |
| *C′* | $b = 2.19$, $SE = 0.51$, $sr = 0.37$*** | $b = 2.86$, $SE = 0.70$, $sr = 0.33$*** | $b = 1.64$, $SE = 0.456$, $sr = 0.24$** | $b = 1.55$, $SE = 0.41$, $sr = 0.32$*** | $b = 1.61$, $SE = 0.55$, $sr = 0.24$** | $b = 2.18$, $SE = 0.63$, $sr = 0.28$*** | $b = 2.88$, $SE = 0.71$, $sr = 0.32$*** |
| Pupillometry | | | | | | | |
| *B* | $b = -2.62$, $SE = 5.67$, $sr = -0.05$ | $b = 5.57$, $SE = 7.97$, $sr = 0.07$ | $b = 2.89$, $SE = 7.341$, $sr = 0.05$ | $b = 4.18$, $SE = 5.38$, $sr = 0.09$ | $b = 3.06$, $SE = 7.38$, $sr = 0.05$ | $b = -4.72$, $SE = 7.53$, $sr = -0.07$ | $b = 5.42$, $SE = 8.00$, $sr = 0.07$ |
| *C* | $b = 2.18$, $SE = 0.58$, $sr = 0.39$*** | $b = 2.54$, $SE = 0.82$, $sr = 0.32$** | $b = 1.71$, $SE = 0.76$, $sr = 0.27$* | $b = 1.80$, $SE = 0.56$, $sr = 0.37$** | $b = 1.73$, $SE = 0.76$, $sr = 0.27$* | $b = 2.01$, $SE = 0.78$, $sr = 0.28$* | $b = 2.52$, $SE = 0.82$, $sr = 0.32$** |
| *C′* | $b = 2.19$, $SE = 0.59$, $sr = 0.39$*** | $b = 2.51$, $SE = 0.83$, $sr = 0.32$** | $b = 1.70$, $SE = 0.77$, $sr = 0.27$* | $b = 1.79$, $SE = 0.56$, $sr = 0.37$** | $b = 1.73$, $SE = 0.77$, $sr = 0.27$* | $b = 2.03$, $SE = 0.79$, $sr = 0.29$* | $b = 2.49$, $SE = 0.83$, $sr = 0.31$** |
| SAM arousal | | | | | | | |
| *B* | $b = 0.33$, $SE = 0.25$, $sr = 0.11$ | $b = 0.77$, $SE = 0.34$, $sr = 0.17$* | $b = 1.11$, $SE = 0.26$, $sr = 0.32$*** | $b = 0.49$, $SE = 0.20$, $sr = 0.20$* | $b = 1.09$, $SE = 0.26$, $sr = 0.32$*** | $b = 0.97$, $SE = 0.30$, $sr = 0.24$** | $b = 0.80$, $SE = 0.34$, $sr = 0.17$* |
| *C* | $b = 2.14$, $SE = 0.49$, $sr = 0.37$*** | $b = 2.97$, $SE = 0.68$, $sr = 0.33$*** | $b = 1.81$, $SE = 0.56$, $sr = 0.26$*** | $b = 1.48$, $SE = 0.42$, $sr = 0.31$*** | $b = 1.77$, $SE = 0.56$, $sr = 0.26$* | $b = 2.37$, $SE = 0.61$, $sr = 0.30$*** | $b = 3.00$, $SE = 0.69$, $sr = 0.33$*** |
| *C′* | $b = 1.97$, $SE = 0.51$, $sr = 0.32$*** | $b = 2.56$, $SE = 0.69$, $sr = 0.27$*** | $b = 1.22$, $SE = 0.54$, $sr = 0.17$** | $b = 1.24$, $SE = 0.42$, $sr = 0.25$** | $b = 1.19$, $SE = 0.53$, $sr = 0.17$* | $b = 1.85$, $SE = 0.60$, $sr = 0.23$** | $b = 2.57$, $SE = 0.70$, $sr = 0.27$*** |
| Total vector | | | | | | | |
| *B* | $b = 1.04$, $SE = 0.35$, $sr = 0.24$** | $b = 1.55$, $SE = 0.48$, $sr = 0.23$** | $b = 1.79$, $SE = 0.37$, $sr = 0.35$*** | $b = 1.51$, $SE = 0.28$, $sr = 0.33$*** | $b = 1.78$, $SE = 0.36$, $sr = 0.35$*** | $b = 1.72$, $SE = 0.42$, $sr = 0.29$*** | $b = 1.57$, $SE = 0.49$, $sr = 0.23$** |
| *C* | $b = 2.10$, $SE = 0.49$, $sr = 0.36$*** | $b = 2.92$, $SE = 0.67$, $sr = 0.33$*** | $b = 1.77$, $SE = 0.55$, $sr = 0.26$** | $b = 1.45$, $SE = 0.41$, $sr = 0.30$*** | $b = 1.72$, $SE = 0.54$, $sr = 0.25$** | $b = 2.30$, $SE = 0.60$, $sr = 0.30$*** | $b = 2.96$, $SE = 0.68$, $sr = 0.33$*** |
| *C′* | $b = 1.73$, $SE = 0.48$, $sr = 0.28$*** | $b = 2.36$, $SE = 0.66$, $sr = 0.25$*** | $b = 1.13$, $SE = 0.51$, $sr = 0.16$* | $b = 1.06$, $SE = 0.39$, $sr = 0.21$** | $b = 1.09$, $SE = 0.51$, $sr = 0.16$** | $b = 1.66$, $SE = 0.58$, $sr = 0.21$** | $b = 2.39$, $SE = 0.67$, $sr = 0.25$*** |

*Note.* EM = experimental manipulation; PSE = picture-story exercise; SAM = Self-Assessment Manikin; Total vector = average of $z$-standardization of mediators (corrugator, zygomaticus, and subjective arousal).
* $p < .05$; ** $p < .01$; *** $p < .001$.

the following analyses, in addition to the AP nSex score, we will use the Affect nSex score as our optimized nSex score, because it is the one score that is maximally sensitive to both the EM and the affect mediation.

*Hypothesis 7*: To test whether participants in the erotic condition will show longer viewing time of erotic stimuli than participants in the control condition in Study 2, a Bayesian repeated measures ANOVA was conducted that included stimulus type and experimental condition as a factor as well as prime duration as a covariate and suggested that the best-fitting model was one that included stimulus type, $BF_m = 5.07$. The analysis of individual effects indicated that there was no evidence in favor of our hypothesis, $BF_{\text{Inclusion}} < 2$. Thus, we obtained no evidence to support a direct effect of EM on KPT viewing time for erotic and nonerotic stimuli. Results using key presses of the KPT are similar.

*Hypothesis 8*: To examine whether AP nSex predicts increased viewing time for erotic stimuli in Study 2, a Bayesian multiple linear regression was conducted and showed that the best-fitting model was the one that included sexual imagery during priming, $BF_M = 10.81$, $R^2 = 0.12$. Similarly, when we used optimized nSex, the best-fitting model was the one that included sexual imagery at priming, $BF_M = 14.99$, $R^2 = 0.15$. The data show strong evidence for our hypothesis that nSex predicts increased viewing time for erotic stimuli. Results using key presses of the KPT were similar.

*Hypothesis 9*: To investigate whether AP nSex is a mediator between the experimental condition and viewing time for erotic stimuli in Study 2, we conducted a mediation analysis with nSex during priming as a mediator, experimental condition as a predictor, and PSE sequence, prime duration, and nSex at baseline as covariates. Results are shown in Table 6 (upper part) and suggest that nSex is a mediator of the relationship between experimental condition and relative viewing time of erotic stimuli. The same mediation analysis was repeated with the optimized nSex score, with similar results (see Table 6, lower part).

## Discriminant and Convergent Validity

Table 7 shows that the motivational arousal manipulation had no effect on nPower, nAffiliation, and nAchievement across both studies, providing evidence for the discriminant validity of our nSex arousal procedure. We also examined the overlap of *dispositional* nSex (i.e., nSex assessed before the EM took place) with dispositional nPower, nAchievement, and nAffiliation. All dispositional scores were residualized for word count and PSE sequence. The correlations can be found in Table 8 for Study 1 and Table 9 for Study 2 and show little evidence for variance overlap by effect size ($r$s < |.20|) and Bayesian ($BF_{10} < 3$) criteria, except for a slight overlap with nAffiliation in the anecdotal range.

Lastly, we investigated the overlap between dispositional nSex and a self-report measure of the Big Five traits in Studies 1 and 2 (see Supplemental 3 in the online supplemental materials for Study 2), and the global score and all subscales of the SOI-R as well as with the SES of the SIS/SES in Study 2. Tables 8 and 9 suggest that there is no evidence for the convergence of nSex with the subscales of the Big Five, SOI-R, or SIS/SES (all $r$s < |.20| and all $BF_{10} < 3$).

**Table 6**
*Mediation Analyses for the Experimental Manipulation → Measure (nSex T2) → Criterion (Viewing Time for Erotic Stimuli) Path*

| Effect | *B* | *SE* | 95% CI | *p* |
|---|---|---|---|---|
| | | AP nSex | | |
| Direct effect | 4.65 | 5.63 | [−6.39, 15.89] | .40 |
| Indirect effect | 4.59 | 2.18 | [0.32, 8.86] | .03 |
| Total effect | 9.24 | 5.57 | [−1.68, 20.15] | .09 |
| | | Optimized nSex | | |
| Direct effect | 5.92 | 5.56 | [−4.96, 16.80] | .35 |
| Indirect effect | 4.16 | 2.02 | [0.11, 8.20] | .04 |
| Total effect | 10.07 | 5.51 | [−0.72, 20.97] | .07 |

*Note*. AP = a priori; nSex = need for sex; CI = confidence interval. Delta method standard errors, bias-corrected percentile bootstrap CIs with 1,000 replications, maximum likelihood estimator.

## Discussion

Studies 1 and 2 represent the first attempt to develop a picture-story measure of sexual motivation that is not only causally valid in the sense of McClelland (1958) and Borsboom et al. (2004) but also reflects motivation properly and predicts relevant outcomes. For this, we tested the EMMIC validation model (Figure 1) step by step. First, we found that priming participants with erotic compared to control stimuli increases sexual imagery in stories written in response to ambiguous pictures of social interactions. Second, in Study 2, we showed that participants' affective responses differed in response to erotic and control stimuli and that some affective measures (i.e., corrugator, zygomaticus, and subjective arousal) mediate the relationship between EM and changes in sexual imagery. Third, we did not find that erotically primed individual show longer relative viewing time (or more key presses) for erotic stimuli than control prime individuals (i.e., our behavioral criterion). However, we did find that nSex predicts increased viewing time (and more key presses) for erotic stimuli and that it mediates the effect of experimental conditions on relative viewing time for erotic stimuli. Fourth, we found evidence for the discriminant validity of the nSex arousal procedure.

Across two studies, we found that priming individuals with erotic compared to control stimuli resulted in greater sexual imagery in the PSE. Effect size estimates and Bayes Factors in Study 1 were smaller than in Study 2 for all nSex scores. This may be due to the different PSE stimuli used in both studies. Specifically, the PSE pictures in Study 2 may have had a stronger potential to "pull" for nSex (Schultheiss & Pang, 2007) compared to those in Study 1. Additionally, the effect sizes of empirically derived nSex scores were all greater than our AP nSex scores in both studies. Specifically, the affect score appeared to deliver the best results in the sense that it yielded evidence of experimental motivational arousal across both studies (which the AP score did not in Study 1) and performed well in all other analyses. However, it needs to be noted that this is only a provisional optimized nSex score. Replication studies are necessary to identify those subcategories that are suitable across samples and arousal procedures to arrive at a final nSex coding system. In addition, our findings hold for two prime durations, 30 and 500 ms, although participants more frequently responded correctly to the 500 ms primes than the 30 ms primes in an FCT. This indicates that variations in conscious

**Table 7**

*Effects of Motivational Arousal Manipulation on nPower, nAchievement, and nAffiliation for Study 1 ($n_{arousal}$: 44; $n_{control}$: 42) and Study 2 ($n_{arousal}$: 56; $n_{control}$: 57)*

| | Study 1 | | | | | | Study 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | | | T1 | | T2 | | | | | |
| Experimental condition | *M* | *SD* | *M* | *SD* | *d* | $BF_{10}$ | *M* | *SD* | *M* | *SD* | *d* | $BF_{10}$ | *Meta d* | EU $BF_{10}$ |
| nPower | | | | | | | | | | | | | | |
| Erotic | 2.91 | 1.67 | 2.84 | 1.54 | −0.03 | 0.17 | 3.19 | 2.13 | 3.69 | 2.43 | 0.17 | 0.30 | **0.08** | **0.05** |
| Control | 2.94 | 1.84 | 2.60 | 2.00 | −0.15 | 0.26 | 3.76 | 3.16 | 4.31 | 3.28 | 0.18 | 0.35 | **0.02** | **0.09** |
| *d* | −0.02 | | 0.14 | | | | −0.21 | | −0.21 | | | | | |
| $BF_{10}$ | 0.23 | | 0.39 | | | | 0.36 | | 0.10 | | | | | |
| *Meta d* | | | | | | | **−0.13** | | **−0.05** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.08** | | **0.04** | | | | | |
| nAchievement | | | | | | | | | | | | | | |
| Erotic | 0.93 | 0.99 | 0.95 | 1.50 | 0.01 | 0.16 | 1.08 | 1.28 | 1.46 | 1.57 | 0.18 | 0.34 | **0.10** | **0.05** |
| Control | 0.83 | 0.81 | 0.93 | 1.12 | 0.07 | 0.18 | 1.25 | 1.59 | 1.53 | 1.86 | 0.11 | 0.20 | **0.09** | **0.04** |
| *d* | 0.11 | | 0.02 | | | | −0.11 | | −0.04 | | | | | |
| $BF_{10}$ | 0.25 | | 0.24 | | | | 0.24 | | 0.17 | | | | | |
| *Meta d* | | | | | | | **−0.02** | | **−0.01** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.06** | | **0.04** | | | | | |
| nAffiliation | | | | | | | | | | | | | | |
| Erotic | 6.06 | 3.00 | 5.66 | 2.91 | −0.09 | 0.19 | 13.96 | 4.95 | 13.23 | 4.63 | −0.18 | 0.34 | **−0.14** | **0.06** |
| Control | 6.23 | 2.98 | 5.86 | 3.03 | −0.09 | 0.19 | 14.67 | 5.44 | 13.68 | 5.00 | −0.19 | 0.38 | **−0.14** | **0.07** |
| *d* | −0.06 | | −0.07 | | | | −0.14 | | −0.09 | | | | | |
| $BF_{10}$ | 0.23 | | 0.18 | | | | 0.25 | | 0.14 | | | | | |
| *Meta d* | | | | | | | **−0.11** | | **−0.08** | | | | | |
| EU $BF_{10}$ | | | | | | | **0.06** | | **0.03** | | | | | |

*Note.* Bold values represent summary effect sizes. nPower = need for power; $BF_{10}$ = evidence in favor of alternative hypothesis Erotic ≠ Control; *Meta d* = Cumming's unbiased *d*, meta-analytically combined via exploratory software for confidence intervals (Cumming, 2011), using single-group calculation for within-group contrasts and two-group calculations for between-group contrasts; EU $BF_{10}$ = evidence updating replication Bayes factor.

awareness of the primes may not play an important role in the arousal manipulation of the PSE.

In line with expectations, in Study 2, participants reported more subjective arousal in response to erotic compared to control stimuli. Participants also showed greater pupil dilation, a marker of emotional arousal (Bradley et al., 2008), in response to erotic compared to control stimuli. In terms of emotional valence, our findings were contrary to what we had expected: participants did not rate erotic stimuli as higher in valence than nonerotic stimuli, and they even responded with more corrugator and less zygomatic activation to the former than the latter. These findings therefore contradict the idea that erotic stimuli are generally perceived as more pleasant than nonerotic stimuli. They also seem to deviate from previous reports that observed higher pleasure responses on subjective and facial EMG measures to erotic versus neutral stimuli (e.g., Lang et al., 1993). However, we note that Lang et al. (1993) also observed an increase in corrugator activity elicited by many of the erotic pictures we used in the present study, and paradoxical effects of sexual stimuli have been observed by others, too (e.g., Janssen et al., 2000). We tentatively explain their and our results with the observation that cognitive conflicts elicit corrugator activity increases and zygomatic activity decreases (Berger et al., 2020).

**Table 8**

*Pearson's ρ for Dispositional nSex, nPower, nAffiliation, nAchievement, and Subscales of BFI for Study 1*

| Measure | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. AP nSex | — | | | | | | | | |
| 2. nSex | 0.88[c] | — | | | | | | | |
| 3. nPower | 0.08 | 0.08 | — | | | | | | |
| 4. nAffiliation | 0.18 | 0.20 | −0.39[b] | — | | | | | |
| 5. nAchievement | −0.07 | −0.04 | −0.02 | −0.06 | — | | | | |
| 6. Agreeableness | −0.07 | −0.08 | 0.11 | −0.05 | 0.00 | — | | | |
| 7. Conscientiousness | 0.17 | 0.12 | 0.00 | 0.08 | 0.10 | −0.14 | — | | |
| 8. Extraversion | 0.13 | 0.04 | −0.12 | −0.07 | 0.07 | −0.03 | 0.07 | — | |
| 9. Neuroticism | 0.11 | 0.10 | 0.02 | 0.11 | 0.01 | −0.15 | −0.01 | −0.11 | — |
| 10. Openness | −0.02 | −0.09 | 0.02 | 0.08 | −0.04 | −0.12 | −0.04 | 0.26[a] | −0.22 |

*Note.* AP = a priori; nSex = need for sex; nPower = need for power; BFI=Big Five Inventory.
[a] $BF_{10}$ = 3–10. [b] $BF_{10}$ = 10–100. [c] $BF_{10}$ > 100.

**Table 9**
*Pearson's ρ for nSex, SOI-R, and SIS/SES for Study 2*

| Measure | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. AP nSex | — | | | | | | | | | | |
| 2. nSex | .88[c] | — | | | | | | | | | |
| 3. nPower | .14 | .17 | — | | | | | | | | |
| 4. nAffiliation | .23 | .24 | −.25[a] | — | | | | | | | |
| 5. nAchievement | −.13 | −.12 | .08 | −.23 | — | | | | | | |
| 6. SOI-R | .02 | −.02 | −.14 | −.03 | −.02 | — | | | | | |
| 7. SOI-R_A | −.08 | −.09 | −.20 | −.03 | −.01 | .78[c] | — | | | | |
| 8. SOI-R_B | −.09 | −.10 | −.27[a] | .03 | −.08 | .63[c] | .40[c] | — | | | |
| 9. SOI-R_D | .18 | .14 | .06 | .02 | −.01 | .59[c] | .16 | −.15 | — | | |
| 10. SES | .10 | .16 | −.003 | .20 | −.11 | .26[a] | .21 | −.02 | .40[c] | — | |
| 11. SIS1 | .02 | .02 | .02 | −.05 | .05 | −.05 | −.01 | .04 | −.10 | .05 | — |
| 12. SIS2 | .08 | .05 | −.03 | −.11 | .06 | −.18 | −.19 | −.30[b] | −.04 | −.04 | .24[a] |

*Note.* SIS = sexual inhibition scale; SES = sexual excitation scale; AP = a priori; nSex = need for sex; nPower = need for power; SOI-R = revised sociosexual orientation inventory; SOI-R_A = SOI-R attitude scale; SOI-R_B = SOI-R behavior scale; SOI-R_D = SOI-R desire scale.
[a] $BF_{10}$ = 3–10. [b] $BF_{10}$ = 10–100. [c] $BF_{10} > 100$.

According to this interpretation, although erotic pictures were clearly arousing, their valence was ambivalent for participants (reflected in the null effect for valence ratings), perhaps because viewing such pictures is experienced as an illicit pleasure and therefore triggers conflictual coactivation of both approach and avoidance motivation.

However, and more importantly, to the extent that participants demonstrated less corrugator and more zygomaticus activity and hence had a more positive affective response to erotic stimuli (and perhaps also less conflict when viewing them), they also injected more sexual imagery into their PSE stories during the priming phase. This suggests that although the main effect of corrugator and zygomaticus activity differs from the predicted direction, the association with nSex and the mediation effect are in the predicted direction.

After we determined which mediators were sensitive to EM, we tested them as a link between manipulation and measure. Results showed that corrugator, zygomaticus, and subjective arousal seem to be particularly suitable mediators. Findings also showed that pupil dilation may be a suitable mediator because the mediation goes in the predicted direction. However, due to the small number of participants tested with the eye tracker not enough evidence was gathered for the effect.

Another crucial assumption in our EMMIC validation model (Figure 1) is that nSex mediates the relationship between EM and the behavioral criterion. We did not find a direct effect of motivational arousal on relative viewing time for erotic stimuli, which may be due to the subtle nature of the EM (i.e., priming) and the time difference between the manipulation and the subsequent administration of the KPT. But more importantly, we found that nSex predicts the viewing time of erotic pictures and that nSex change is a mediator between the experimental condition and the KPT, supporting our EMMIC validation model for nSex.

To examine discriminant validity, we tested whether the motivational arousal manipulation was specific to nSex or whether it would also have an effect on nPower, nAffiliation, and nAchievement, three commonly studied motives. Results showed that there was no arousal effect for these motives across both studies, providing support for the discriminant validity of our nSex arousal procedure. Additionally, we examined the overlap of dispositional nSex, the three motives as well as the subscales of the BFI, the SOI-R, and the SIS/SES. Results demonstrated that correlations with the BFI were low, providing support for the discriminant validity of our nSex arousal procedure. Yet, correlations with the SOI-R and the SES of the SIS/SES were also low, providing no evidence for the convergent validity of our nSex arousal procedure. One explanation for this might be the low reliabilities of some questionnaire scales, which might attenuate the convergence effect size. Another may be the fundamental differences in the validation and hence the validity of these measures vis-à-vis ours.

## Limitations

There are some limitations worth mentioning. Specifically, results regarding subjective affect in both studies were not well-aligned, a finding that is likely due to the unspecific and therefore unsuitable measure used in Study 1. The stimulus-specific measures in Study 2 yielded more meaningful results.

In search of suitable mediators for the effect of the EM on changes in nSex, we found that the results of pupillometry went in the right direction; however, the small sample size of participants with eye-tracking data did not allow us to use these data for mediation analyses. This may represent a fruitful route for future inquiries into psychophysiological correlates of the nSex measure.

An additional shortcoming is the choice of our indicator measures. Despite the fact that subjective and physiological affect is a meaningful marker of motivational processes, a more specific and objective marker of *sexual* motivation would have been genital responses. However, genital measurements require the assessment of penile circumference and vaginal blood flow through intrusive instruments which in turn restricts the number of participants willing to attend such a study. For this reason and because of the convergence of genital and subjective arousal measures (e.g., Chivers et al., 2010), we stuck to our indicator measures.

Lastly, the PSE appears to be a suitable tool for measuring sexual motivation in a causally valid manner. However, trained coders are needed to code PSE stories for nSex. For this, researchers may reach out to experienced coders, or learn how to content-code themselves. We have made coding manual and training materials available to the public via OSF.

## Future Research

In the current studies, we presented a new approach to validating motive measurement based on incentive motivation concepts and extending the previously introduced notion that a valid measure needs to reflect variations in the attribute it targets. Specifically, we used priming procedures as a motivational arousal manipulation and showed these to be effective in changing sexual themes in the PSE. To replicate these findings, future studies should apply other EMs (e.g., audio stories, and movies). These methods may show even stronger effects (e.g., Both et al., 2004) and will be able to assess our indicator (affect) while presenting the relevant stimuli which our current priming design did not allow for.

As outlined above, future validation work for the nSex measure should examine its relation to genital arousal as a more specific indicator within the EMMIC validation framework.

Although readers may wish for such a kind of closure, we refrain from deciding on a final nSex coding system based on the present two studies. We fear that we would fall prey to specific effects immanent in the methodological approach we used in the present research. Instead, we refer readers to additional experimental studies using other arousal techniques and the papers resulting from them that will help to select sensitive categories for the final nSex coding system. Because a coding system can depend substantially on PSE stimuli, statistical analyses should also focus on which PSE pictures are most suitable to measure sexual motivation.

Once the final nSex coding system is established and the most suitable PSE pictures are selected, we aim to investigate gender differences in nSex. A recent meta-analysis focusing on self-report measures of sexual motivation and behavior revealed a stronger sex drive in men compared to women (Frankenbach et al., 2022) and it remains to be tested whether these findings can be replicated using the nSex PSE.

Looking beyond these more immediate steps, we think that it will be important to apply the nSex PSE in longitudinal studies. Specifically, in the current experimental studies that were conducted in the laboratory, we used the KPT as the behavioral criterion. In everyday life, key criteria of nSex would be the frequency of sexual activity and orgasm. And surely it should be tested if nSex predicts these much more fundamental behaviors.

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