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ABSTRACT

Subliminal presentation of a stimulus can influence responses to later stimuli. This effect is known as priming. The current study used Microsoft PowerPoint as a novel, low-cost paradigm to present experimental stimuli. Thirty-one undergraduate participants viewed a PowerPoint presentation that contained conditions with no, with unscrambled, and with center-scrambled sexually-themed messages. The effects of gender, counterbalancing, and type of message on perceived sexual content in experimenter-made inkblots was assessed. The current study failed to find any significant differences or interaction effects between any of the variables. A post-hoc analysis revealed a significant priming effect. Possible confounding variables and suggestions for future research are discussed.

INTRODUCTION

Subliminal presentation of a stimulus has been shown to influence responses to later stimuli (Ferguson, Bargh, & Nayak, 2005). This effect is known as priming with the preceding stimulus known as a prime. Masking and short stimulus duration are used to render primes unidentifiable ("subliminal"). Even under these circumstances, however, a stimulus used as a prime is capable of priming a response to the target stimulus for a minimum of 1 second following the onset of the prime (Visser, Merikle, & Di Lollo, 2005).

Semantic priming studies use primed words to affect participants' later interpretation of other words (Abrams, 2005; Abrams & Greenwald, 2000; Abrams, Klinger, & Greenwald, 2002; Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996; Kouider & Dupoux, 2004). Evaluative priming studies can use a variety of stimuli as primes and rely on participants' automatic interpretation of the primed stimulus as "good" or "bad" to influence their reactions to later stimuli (Duckworth, Bargh, Garcia, & Chaiken, 2002; Ferguson et al., 2005; Klauer, Roßnagel, & Musch, 1997). Affective priming studies use emotionally laden stimuli as primes to affect participants' responses to later target stimuli (Hermans, Spruyt, De Houwer, & Eelen, 2003; Klauer, Mierke, & Musch, 2003).

Most priming studies use one consistent type of stimulus for both the prime and the target stimuli (i.e., one picture as a prime followed by another as the target stimulus). In

contrast, and in line with the current study, Spruyt, Hermans, De Houwer, and Eelen (2002) used word primes and picture targets as a condition in their Experiment 3. Unfortunately, they found only a marginally significant priming effect ($p = 0.079$). They claimed this result was because semantic processing of pictures is more effective than semantic processing of words, so pictures therefore serve both as better primes and as better target stimuli than do words.

The features of the stimuli used are known to affect priming effects. Processing of the masks can interfere with processing of the relevant stimuli (Ja kowski & Przekoracka-Krawczyk, 2005). Additionally, Storbeck and Robinson (2004) found that words used as primes need to be semantically related in order for priming to occur and Thomas and LaBar (2005) found greater priming effects when using "taboo" words rather than neutral words.

Another dimension that could be important with respect to using a word as the prime is the physical features of the word itself. Abrams (2005) found that subliminal processing occurred not for the whole word, but at four- to five-letter parts of words. Researchers have found that reading speed is slower for words with an altered shape (Rayner & Kaiser, 1975) and for words with the center letters scrambled (Rayner, White, Johnson, & Liversedge, 2006). According to Grainger and Whitney (2004), when some of the letters in the target word are deleted, the resulting word functions as a prime only when the letters are in order ("relative position priming," p. 58). Moreover, when all the letters are present, the letters can be jumbled and the resulting jumbled word will still function as a prime ("transposition priming," p. 58). In contrast, Perea and Lupker (2004) found that words with transposed letters functioned as primes only when the transposed letters were consonants as opposed to vowels. Furthermore, Christianson, Johnson, and Rayner (2005) found significant priming effects only when letter transpositions occurred within morphemes rather than across them.

In the current study, both unscrambled and center-scrambled sexual words, similar to the ones used by Thomas and LaBar (2005), will be used as primes. Experimenter-made inkblots will serve as target stimuli. Processing of center-scrambled words takes longer than processing of unscrambled words, possibly due to a lack of practice reading center-scrambled words. Therefore, center-scrambled words should not function as effectively as primes as will unscrambled words, hence more inkblots with unscrambled-word primes should be described sexually than will inkblots with center-scrambled primes or with no primes. Additionally, in order to highlight variables for future research, the effects of gender and of counterbalancing order will be assessed to determine if either affects the degree of sexual content participants perceive in inkblots.

METHOD

Participants

Thirty-one undergraduates (6 men and 25 women) recruited from psychology classes at South Dakota State University participated. The participants ranged from 18 to 22 years of age, with a mean age of 20.19 years ($SD = 1.33$ years). The group of

participants represented all undergraduate educational levels (n = 6 freshmen, n = 8 sophomores, n = 11 juniors, n = 6 seniors). The students received extra credit for their participation. All researchers involved in this study followed APA ethical guidelines (American Psychological Association [APA], 2002) and completed NIH online training on protection of human participants (http://cme.cancer.gov/clinicaltrials/learning/humanparticipant-protections.asp). The Institutional Review Board at South Dakota State University approved this project.

Materials

Sexual words, both taken from and modeled after those used by Thomas and LaBar (2005), were used as primes. The specific words used can be seen in Table 1. The chosen words were center-scrambled without respect to either morphemes or whether the letters were consonants or vowels. Experimenter-made inkblots were used as target stimuli. Participants circled on a data-recording sheet whether what they saw in the inkblot was violent, happy, human, drug-related, sad, angry, animal, or sexual in nature. These categories were staggered within each response to avoid biasing the participants' interpretations.

Procedure

Before participants were recruited, students in the upper level Experiments in Psychology class at South Dakota State University evaluated 20 inkblots rotated three different ways and 34 words for perceived sexual content on a 1-9 scale. The mean rating of sexual content in all inkblot orientations was assessed, and the ten blots with z-scores in the medium range of ratings were chosen for the study (chosen range: -0.28 to 0.30). The ratings of all participants for each word were averaged, and the ten words they rated as most graphic in terms of absolute ratings (range: 5.90 to 6.60) were chosen for the study.

Participants initially recruited for the study were told they would assess individual differences in the interpretation of abstract images. It was necessary to explain the project broadly, because if participants had known they would be viewing subliminal messages, they might have changed their behavior with respect to describing the inkblot content. Participants were fully debriefed following the experiment.

Table 1.

Words Used as Priming Stimuli

Unscrambled	Center-Scrambled
vagina	vniaga
clitoris	cioitlrs
orgasm*	oasgrm
masturbation	mubosatriatn
vibrator	vbatoirr
dildo*	dldio
ejaculate*	eltucjaae
incest*	iescnt
pussy*	pssuy
schlong*	snlchog

Note. An asterisk denotes words from Thomas and LaBar's (2005) study.

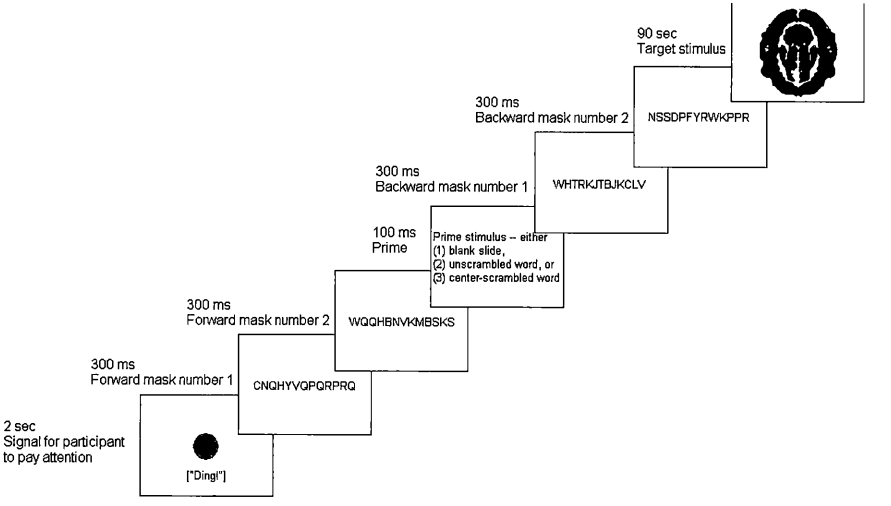

Figure 1. An example of the method used in the current study.

Figure 1 shows an example of the method. The experiment was conducted using Microsoft PowerPoint 2003. Participants were first shown a red dot (duration 2 s) on the overhead screen as a signal to pay attention. Two forward and two backward masks (duration 300 ms apiece), each a string of 13 consonants as in Abrams et al. (2002), appeared before and after the prime (duration 100 ms). In the control phase, the masking stimuli appeared before and after a blank slide (duration 100 ms). Finally, the inkblot appeared (duration 90 s) and the participants recorded what they saw in it. To make the 10 inkblots last for all 30 trials (10 control, 10 unscrambled primes, 10 center-scrambled primes), the inkblots were used right-side up, rotated 90 degrees to the left, and upside-down. Participants saw all the slides for one type of prime before advancing to the next type of prime. Conditions were Latin-square counterbalanced and consisted of three phases: (1) control, unscrambled, center-scrambled; (2) unscrambled, center-scrambled, control; and (3) center-scrambled, control, unscrambled.

RESULTS

Figure 2 depicts the mean (SD) number of inkblots participants described as containing sexual content. Panel A represents the women and Panel B represents the men. In all counterbalancing orders for the no prime condition, men tended to see more inkblots as sexual than did women. In two of three counterbalancing orders for both priming conditions, however, women tended to perceive more inkblots as containing sexual content than did men. All effects were observed through considerable variability except for the third counterbalancing order for men, in which there was only one participant and hence no standard deviation.

A 3 (counterbalancing order) x 2 (gender) x 3 (type of prime) mixed between-within subjects ANOVA was conducted to test priming effects. The results are shown in Table 2. Neither counterbalancing order (S; $F(2, 25) = 0.13$, $p = 0.88$), gender (G; $F(1, 25) = 0.01$, $p = 0.91$), nor type of prime (P; $F(2, 50) = 2.67$, $p = 0.08$) had any significant main effect. Similarly, no interaction effects were significant. Because the main effect of type of prime was marginally significant and collapsing across gender and counterbalancing condition showed the mean number of inkblots described sexually to be very similar for the unscrambled ($M = 4.97$, $SD = 3.10$) and center-scrambled ($M = 4.48$, $SD = 3.08$) priming phases, a post-hoc paired-samples t-test was conducted between the control and the unscrambled prime conditions. This analysis was significant, revealing a priming effect, $t(30) = -4.20$, $p = 0.0002$ (two-tailed).

DISCUSSION

The nonsignificant main effect of counterbalancing condition suggests that counterbalancing does not affect priming effects. Too few men participated in this study to draw any inferences about the effect of gender on priming effects. Importantly, because the words used in the current study were center-scrambled without concern either for morphemes or for vowel position, the similarity in the means of the unscrambled and center-scrambled priming phases somewhat contradicts Christianson et al.'s (2005) and Perea and Lupker's (2004) findings.

The marginal significance of the main effects of type of prime and the significance of the post-hoc t-test suggest that a priming effect was obtained in this study, a finding that contrasts with Spruyt et al.'s (2002) assertion. One reason for this effect might have been that the computers

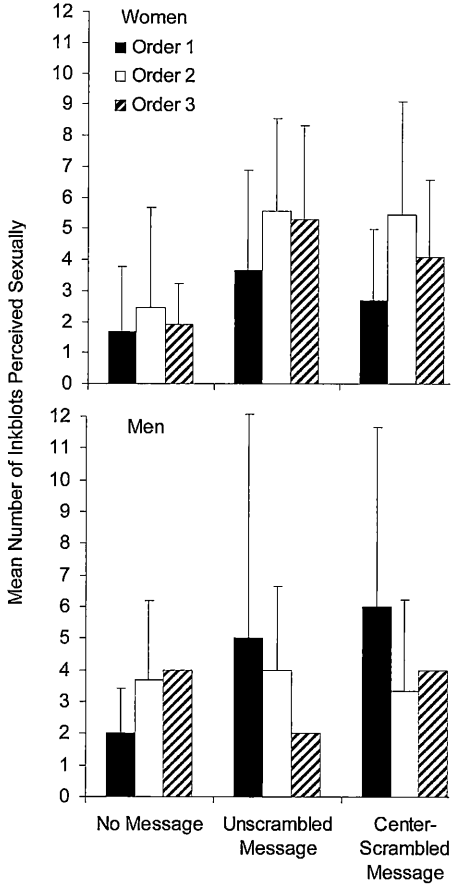

Figure 2. Average (SD) number of inkblots described as containing sexual content by counterbalancing order and type of prime. Panel A represents women and Panel B represents men.

and projectors used during experimental sessions were much slower than the computers and projectors used during the design phase of the study. This problem led to the masks and primes remaining on screen for longer than the planned durations, making it possible for the participants to read all the primes and eliminating the subliminal aspect of the priming. The timing problem might also have added in practice effects despite the use of counterbalancing. According to Abrams (2005), the greatest subliminal semantic priming effects occur when the primes have first been viewed supraliminally. Because the unscrambled and center-scrambled primes were the same words and were viewed clearly due to the timing problems, practice could account for the priming effect observed.

Table 2.

Analysis of Variance

Source	*df*	*F*	*p*
	Between subjects		
Session (S)	2	0.13	0.88
Gender (G)	1	0.01	0.91
S × G	2	0.47	0.63
Error	25	(16.28)	
	Within subjects		
Prime (P)	2	2.67	0.08
P × S	4	0.23	0.92
P × G	2	1.08	0.35
P × S × G	4	1.07	0.38
Error (P)	50	(5.13)	

One of the largest confounds in the current study was the aforementioned timing problems. Because 100 ms is both the shortest slide duration possible in the 2003 version of PowerPoint and the maximum recommended duration for subliminal stimuli (Greenwald & Abrams, 2000), PowerPoint is not recommended for future priming studies until technology improves significantly. Participants reported fatigue due to the long response duration when leaving the study, so future research should use a shorter response window. Based on observation of the participants during the sessions, it is suggested that 30 seconds is an optimal response window for a task such as this one.

Though the majority of participants responded that they had never heard anything about inkblot tests, they were primarily psychology majors who could have experience with other projective tests and might expect sexual content. The nonmatching stimulus modalities used also do not allow easy comparisons with the results of similar priming studies. An interesting offshoot of this experiment, based on Spruyt et al.'s (2002) assertion that pictures make better primes than words, would be to use sexually explicit pictures rather than words.

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