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## Consensual BDSM Facilitates Role-Specific Altered States of Consciousness: A Preliminary Study

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Researchers studying consensual bondage/discipline, dominance/submission, and sadism/masochism (BDSM) have theorized that individuals pursue BDSM activities, in part, due to the pleasant altered states of consciousness these activities produce. However, to date, no research has tested whether BDSM activities actually facilitate altered states. To this end, we randomly assigned 14 experienced BDSM practitioners to the bottom role (the person who is bound, receiving stimulation, or following orders) or the top role (the person providing stimulation, orders, or structure) for a BDSM scene. Results suggest that topping was associated with an altered state aligned with Csikszentmihalyi's (1991) flow (measured with the Flow State Scale), and bottoming was associated with an altered state aligned with Dietrich's (2003) transient hypofrontality (measured with a Stroop test) as well as some facets of flow. Additional results suggest that BDSM activities were associated with reductions in psychological stress and negative affect, and increases in sexual arousal.

*Keywords:* sadomasochism, altered states of consciousness, flow, sexuality

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Research suggests that a substantial minority of people fantasize about or engage in bondage/discipline, dominance/submission, and sadism/masochism (BDSM) activities (Jozifkova & Flegr, 2006; Moser & Levitt, 1987; but see

Richters, de Visser, Rissel, Grulich, & Smith, 2008, for lower prevalence rates when respondents are asked about "B&D or S&M," specifically). A BDSM taxonomy developed by Alison, Santtila, Sandnabba, and Nordling (2001)

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illustrates the wide range of behavior encompassed by BDSM, with categories of physical restriction (e.g., bondage, handcuffs), administration of pain (e.g., clothespins, spanking), humiliation (e.g., verbal humiliation, gags), and a category the authors refer to as hypermasculinity (e.g., rimming, dildos). Although BDSM is often conceptualized as inherently sexual, Wiseman's (1998) definition of SM from *SM 101* recognized both sexual and nonsexual motivations for BDSM:

The knowing use of psychological dominance and submission, and/or physical bondage, and/or pain, and/or related practices in a safe, legal, consensual manner in order for the participants to experience erotic arousal and/or personal growth. (p. 10)

Likewise, some BDSM practitioners incorporate sexual behaviors such as oral sex or sexual intercourse into their BDSM activities, whereas other BDSM practitioners engage in BDSM activities that do not include these types of sexual behaviors.

Early psychiatrists contended that BDSM practitioners suffered from mental illness (e.g., Freud, 1938), but recent research refutes this conclusion. For example, Connolly (2006) compared BDSM practitioners to published norms on 10 psychological pathologies. Compared with non-BDSM practitioners, BDSM practitioners exhibited lower levels of depression, anxiety, posttraumatic stress disorder, psychological sadism, psychological masochism, borderline pathology, and paranoia, although the researcher reported similar levels of obsessive-compulsive disorder and higher levels of dissociation and narcissism across groups. Similarly, Wismeijer and van Assen (2013) compared BDSM practitioners with non-BDSM practitioners on major personality traits. They found that compared with non-BDSM practitioners, BDSM practitioners exhibited higher levels of extraversion, conscientiousness, openness to experience, and subjective well-being, and lower levels of neuroticism, rejection sensitivity, and agreeableness (see also Hébert & Weaver, 2014, for an examination of differential personality characteristics associated with dominant BDSM practitioners and submissive BDSM practitioners). Consistent with the perspective that BDSM does not stem from pathology, Faccio, Casini, and Cipolletta (2014) wrote,

In line with previous literature (Hoff, 2006; Richters et al., 2008), our findings support the idea that BDSM is a sexual interest or subculture attractive to a minority, rather than a pathological symptom that may be derived from past abuse or difficulty with "normal" sex. (p. 761)

Thus, rather than deriving from pathology, the motivation for BDSM may be rooted in normal psychological functioning. Researchers have forwarded a range of explanations for BDSM behaviors including conceptualizing BDSM as serious leisure (Newmahr, 2010), as a method of increasing eroticism (Ortmann & Sprott, 2013), as a common interest around which meaningful communities develop (Graham, Butler, McGraw, Cannes, & Smith, 2015), and as a method of temporarily escaping the burdens of selfhood (Baumeister, 1988). Although we find value in each of these explanations, we focus on Baumeister's theory because it provides the most direct links to one of the altered states of consciousness that the present study investigates.

Baumeister's (1988) escape from self-theory argued that masochism, like many non-BDSM activities (e.g., extreme sports, watching TV or movies, playing games, using alcohol or drugs), is one mechanism through which people can escape from the sometimes burdensome self:

. . . High-level awareness can lead to anxiety and discomfort under some circumstances. The requirements of making decisions under pressure or uncertainty, of taking responsibility for actions that may disappoint or harm others, of maintaining a favorable public image and private image of self despite all threats and challenges, and of asserting control over a recalcitrant social environment can become oppressive and stressful and can foster desires to escape. (p. 29)

According to Baumeister, many elements of masochism, such as pain without permanent harm or damage, bondage, diminished personal power, and degradation facilitate escape from the self. Consistent with this, interviewees in Hébert and Weaver's (2015) study of BDSM practitioners identified psychological release as one of the benefits of BDSM. Likewise, Pascoal, Cardoso, and Henriques (2015) found that BDSM practitioners reported lower levels of sexual dysfunction when engaged in BDSM sexual activity compared to non-BDSM sexual activity, possibly because "BDSM practices can divert distress away from concerns about sexual functioning" (p. 1059).

Motivation to escape from the self may spur people to seek pleasant altered states of consciousness that may be experienced during BDSM activities to facilitate escape (Newmahr, 2010; Pitagora & Ophelian, in press). This possibility is supported by the reports of BDSM practitioners, who use the term *subspace* to refer to a unique, subjectively pleasant, altered state of consciousness that is sometimes experienced by the receiver of sensation (i.e., the bottom) in a BDSM scene.<sup>1</sup> Although Baumeister's (1988) theory only accounts for altered states of consciousness in bottoms, BDSM practitioners also describe a subjectively pleasant, altered states of consciousness called *topspace* that is sometimes experienced by the giver of sensation (i.e., the top) in a BDSM scene. As described by Newmahr (2010),

Bottoming is more likely to result in observable altered consciousness than topping, but the community is also more highly motivated to recognize altered states in bottoms than in tops. The flow experience for bottoms is most frequently called "subspace" or "bottom space," and has many other descriptors, including "loopy," "flying," and "fried." When the flow experience in topping is recognized discursively, these phrases include "in the zone," "grooving" or "in top space." (p. 327)

The goal of our study is to empirically test whether BDSM behaviors facilitate altered subjective experiences. In doing so, we link topping and bottoming in BDSM scenes to different altered states of consciousness. Consistent with Newmahr (2010), we suggest that topping may facilitate an altered state aligned with Csikszentmihalyi's (1991) concept of mental *flow*. Although Newmahr also linked bottoming to flow, we suggest that bottoming may facilitate an altered state more closely aligned with Dietrich's (2003) ideas about *transient hypofrontality*. These concepts are reviewed in the sections that follow.

### Flow

Csikszentmihalyi (1991) conceptualized flow as an altered state of consciousness achieved during optimal experiences. According to Csikszentmihalyi, flow contains nine dimensions: "challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on task, sense of control, loss of self-consciousness, time transformation, and

autotelic experience" (Jackson, Eklund, & Martin, 2010, p. 6), and is, subjectively, extremely rewarding.

As noted earlier, Newmahr (2010) already has forged a link between BDSM activities and flow. She explained,

SM participants speak of their play in terms of ecstatic experience, or what can be understood as flow. They speak of weightlessness: of grooving and flying, of the cessation of cognitive process and of the disappearance of the world around them. (p. 328)

However, Newmahr also distinguished the ways that tops and bottoms achieve flow, noting that "Tops achieve flow through mental focus, particularly when engaged in activities that require intense concentration, such as knife play, needle play, and advanced bondage" (p. 328), whereas "When bottoming, players experience flow as a result of intense rhythmic sensation, sensation or pain itself, unrelenting focus on a particular task or concentrated effort to endure a sensation or circumstance" (p. 328).

We similarly predict that BDSM will be linked to the flow experience and that this link will be especially strong for practitioners who adopt the top role in a scene. We advance this hypothesis because flow denotes optimal performance on controlled, purposeful activities, which are the types of activities that a top performs during a scene, that is, directing and controlling the person in the bottom role. In contrast, participants who adopt the bottom role in a scene temporarily cede power, control, and decision-making to the top, although mechanisms such as safewords enable the bottom to reassert control if needed during a scene (Pitagora, 2013), and abandoning these mental activities does not seem to be consistent with the flow experience described by Csikszentmihalyi (1991).

### Transient Hypofrontality

Participants in the bottom role may experience a distinct altered state of consciousness

<sup>1</sup> Sagarin, Cutler, Cutler, Lawler-Sagarin, and Matuszewich (2009) define *scenes* as "defined periods of time during which participants engage in a series of [BDSM] activities", *bottoms* as "participants who [are] bound, receiving stimulation, following orders, etc.," and *tops* as "participants who provide stimulation, orders, or structure" (p. 187).

related to Dietrich's (2003) transient hypofrontality hypothesis, which is also pertinent to an array of subjective altered states of consciousness including daydreaming, runner's high, meditation, and some drug highs.

The notion of transient hypofrontality rests on two premises: (a) the brain possesses limited resources that brain structures, systems, and areas compete for, and (b) the subjective experience of consciousness is a process. When activities such as exercise increase the demands on brain areas responsible for basic sensory and perceptual processes, autonomic nervous system regulation, and motor output, the brain does not receive additional blood flow to meet competing demands (Dietrich, 2003). Instead, the brain down-regulates certain regions to increase blood flow to currently important areas of demand. Research suggests that the frontal cortex and the prefrontal cortex of the brain are consistently down-regulated in this way (Del Giorno, Hall, O'Leary, Bixby, & Miller, 2010; Dietrich & Sparling, 2004).

Because the dorsolateral prefrontal cortex is heavily active in working memory and sustained attention (Cabeza & Nyberg, 2000), such down-regulation can produce time distortions, disinhibition from social constraints, and changes in focused attention. Additionally, people theorized to be experiencing transient hypofrontality report reductions in pain, decision making activity, logic, and difficulty with memory, along with increased feelings of floating, peacefulness, and living in the here and now (Dietrich, 2003).

To examine a possible alignment of the effects of transient hypofrontality with *subspace*, we asked workers ( $N = 56$ ) on Amazon's Mechanical Turk (MTurk) who had experienced subspace to describe the experience (see Buhrmester, Kwang, & Gosling, 2011, for evidence that "the data obtained [through MTurk] are at least as reliable as those obtained via traditional methods," p. 3; though see Chandler, Paolacci, Peer, Mueller, & Ratliff, 2015, for concerns regarding the effects of MTurk workers participating in multiple studies). Aside from one respondent who interpreted subspace from a Star Trek perspective, respondents' descriptions were consistent with characteristics of transient hypofrontality:

With my girl, she was punishing me, and I felt a deep sense of pain and pleasure, sort of a one with nature and my environment, it was incredible.

It's very dreamlike. I knew that I felt good, and I was aware of my partner, but I was not paying attention to anything else.

An almost trance like state. Pain didn't exist in any form.

Quotes from Wiseman (1998) are also consistent with characteristics of transient hypofrontality:

Whenever I'm in bottom space I become sort of non-verbal. It becomes hard for me to remember how to talk. (p. 33)

I cannot relax unless I'm really tied up. (p. 134)

(from a professional dominant): I see a lot of engineers. A heavy whipping is the only thing that brings them out of their heads and into their bodies—out of their thoughts and into the here and now. (p. 177)

In addition to these subjective alterations, a state of transient hypofrontality would also be expected to be associated with impairments on objective tasks that involve the down-regulated brain areas. One testable implication of this possibility in the BDSM domain is that bottoms would be expected to exhibit decrements in performance on cognitive tests that assess the ability to exert executive control during and following engagement in a scene. For example, after a BDSM scene, bottoms, but not tops, may evince performance impairment on a Stroop task (MacLeod, 1991).

### Other Physiological and Psychological Effects of BDSM Activities

Although, to our knowledge, no prior quantitative studies have examined whether BDSM scenes facilitate altered states, previous research suggests a number of other physiological and psychological effects of BDSM activities. Sagarin, Cutler, Cutler, Lawler-Sagarin, and Matuszewich (2009) had 58 experienced BDSM practitioners complete surveys and provide saliva samples before and after participating in BDSM scenes. Saliva samples were used to measure cortisol (a hormone associated with stress) and testosterone (a hormone associated with dominance and aggression). From before to after their scenes, bottoms (but not tops) showed increases in physiological stress, as

measured by cortisol, whereas both bottoms and tops showed increases in relationship closeness.

Klement et al. (2015) administered surveys and collected saliva samples from participants engaged in a ritual involving temporary piercing and pulling against hooks placed through the piercings. Ritual participants showed increases in physiological stress, as measured by cortisol, but reductions in psychological stress and negative affect. Although the ritual did not constitute a traditional BDSM scene, nor was it conceptualized by participants as a BDSM scene (participants perceived the experience as more spiritual than sexual or sadomasochistic), we anticipated that the physiological and psychological effects might mirror those observed among bottoms in BDSM scenes.

### The Present Study

In the present study, we used an experimental methodology to test the facilitative effects of BDSM role on altered states of consciousness as well as other physiological and psychological variables. In the BDSM community, some individuals self-identify as switches. Switches sometimes take on the bottom role and sometimes take on the top role in BDSM scenes. We recruited seven pairs of switches who were willing to be randomly assigned (by roll of a die) to either the top or bottom role for a BDSM scene. In contrast with prior studies, in which participants self-selected into the top or bottom role (e.g., Sagarin et al., 2009), the random assignment of switches to the top or bottom role removes some of the ambiguity in interpreting the results. That is, observed differences between tops and bottoms in the present study can be attributed more confidently to the activities performed by that role, rather than to the type of person who chooses that role.

After each scene ended, participants completed a measure of mental flow. We predicted that tops would report greater flow than bottoms. We also asked participants to complete three Stroop tests: one prior to random assignment, one just before their scene began, and one just after their scene ended. We predicted that after the scene, the performance of bottoms on the test would be impaired relative to the performance of tops. In particular, we predicted a Role  $\times$  Time interaction such that bottoms would show a greater increase in Stroop scores

from baseline to after their scenes than would tops (higher Stroop scores represent worse performance on the Stroop test).

Finally, based on Sagarin et al. (2009) and Klement et al. (2015), we measured cortisol, testosterone, psychological stress, self-other overlap (a measure of relationship closeness, Aron, Aron, & Smollan, 1992), positive and negative affect, sexual arousal, and perceptions of the scene. We predicted that both tops and bottoms would show increases in self-other overlap (consistent with Sagarin et al., 2009), decreases in negative affect, and decreases in self-reported stress from before to after their scenes (consistent with Klement et al., 2015). We also predicted Role  $\times$  Time interactions for cortisol (consistent with Sagarin et al., 2009) such that cortisol would increase from baseline to after scenes for bottoms, whereas no change would be evident for tops. With respect to testosterone, we predicted that bottoms would exhibit decreases in testosterone from baseline to just before their scenes, whereas tops would exhibit increases, based on the idea that BDSM practitioners might evidence anticipatory changes in testosterone consistent with the dominant or submissive role they are about to adopt.

## Method

### Participants

Fourteen participants enrolled in the experiment in seven pairs. Ten participants were women; four were men. Participants ranged in age from 23 to 64 years,  $M = 40.86$  years,  $SD = 12.47$  years. All participants were Caucasian. Ten participants reported their sexual orientation as bisexual, three as heterosexual, and one as gay. Seven participants indicated they had no religion or were atheist, two reported being spiritual or “woo,” and the five others respectively reported their religion as Buddhist, Hindu, Pagan, Christian, and nature-based. All participants were experienced BDSM practitioners, with experience ranging from 1 to 17 years,  $M = 6.86$  years,  $SD = 5.07$  years. Two pairs of participants were in a polyamorous relationship, two pairs were in long-term dating relationships, two pairs were friends, and one pair had just met the evening of the study. Participants reported they had performed be-

tween 18 and 1,500 prior scenes overall and between 0 and 250 prior scenes with their study partner.

## Materials

**Surveys.** Participants responded to a total of three paper surveys. The baseline survey contained the Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988), measures (scale anchors are presented in the results section) of self-reported stress and sexual arousal, how much participants would use the word “we” to describe their relationship with their scene partner, the Inclusion of Other in Self Scale (IOS, Aron et al., 1992, a one-item scale consisting of seven pairs of increasingly overlapping circles labeled “self” and “other”; see Aron et al. for evidence of the reliability and validity of the IOS including convergent validity with measures of relationship closeness and intimacy), and demographics, including questions regarding previous BDSM experience. The prescene survey was administered just prior to the beginning of a scene and only included the PANAS, self-reported stress, and sexual arousal. Finally, the postscene survey included the following: a retrospective PANAS (“How did you feel at the end of your scene?”) and a current PANAS (“How do you feel now?”), retrospective and current psychological stress and sexual arousal, use of the word “we” and IOS, how participants felt the scene had gone, how much the scene had been affected by the random assignment to role, how spiritual, sexual, sadomasochistic, and intense participants found the scenes, and the Flow State Scale (Jackson et al., 2010; Jackson & Marsh, 1996). Cronbach’s alpha for positive affect was .89 in Watson et al. (1988) and ranged from .71 to .91 in the present study.<sup>2</sup> Cronbach’s alpha for negative affect was .85 in Watson et al. Cronbach’s alphas could not be calculated for negative affect in the present study as some of the items had 0 variance (e.g., all participants responded “very slightly or not at all” for “ashamed”). Past research supports the use of the PANAS in repeated-measures designs (Brose, Voelkle, Lövdén, Lindenberger, & Schmiedek, 2015; Kennedy-Moore, Greenberg, Newman, & Stone, 1992).

**Saliva samples.** Participants provided five saliva samples over the course of the experi-

ment. Saliva samples were placed in an ice chest immediately after collection. Subsequently, samples were stored in a household freezer before being sent to Northern Illinois University for analysis. Samples were shipped on dry ice via overnight delivery and then stored at  $-65^{\circ}\text{C}$  prior to analysis. Samples were analyzed for cortisol and testosterone (see Sagarin et al., 2009, Study 2 for information on the procedures for analysis; correlations for duplicate assays in the present study were  $r(64) = .98, p < .001$  for cortisol,  $r(63) = .98, p < .001$  for testosterone).

**Flow.** Flow was measured using the Flow State Scale (Jackson et al., 2010; Jackson & Marsh, 1996). This 36-item scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, 5 = *strongly agree*) measures nine dimensions of flow: Challenge-Skill Balance (a feeling of balance between the demands of the situation and personal skills), Action-Awareness Merging (a feeling of being so involved that one’s actions are automatic), Clear Goals (a feeling of knowing exactly what is needed in the situation on a moment to moment basis), Unambiguous Feedback (immediate and clear feedback that is seamlessly integrated into the ongoing activity), Concentration on Task at Hand (a feeling of being totally focused), Sense of Control (an empowering feeling of being in control and being free of the fear of failure), Loss of Self-Consciousness (concern for the self disappears), Transformation of Time (a change in how the passage of time is perceived, either faster, slower, or a lack of awareness), and Autotelic Experience (a feeling of intrinsic reward, task is enjoyable in and of itself). Each dimension is measured by four items; participants were instructed to respond to each item in terms of how they felt during the scene. We included an “N/A” option for participants who felt an item was not relevant to their experience. Cronbach’s alpha for the Flow State Scale was .80 to .92 in Jackson and Eklund (2002) and .89 in the present study. Jackson, Martin, and Eklund (2008) reported convergent validity of the Flow State Scale with measures

<sup>2</sup> The range of values for Cronbach’s alpha refers to the Cronbach’s alphas calculated across the repeated measures of each scale.

of intrinsic motivation, positive well-being, and psychological distress.

**The Stroop test.** The Stroop test (MacLeod, 1991) was administered on an iPad and consisted of 40 trials in which a character string (*red, blue, green, yellow, or xxxx*) was displayed in red, blue, green, or yellow font color (each of the 20 combinations was presented twice). Participants were instructed to ignore the semantic meaning of the word and to respond to each by pressing a button on the screen indicating the font color (labeled in black type *red, blue, green, and yellow*). No feedback was provided for correct or incorrect answers. Stroop scores reflect the difference between the mean latencies on incongruent trials (e.g., *red* in green type) and the mean latencies on control trials (e.g., *red* in red type, *xxxx* in any color of type) with higher Stroop scores indicating greater relative difficulty in responding to incongruent trials. Trials with erroneous responses and trials with latencies  $>3 SD$  from a participant's mean latency were removed (Linnman, Carlbring, Ahman, Andersson, & Andersson, 2006). Alternative analyses that include these erroneous and  $>3 SD$  trials do not substantively change the results. The Stroop test has been used successfully in repeated-measures designs, although past research is mixed on whether the Stroop test shows practice effects (see MacLeod, 1991, for a review).

Because our predictions specify a decrement in Stroop performance for bottoms, practice effects would work against our hypothesis. Further, Stroop results in the present study suggest the absence of practice effects in our data.

## Procedure

Participants were recruited through announcements at the host organization (the Arizona Power Exchange), through e-mail to a mailing list of individuals who had previously expressed interest in BDSM research, and through postings on FetLife. Recruitment materials explained that we were recruiting pairs of participants who would be willing to be randomly assigned to the top role or bottom role in a BDSM scene to be performed with their study partner. No restrictions were placed on the scene activities, apart from the random assignment to the top and the bottom. Thus, participants could choose the activities they wished to

perform, the length of their scene, and so forth. Recruitment materials also explained that all scenes would take place on the same evening at the facility of the Arizona Power Exchange.

After reading the informed consent form and providing verbal agreement,<sup>3</sup> participants completed (a) the baseline survey, (b) a practice Stroop, and (c) a baseline Stroop and provided a baseline saliva sample. Participants were then randomly assigned to the top or bottom role for their scene via a die role and a researcher was assigned to each scene.<sup>4</sup> Participants were then asked to wait at least 30 min prior to beginning their scenes to allow for changes in cortisol or testosterone to appear in the saliva. Some participants began setting up equipment for their scenes prior to 30 min passing, but all waited at least 30 min to begin their scenes.

Just before participants began scene activities, the researcher administered the prescene survey and the prescene Stroop and obtained a prescene saliva sample. Participants then conducted their scene. A separate researcher was assigned to observe each scene (all participants consented to observation, and all observations were made within sight of the scene; thus, participants could see the researcher observing their scene), and the researcher's priority during the scene was to administer the study measures and record timestamps of when those measures were administered. However, the researchers were also instructed to code whether certain activities happened during the scene (yes/no). Before the study began the researchers received training on how to categorize BDSM activities on a specific coding sheet. The training included watching video clips of BDSM scenes and going over responses as a group. Additionally, the researchers could reference the coding sheet category definitions and examples at any time while they were observing their assigned scene.

As soon as the primary scene activities were over, the researcher administered a post-

<sup>3</sup> The study was approved by Northern Illinois University's Institutional Review Board. We requested and received approval for a verbal informed consent procedure to protect the anonymity of participants.

<sup>4</sup> The number of simultaneous scenes prevented us from assigning more than one researcher to a scene. All researchers were trained in the study's methodology and observation protocol. Further all researchers had practiced the observation protocol using video clips of BDSM scenes.



scene Stroop and obtained a postscene saliva sample. Participants then began aftercare, if they wished. Sagarin et al. (2009) define aftercare as “participant interaction after completing the main scene activities and before leaving the play area” that, in their study, “included gentle contact (e.g., hugging, cuddling), pleasurable stimulation (e.g., caressing, massaging), and communication (e.g., talking, eye contact)” (p. 190).

Additional saliva samples were collected 20 min later and 40 min later. When participants were ready, they completed the postscene survey, which included the flow measure.

## Results

### Missing Data

We obtained complete data on all measures with three exceptions: (a) On the prescene PANAS, one participant left one positive affect item blank. This participant’s prescene positive affect score was calculated using the other nine items. (b) One participant did not answer the question about the impact of random assignment. This participant was excluded from the analysis of that variable. (c) As detailed below, a number of bottoms responded “N/A” on some of the items on the Flow State Scale. For these participants, dimensions of flow were calculated using the nonmissing items. In one instance, a participant responded “N/A” for all four items within one dimension. For this participant, this dimension was set as missing. Thereafter, the total flow score and the two factors of flow were calculated using the nonmissing dimensions. (d) Saliva samples from two participants did not allow us to obtain full measures of testosterone and cortisol. These participants were excluded from the corresponding hormonal analyses.

### Characteristics of the Scenes

The duration of scenes varied from 37 to 79 min ( $M = 57$  min,  $SD = 15$  min). Aftercare occurred after six of the scenes and varied in duration from 7 to 40 min (including 0 for the scene with no aftercare,  $M = 19$  min,  $SD = 12$  min). The postscene survey was administered between 30 and 77 min after the end of the scene ( $M = 46$  min,  $SD = 16$  min). Research on autobiographical memory and the fading affect

bias suggests that this delay should not impact participants’ ability to accurately report their affective state during the scene (Skowronski, Walker, Henderson, & Bond, 2014).

All seven scenes included some form of gentle, soft touching (feather duster, massage, back scratching, tickling) and communication (conversation, laughter, moaning, whispering). Six out of seven scenes ended with aftercare (cuddling on couch, hugging, talking and discussing the scene, wrapping bottom in blanket). The next most frequently observed activities were seen in five scenes and included during care (asking how things feel, asking if bottom needs anything, offering water) and prescene preparation/negotiation (discussion of preferences, preparation of toys, deep breathing together). Four out of seven scenes included some form of striking (flogging, caning, sharp slap with rod, spanking). Three scenes involved some form of bondage (shackles, chains), sexual activity (contact with genitals), and playing with clothing (fetish dress, collars, leather gloves). Two scenes involved pinching/pulling activities (metal clamps, biting), and explicit control behavior (call and response commands). The following activities were only seen in one scene: role or gender play (puppy play: roleplay in which one or more people take on the roles of dogs or puppies), sensory deprivation (blindfold), and aural stimulation (making thudding sound of paddle against palm next to bottom’s ear).

### Perceptions of the Scenes

Two questions assessed scene quality. In response to the question, “How well did the scene go?” (1 = *very poorly*, 7 = *very well*), both tops ( $M = 6.29$ ,  $SD = 1.11$ ) and bottoms ( $M = 6.57$ ,  $SD = .79$ ) reported that their scenes had gone well. Tops’ and bottoms’ ratings of how well the scene went did not differ significantly,  $t(12) = -.56$ ,  $p = .59$ ,  $d = -0.29$ . Tops’ and bottoms’ rating of scene intensity (1 = *not at all intense*, 7 = *very intense*) also did not differ significantly (tops:  $M = 5.21$ ,  $SD = 1.63$ ; bottoms:  $M = 3.43$ ,  $SD = 1.81$ ),  $t(12) = 1.94$ ,  $p = .08$ ,  $d = 1.03$ .

Two questions assessed the impact of the experiment on the scene. Participants were asked how much being observed affected their scene (1 = *not at all affected*, 7 = *very strongly*

affected). Both tops ( $M = 2.86$ ,  $SD = 1.86$ ) and bottoms ( $M = 1.71$ ,  $SD = 0.95$ ) reported little effect of observation. Tops' and bottoms' ratings of the effect of observation did not differ significantly,  $t(12) = 1.45$ ,  $p = .17$ ,  $d = 0.78$ . Participants were then asked to rate the impact of the random assignment on their scene (1 = *strongly detracted from my scene*, 7 = *strongly enhanced my scene*). Tops ( $M = 4.00$ ,  $SD = 1.41$ ) and bottoms ( $M = 4.50$ ,  $SD = 1.23$ ) reported little impact. As with the effect of observation, tops' and bottoms' ratings of the impact of random assignment did not differ significantly,  $t(11) = .68$ ,  $p = .51$ ,  $d = -0.38$ .

Finally, participants responded to three questions assessing how spiritual, how sadomasochistic, and how sexual they found their scenes to be (anchors: 1 = *not at all*, 5 = *very*). A 2 (Role: top vs. bottom)  $\times$  3 (Characteristic: spiritual, sadomasochistic, sexual) analysis of variance was run to test whether tops and bottoms differed in their characterization of the scene. The role by characteristic interaction was non-significant, but, nonetheless, showed a trend toward significance,  $F(2, 24) = 2.89$ ,  $p = .08$ ,  $\eta_p^2 = .19$ , with tops perceiving the scene as highest in sexuality ( $M = 3.14$ ,  $SD = 1.35$ ) then spirituality ( $M = 2.86$ ,  $SD = 1.35$ ) and lowest in sadomasochism ( $M = 2.43$ ,  $SD = 1.27$ ) and bottoms perceiving the scene as highest in sadomasochism ( $M = 3.29$ ,  $SD = 1.11$ ) then sexuality ( $M = 2.71$ ,  $SD = 1.60$ ) and lowest in spirituality ( $M = 1.86$ ,  $SD = 0.90$ ).

## Flow

Items on the 36-item Flow State Scale were answered on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale with scores higher than 3 (*neither agree nor disagree*) indicating flow. Participants were also given the option of responding "N/A" if they felt that an item was not applicable for their experience. Across all 36 items (ignoring N/As), both tops ( $M = 4.11$ ,  $SD = 0.36$ ) and bottoms ( $M = 4.11$ ,  $SD = 0.55$ ) reported levels of flow significantly above 3,  $t(6) = 8.07$ ,  $p < .001$ ,  $t(6) = 5.33$ ,  $p = .002$ , respectively. Tops and bottoms did not differ significantly in their reported levels of flow,  $t(12) = 0.00$ ,  $p = 1.00$ ,  $d = 0.00$ . However, an examination of the N/A responses suggests greater flow in tops than bottoms. In particular, bottoms responded N/A on an average of 4.3

items ( $SD = 5.6$ ), whereas tops responded N/A on no items. Further, bottoms' N/A responses were most often on flow dimensions associated with optimal performance (Challenge-Skill Balance, Clear Goals, and Immediate Feedback). In contrast, bottoms provided no N/A responses on flow dimensions associated with autotelic absorption (Loss of Self-Consciousness, Transformation of Time, and Autotelic Experience).

To further examine responses to the different dimensions of flow, we calculated factor scores based on the two factors that emerged in a study on hook-pulls we conducted that also used the Flow State Scale (Lee et al., 2016). The first factor consisted of Challenge-Skill Balance, Clear Goals, Unambiguous Feedback, Concentration on Task at Hand, and Sense of Control, and the second factor consisted of Action-Awareness Merging, Loss of Self-Consciousness, Transformation of Time, and Autotelic Experience. We labeled the first factor optimal performance and the second factor autotelic absorption. When we calculated these factors in the present data, they showed a different pattern in tops and bottoms. Specifically, tops showed consistency across both factors of flow, showing no significant differences between optimal performance ( $M = 4.12$ ,  $SD = 0.57$ ) and autotelic absorption ( $M = 4.09$ ,  $SD = 0.48$ ),  $t(6) = 0.12$ ,  $p = .91$ . Bottoms, in contrast, showed significantly lower levels of optimal performance ( $M = 3.69$ ,  $SD = 0.90$ ) compared to autotelic absorption ( $M = 4.58$ ,  $SD = 0.41$ ),  $t(6) = -2.66$ ,  $p = .04$ . These results are consistent with the N/A responses of bottoms, which were most often on the optimal performance dimensions of flow.

## Stroop Scores

Table 1 and Figure 1 display the Stroop test scores for tops and bottoms at baseline (prior to random assignment to role), just prior to beginning their scenes, and just after finishing their scenes. Because the prediction regarding Stroop scores involved only the baseline and postscene Stroop tests, Stroop scores were analyzed twice, once with prescene Stroop scores included and once with prescene Stroop scores excluded.

For the first analysis, the Role (top vs. bottom)  $\times$  Time (baseline vs. prescene vs. postscene) interaction was significant,  $F(2, 24) = 6.69$ ,  $p = .005$ ,  $\eta_p^2 = .36$ . The main effects of

Table 1  
*Psychological Measures in Tops and Bottoms*

Measure	Role	Baseline	Prescene	Immediate postscene	Postscene
Stroop scores	Top	180.2 (267.3)	273.9 (164.0)	131.6 (177.2)	—
	Bottom	92.3 (128.1)	83.2 (140.8)	504.3 (384.6)	—
Positive affect	Top	34.86 (4.56)	41.71 (5.41)	43.43 (4.79)	35.86 (6.39)
	Bottom	38.43 (4.65)	40.25 (5.36)	33.29 (11.32)	33.71 (5.19)
Negative affect	Top	13.57 (2.30)	11.43 (1.13)	10.57 (.98)	10.57 (1.13)
	Bottom	14.86 (1.68)	13.71 (2.43)	10.14 (.38)	10.29 (.49)
Stress	Top	1.71 (.76)	1.43 (.79)	1.00 (.00)	1.00 (.00)
	Bottom	1.86 (.90)	1.43 (.54)	1.00 (.00)	1.00 (.00)
Sexual arousal	Top	2.57 (.98)	3.14 (1.22)	3.57 (1.40)	2.86 (1.07)
	Bottom	1.71 (.76)	2.57 (1.51)	2.86 (1.77)	2.14 (.90)
We	Top	5.14 (2.34)	—	—	5.00 (2.31)
	Bottom	4.14 (2.61)	—	—	4.29 (2.63)
IOS	Top	3.14 (1.86)	—	—	4.14 (1.77)
	Bottom	2.71 (1.89)	—	—	3.00 (2.24)

*Note.* IOS = Inclusion of Other in Self Scale. Stroop scores reflect the difference between the mean latencies on incongruent trials (e.g., *red* in green type) and the mean latencies on control trials (e.g., *red* in red type, *xxxx* in any color of type). Immediate postscene measures were retrospective for affect, stress, and sexual arousal.

role and time were nonsignificant,  $F(1, 12) = 0.16$ ,  $p = .69$ ,  $\eta_p^2 = .01$ ,  $F(2, 24) = 2.69$ ,  $p = .09$ ,  $\eta_p^2 = .18$ , respectively.

For the second analysis, the predicted Role (top vs. bottom)  $\times$  Time (baseline vs. postscene) interaction was significant,  $F(1, 12) = 6.64$ ,  $p = .02$ ,  $\eta_p^2 = .36$ . Examination of the simple time of administration effects (baseline vs. postscene) within each role showed a significant simple effect of time for bottoms,  $F(1, 12) = 10.62$ ,  $p = .007$ ,  $\eta_p^2 = .47$ , but not for tops,  $F(1, 12) = 0.15$ ,  $p = .71$ ,  $\eta_p^2 = .01$ .

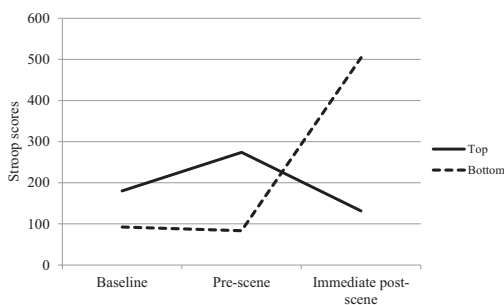


Figure 1. Stroop scores for tops and bottoms. Stroop scores reflect the difference between the mean latencies on incongruent trials (e.g., *red* in green type) and the mean latencies on control trials (e.g., *red* in red type, *xxxx* in any color of type) with higher Stroop scores indicating greater relative difficulty in responding to incongruent trials.

## Cortisol

Table 2 displays cortisol levels for tops and bottoms at baseline (prior to random assignment to role), just prior to beginning their scenes, just after finishing their scenes, 20 min later, and 40 min later. The omnibus Role (top vs. bottom)  $\times$  Time (baseline vs. prescene vs. postscene vs. 20-min postscene vs. 40-min postscene) interaction was nonsignificant,  $F(4, 40) = 1.57$ ,  $p = .20$ ,  $\eta_p^2 = .14$ . The main effects of role and time were also nonsignificant,  $F(1, 10) = 1.34$ ,  $p = .27$ ,  $\eta_p^2 = .12$ ,  $F(4, 40) = 0.21$ ,  $p = .93$ ,  $\eta_p^2 = .02$ , respectively. The predicted Role (top vs. bottom)  $\times$  Time (baseline vs. postscene) interaction was nonsignificant, but, nonetheless, showed a trend toward significance,  $F(1, 10) = 3.96$ ,  $p = .08$ ,  $\eta_p^2 = .28$ . Simple effects within each role showed nonsignificant simple effects of time for bottoms,  $F(1, 10) = 2.97$ ,  $p = .12$ ,  $\eta_p^2 = .23$ , and tops,  $F(1, 10) = 1.09$ ,  $p = .32$ ,  $\eta_p^2 = .10$ .

## Testosterone

Table 2 displays testosterone levels for tops and bottoms at baseline (prior to random assignment to role), just prior to beginning their scenes, just after finishing their scenes, 20 min later, and 40 min later. The omnibus Role  $\times$  Time interaction was nonsignificant,  $F(4, 40) = 0.35$ ,  $p = .84$ ,  $\eta_p^2 = .03$ . The main effects of role

Table 2  
*Hormonal Measures in Tops and Bottoms*

Measure	Role	Baseline	Prescene	Immediate postscene	20 min later	40 min later
Cortisol	Top	.113 (.075)	.143 (.151)	.090 (.043)	.096 (.032)	.099 (.056)
	Bottom	.144 (.093)	.121 (.076)	.189 (.099)	.158 (.071)	.135 (.057)
Testosterone	Top	120.9 (73.0)	110.6 (44.4)	85.2 (49.5)	84.0 (38.4)	81.9 (45.7)
	Bottom	186.8 (258.4)	129.9 (90.3)	115.3 (33.3)	158.8 (77.0)	96.4 (32.3)

*Note.* The *SD* for baseline testosterone for bottoms is due to an extremely high score for one participant (647.0). Exclusion of this score does not substantively change the testosterone results.

and time were also nonsignificant,  $F(1, 10) = 1.53$ ,  $p = .24$ ,  $\eta_p^2 = .13$ ,  $F(4, 40) = 1.13$ ,  $p = .26$ ,  $\eta_p^2 = .10$ , respectively. Finally, the predicted Role  $\times$  Time (baseline vs. prescene) interaction was also nonsignificant,  $F(1, 10) = 0.39$ ,  $p = .55$ ,  $\eta_p^2 = .04$ .

### Other Psychological Effects

Table 1 contains descriptive statistics for tops' and bottoms' levels of positive affect, negative affect, stress, sexual arousal, the use of "we" to describe their relationship, and self-other overlap. For positive affect, participants indicated the extent to which they were feeling 10 positive affect terms (e.g., interested, excited) on a 5-point scale (1 = *very slightly or not at all*, 2 = *a little*, 3 = *moderately*, 4 = *quite a bit*, 5 = *extremely*). For negative affect, participants indicated the extent to which they were feeling 10 negative affect terms (e.g., distressed, upset) on the same scale. For stress and sexual arousal, participants indicated the extent to which they were feeling "stressed" and "sexually aroused" on the same scale. Use of "we" was indicated on a 7-point scale (1 = *I definitely would not use the word "we" to describe my relationship*, 7 = *I definitely would use the word "we" to describe my relationship*). Self-other overlap was indicated on a scale displaying seven sets of increasingly overlapping circles labeled "self" and "other."

**Positive affect.** For positive affect, there was a significant main effect of time (baseline vs. prescene vs. retrospective immediate postscene vs. later postscene),  $F(3, 36) = 4.00$ ,  $p = .02$ ,  $\eta_p^2 = .25$ , no main effect of role,  $F(1, 12) = 1.04$ ,  $p = .33$ ,  $\eta_p^2 = .08$ , and a significant Time  $\times$  Role interaction,  $F(3, 36) = 4.63$ ,  $p = .01$ ,  $\eta_p^2 = .28$  (see Figure 2). From baseline to before the scene began, tops re-

ported a significant increase in positive affect,  $F(1, 12) = 21.17$ ,  $p = .001$ ,  $\eta_p^2 = .64$ , whereas bottoms did not,  $F(1, 12) = 1.50$ ,  $p = .24$ ,  $\eta_p^2 = .11$ . From before the scene began to immediately after the scene ended, bottoms reported a significant decrease in positive affect,  $F(1, 12) = 5.41$ ,  $p = .04$ ,  $\eta_p^2 = .31$ , whereas tops did not,  $F(1, 12) = 0.33$ ,  $p = .58$ ,  $\eta_p^2 = .03$ . Thereafter, from immediately after the scene ended to well after the scene ended, tops reported a significant decrease in positive affect,  $F(1, 12) = 9.06$ ,  $p = .01$ ,  $\eta_p^2 = .43$ , whereas bottoms did not,  $F(1, 12) = 0.03$ ,  $p = .87$ ,  $\eta_p^2 = .00$ .

**Negative affect.** For negative affect, there was a significant main effect of time,  $F(3, 36) = 27.51$ ,  $p < .001$ ,  $\eta_p^2 = .70$ , no main effect of role,  $F(1, 12) = 1.94$ ,  $p = .19$ ,  $\eta_p^2 = .14$ , and a significant Time  $\times$  Role interaction,  $F(3, 36) = 3.39$ ,  $p = .03$ ,  $\eta_p^2 = .22$  (see Figure 3). Both tops and bottoms reported decreases in negative affect from baseline to postscene, but the decrease in tops' negative affect occurred from baseline to prescene, whereas the decrease in bottoms' negative affect occurred from prescene to immediate postscene.

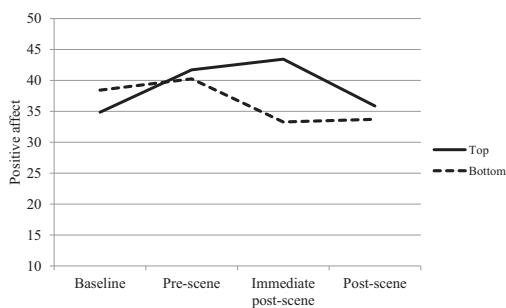


Figure 2. Positive affect scores for tops and bottoms.

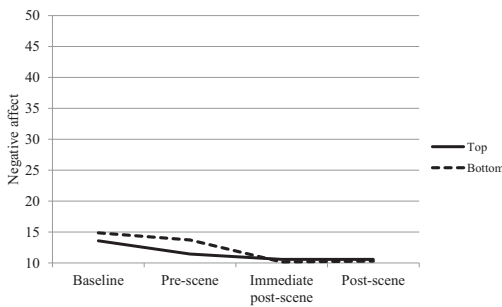


Figure 3. Negative affect scores for tops and bottoms.

**Psychological stress.** For psychological stress, there was a significant main effect of time,  $F(3, 36) = 8.92, p < .001, \eta_p^2 = .43$ , no main effect of role,  $F(1, 12) = .04, p = .85, \eta_p^2 = .003$ , and no Time  $\times$  Role interaction,  $F(3, 36) = .08, p = .97, \eta_p^2 = .01$ . Both tops and bottoms reported decreases in psychological stress from baseline to prescene and then from prescene to postscene.

**Sexual arousal.** For sexual arousal, there was a significant main effect of time,  $F(3, 36) = 5.12, p < .01, \eta_p^2 = .30$ , no main effect of role,  $F(1, 12) = 1.62, p = .23, \eta_p^2 = .12$ , and no Time  $\times$  Role interaction,  $F(3, 36) = .08, p = .97, \eta_p^2 = .01$ . Both tops and bottoms reported increases in sexual arousal from baseline to prescene and from prescene to immediately postscene. Sexual arousal decreased thereafter in both tops and bottoms.

**“We.”** For the use of the word “we” to describe their relationship with their scene partner, there was no main effect of time (baseline vs. postscene),  $F(1, 12) = .00, p = 1.0, \eta_p^2 < .001$ , no main effect of role,  $F(1, 12) = .43, p = .53, \eta_p^2 = .03$ , and no Time  $\times$  Role interaction,  $F(1, 12) = .60, p = .45, \eta_p^2 = .05$ . Both tops and bottoms showed little change from before to after their scenes in the use of the word “we” to describe their relationship with their scene partner.

**Self-other overlap.** For the IOS, there was a significant main effect of time (baseline vs. postscene),  $F(1, 12) = 6.08, p = .03, \eta_p^2 = .34$ , no main effect of role,  $F(1, 12) = .61, p = .45, \eta_p^2 = .05$ , and no Time  $\times$  Role interaction,  $F(1, 12) = 1.88, p = .20, \eta_p^2 = .14$ . Both tops and bottoms indicated greater self-other overlap from baseline to postscene.

## Discussion

Researchers studying consensual sadomasochism (e.g., Baumeister, 1988; Newmahr, 2010; Pitagora & Ophelian, in press) have theorized that individuals pursue BDSM activities, in part, due to the pleasant altered states of consciousness these activities produce. However, to date, no research has tested whether BDSM activities actually facilitate altered states. To this end, we randomly assigned experienced BDSM practitioners to the top role or to the bottom role for BDSM scenes and examined the impact of this assignment on measures that reflect altered states. We hypothesized that topping would facilitate an altered state aligned with Csikszentmihalyi’s (1991) flow (measured with the Flow State Scale), and bottoming would facilitate an altered state aligned with Dietrich’s (2003) transient hypofrontality (measured with a Stroop test).

Consistent with predictions, tops reported high levels of flow. Unexpectedly, bottoms also reported high levels of flow. In fact, contrary to predictions, tops and bottoms reported nearly identical levels of flow across the full scale. However, an examination of the N/A responses revealed that some bottoms (but no tops) indicated that flow subdimensions associated with agency (challenge-skill balance, clear goals, immediate feedback) were not applicable to their experience. Likewise, a comparison of the optimal performance and autotelic absorption factors of flow showed consistent flow across both factors in tops but significantly lower levels of optimal performance than autotelic absorption in bottoms. These results suggest that topping facilitates flow, whereas bottoming facilitates pleasure and engagement but without the optimal intentional performance characteristic of flow.

A limitation of the present study is that flow was measured only once after the scene was over. Future studies that measured flow before and after a scene would be better able to determine whether the scene activities facilitated flow. In addition, the endorsement of N/A responses by bottoms on some flow items suggests that the Flow State Scale might not be the best scale to use to capture the relevant experiences of bottoms. A final concern with the Flow State Scale is that its questions are overt in what they are asking. It is plausible that participants

could have inferred what the scale is measuring and could have provided answers corresponding to what they believed the researchers were seeking. Validation with an alternative, covert measure of flow would help address this concern. The Stroop test seems less susceptible to this type of strategic responding, as intentionally manipulating a Stroop test would require artificially delaying either the incongruent trials (if one wanted a higher Stroop score) or the control trials (if one wanted a lower Stroop score).

Also consistent with predictions, bottoms, but not tops, displayed short term reductions in executive functioning consistent with transient hypofrontality. These results are consistent with Baumeister's (1988) theory that bottoming facilitates an escape from self, and they suggest a possible mechanism for this escape. Supporting this interpretation, bottoms' reported high levels of Loss of Self-Consciousness on the Flow State Scale ( $M = 4.54$ ,  $SD = 0.62$ , on the 1 to 5 scale).

Of course, transient hypofrontality is not the only mechanism that can reduce Stroop performance. For example, ego depletion has been shown to decrease Stroop performance (Inzlicht & Schmeichel, 2012). We believe that the transient hypofrontality hypothesis has the advantage of parsimony: The descriptions of subspace collected from MTurk respondents include elements that seem much more closely aligned with transient hypofrontality than with ego depletion ("one with nature and my environment," "very dreamlike," "an almost trance like state"). Furthermore, if bottoming consisted primarily of willful, effortful endurance (e.g., enduring the pain and humiliation while suppressing the desire to use a safeword to end the scene), we would expect bottoms to report increases in psychological stress and negative affect. Instead, bottoms reported reductions in stress and negative affect and rated their experience as highly autotelic (4.79 out of 5 on the autotelic dimension of the Flow State Scale). Nonetheless, a goal of future research might be to further explore the mechanisms of transient hypofrontality and ego depletion as they apply to BDSM activity.

These results help to illuminate one of the reasons why people choose to engage in BDSM activities: for the pleasurable altered states of consciousness that appear to be associated with these activities. However, we are not claiming

that BDSM is unique in facilitating these altered states. Prior research on flow has identified a number of activities that can facilitate flow (e.g., athletics, music, yoga). Likewise, prior research on transient hypofrontality has identified a number of activities that can facilitate this effect (e.g., running, meditation, certain drugs). Our study is, to our knowledge, the first to provide empirical evidence that BDSM also facilitates these altered states. We are not claiming, however, that BDSM is the only activity that does so.

### Additional Effects of Scenes

Prior research (Sagarin et al., 2009) reported a Role  $\times$  Time interaction for cortisol such that bottoms' cortisol increased significantly from baseline to just after the scene ended, whereas tops' cortisol did not change significantly from baseline to just after the scene ended. In the present study, the corresponding interaction was nonsignificant, but, nonetheless, showed a trend toward significance ( $p = .08$ ). Coupled with the findings that psychological stress (measured prescene to postscene) decreased for both tops and bottoms, we suggest that BDSM activities, despite their physical stress, can be psychologically stress relieving for practitioners. Negative affect also decreased from prescene to postscene for tops and bottoms, although the decrease occurred prescene for tops and during the scene for bottoms. Additionally, both tops and bottoms reported increases in sexual arousal during their scenes.

Taken as a whole, BDSM activities appear to facilitate subjectively enjoyable altered states of consciousness, reductions in psychological stress and negative affect, and increases in sexual arousal. Furthermore, although the broad pattern applies to both bottoms and tops, there are role differences in the nature of the altered states and the timing of the changes in affect.

### Sample Size

In this section, we consider the implications of our study's small sample size. Our  $N$  of 14 is clearly low and notably lower than prior studies of BDSM scenes (e.g., Sagarin et al., 2009, had a total  $N$  of 58). However, in contrast to prior studies in which participants chose their roles and provided fairly nonintrusive measures, the demands of this experiment (a willingness to be

randomly assigned to role; physiological and cognitive measures administered just prior to scene commencement and just after scene completion but prior to aftercare) set a higher bar for participant involvement.

Below, we consider whether the small sample size increases the risk of four types of errors: Type I error (the probability of a false positive result), Type II error (the probability of a false negative result), Type S error (the probability that a significant result is in the wrong direction), and Type M error (the probability that a significant result exaggerates the magnitude of the effect).

**Type I error.** The Type I error rate of a statistical test is held at a desired level based on the critical value chosen for statistical significance (typically .05), regardless of the sample size (a smaller sample size requires a larger effect size to achieve significance). Because our methodology and analyses do not include the types of questionable research practices that inflate the Type I error rate (e.g., post hoc exclusion of experimental conditions, post hoc inclusion of covariates in analyses, etc.; John, Loewenstein, & Prelec, 2012; Simmons, Nelson, & Simonsohn, 2011), the Type I error rate of our significance tests is held at 5%. We should note, however, that the separate significance tests we performed on each of our measures combined with our choice to not correct for alpha inflation (due to the a priori nature of our predictions) increases the experiment-wise Type I error rate.

**Type II error.** The Type II error rate of a statistical test increases as the sample size decreases. This is where our small sample size clearly carried costs: A number of potentially interesting findings were not significant despite the presence of moderate effect sizes.

**Type S and Type M errors.** Gelman and Carlin (2014) provides a statistical technique for estimating two additional risks: That significant results will have the wrong sign (a Type S error), and that significant results will overestimate the magnitude of the effect size (a Type M error). We used Gelman and Carlin's (2014) technique to estimate the Type S and Type M error rates for one of our primary findings: the Role (top vs. bottom)  $\times$  Time (baseline vs. postscene) interaction for Stroop scores. Gelman and Carlin's calculations use the standard error observed in the present study, but

they require an estimate of the population effect size that is not taken from the present study (this prevents a biased effect size estimate in the present study from biasing the calculation of the Type S and Type M errors).

Based on Cohen's (1988) description that a large effect would be obvious to a superficial glance, we estimated a population effect size corresponding to Cohen's rule of thumb value for large effects:  $d = 0.8$ . The analyses produced an estimated Type S error rate of 0.006 and an estimated Type M error rate of 1.91. From this, we can be fairly confident (99.4% probability) that our significant Stroop effect is in the correct direction, but our estimated effect size probably overestimates the actual population effect size by approximately a factor of 2.

## Implications and Future Directions

As noted above, ego depletion represents a plausible alternative explanation for the decrements in Stroop performance in bottoms. In addition, although the present data suggest that consensual BDSM activities can exert positive psychological effects (e.g., reductions in negative affect and self-reported stress), the present data cannot speak to the mechanisms that caused these effects. It is possible that these effects stemmed directly from the BDSM activities, but it is also possible that they stemmed indirectly via the increases in sexual arousal or one of the other measured or unmeasured effects of the BDSM scenes. Future studies that compared the effects of BDSM to the effects of other types of sexual/intimate activities (e.g., non-BSDM sexual behaviors, massage) would be of value in determining which effects (if any) are unique to BDSM.

Because the postscene survey was administered after participants engaged in aftercare, the "right now" questions on the postscene survey (the PANAS, self-reported stress, self-reported sexual arousal, "we"ness, and the IOS) and the 40-min postscene hormonal measures were likely impacted by aftercare. Future studies could disentangle the possible impact of aftercare by administering these measures before and after aftercare. In addition, it is not clear whether certain questions were interpreted as average across the scene or the peak during the scene. For example, it is not clear whether scene intensity represents the average intensity across

the scene or the peak intensity of the scene. Further, the effects observed in this study are almost certainly moderated by a variety of individual difference factors including a person's response to BDSM activities in general and with a particular partner. If we randomly selected a couple from the general population and asked them to engage in BDSM behavior, for example, their results would likely differ from the results of self-selected individuals.

The observed scenes varied greatly in terms of the activities that took place, the presence or absence of sexual activity, the presence or absence of orgasm, the length of the scenes, the decision whether to start setting up the scene during the 30-min waiting period, the relationship between the scene partners, and the genders, ages, sexual orientations, and other demographics of the participants. Unfortunately, the present sample size precludes an examination of whether certain scene elements (e.g., pain, bondage, sexual activity, orgasm, length of scene, timing of activities), relationship elements (e.g., level of experience, relationship quality, relationship novelty, attraction, trust between scene partners), or gender or other demographic pairings are associated with observed effects. Future research that tested these potential mediating processes and moderating variables and that measured additional personality and psychopathology characteristics (particularly with larger samples) would be of value. It should be noted, however, that the variation in scene activities and timing does not represent a confound, as each scene provided both a top and a bottom for analysis (and as a result, the variation in scene activities and timing were equally represented in both levels of the Role independent variable).

In addition, it would be of benefit for future studies to ask participants directly whether they had entered subspace or topspace, to administer related measures such as a state scale of dissociation, and to examine whether these subjective reports align with other measures of these altered states. Likewise, it would be of benefit for future studies to measure the effects of private BDSM activity. Although all participants in the current study consented to observation and reported that the observation had little impact on their scenes, it is possible that the observation impacted participants in a manner that they did not perceive. Finally, future studies

could profitably examine whether the present results replicate in individuals who show a strong preference for the top or bottom role. It is possible that individuals who exclusively take on the top role or the bottom role might more easily enter role-specific altered states of consciousness. Alternatively, experience in role, rather than exclusivity of role, might facilitate altered states.

## Conclusion

The present study provides preliminary evidence that consensual BDSM activities facilitate role-specific altered states of consciousness, with topping aligned with Csikszentmihalyi's (1991) flow and bottoming aligned with Dietrich's (2003) transient hypofrontality as well as some facets of flow. The results contribute to a growing body of evidence that individuals pursue BDSM for nonpathological reasons including the pleasant altered states of consciousness these activities are theorized to produce.

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