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LOOKING AT THE OTHER SIDE OF THE COIN: A META-ANALYSIS OF SELF-REPORTED EMOTIONAL AROUSAL IN PEOPLE WITH SCHIZOPHRENIA

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Abstract

Abnormalities in emotional experience have long been viewed as core features of schizophrenia. Numerous studies indicate that people with schizophrenia report less pleasure than controls when reporting non-current feelings using trait, hypothetical, prospective, and retrospective emotional self-report formats; however, current research has demonstrated that schizophrenia patients and controls do not differ in their subjective reactions to emotional stimuli in most laboratory studies. Although substantial attention has been paid to studies examining self-reported valence in schizophrenia, subjective reports of arousal in response to affective stimuli have been neglected. Understanding the role of arousal in schizophrenia is imperative given that valence and arousal are differentially associated with physiological and behavioral responses. To understand the role of self-reported arousal, a meta-analysis of 26 published studies employing laboratory emotion induction paradigms in patients with schizophrenia and healthy controls was conducted. Medline, PsycINFO, Web of Science, and PubMed electronic databases and reference lists from identified articles were used as data sources. Using a random effects model, analyses demonstrated that controls and people with schizophrenia reported similar levels of subjective arousal in response to pleasant and unpleasant stimuli; however, people with schizophrenia reported experiencing greater arousal than controls in response to neutral stimuli. Furthermore, moderator analyses suggested that gender and methodological factors, such as rating scale and stimulus type, may affect these patterns of results and play a key role in determining whether patients and controls differ in self-reported arousal.

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Conflict of Interest

The authors have no conflicts of interest.

Contributors

All authors contributed to and have approved the final manuscript. Conceptualization, statistical analysis, and writing of the first draft of the manuscript were performed by Katiah Llerena and Gregory P. Strauss. Alex Cohen has contributed to the writing of this manuscript.

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Keywords

Emotional Experience; Affect; Psychosis

1. Introduction

Anhedonia has long been considered a core negative symptom of schizophrenia (Bleuler, 1952; Kraepelin, 1919). However, recent empirical research contradicts these early conceptualizations of anhedonia as a diminished capacity for pleasure, as studies have consistently shown that individuals with schizophrenia report levels of in-the-moment positive emotion that are similar to controls in response to pleasant stimuli or real-world activities (Gard et al., 2007; Heerey & Gold, 2007; Herbener et al., 2008; Kring & Neale, 1996; Oorschot et al., in press). A recent meta-analysis of laboratory-based studies by Cohen and Minor (2010) supported the conclusions of these studies, indicating that people with schizophrenia did not report experiencing less state pleasure than controls in response to pleasant stimuli. However, patients did report experiencing increases in negative affectivity in relation to unpleasant, neutral, and pleasant stimuli. These findings have led some to conclude that anhedonia should no longer be considered a diminished capacity for pleasure in schizophrenia (see Strauss & Gold, 2012 for a review)

Although substantial attention has been paid to studies examining self-reported “valence” in schizophrenia, reports of pleasantness are only one component of emotional experience. In a prominent model of emotional experience, the valence-arousal model, it has been proposed that emotions exist within a two-dimensional space, with one axis representing arousal (*low* to *high*) and the other valence (*pleasant* to *unpleasant*) (Feldman Barrett & Russell, 1999). These two dimensions have been proposed to be critical for motivational activation, with valence determining whether the appetitive or defensive motivational system is activated, and arousal dictating the intensity of that activation (Bradley et al., 2001). There is substantial support for the existence of these two factors in studies examining the hierarchical structure of emotion (Mehrabian & Russell, 1974; Osgood et al., 1957; Smith & Ellsworth, 1985) and evidence that this structure applies to people with schizophrenia as well (Kring et al., 2003). Given the importance of arousal in determining motivational activation, and the known volitional deficits affecting people with schizophrenia (see Foussias & Remington, 2010 for review), it is possible that arousal may be a more important aspect of the motivational and affective deficits in schizophrenia than has previously been considered.

Understanding the role of arousal in schizophrenia, in addition to that of valence, is imperative given that valence and arousal are differentially associated with physiological and behavioral responses. For example, valence is strongly associated with startle reflex responsivity, heart rate acceleration/deceleration, and facial muscle responsiveness (e.g., Lang et al., 1993; Springer et al., 2007; Wolf et al., 2005; Vrana & Gross, 2004), whereas arousal is associated with skin conductance, viewing time, interest ratings, and early and late Event Related Potential (ERP) components (e.g., Hempel et al., 2007; Schmidt et al., 2011; Zhang et al., 2011). Additionally, arousal, rather than valence, has been found to play a more prominent role in determining the extent to which emotional stimuli influence cognitive processes (e.g., Cahill & McGaugh, 1998; Anderson, 2005). If the subjective experience of arousal is abnormal in schizophrenia, it is possible that such abnormalities could predict a variety of affective dysfunctions, aberrant cognition-emotion interactions, or psychiatric symptoms; however, few studies have examined associations between arousal and such processes.

Studies examining self-reported arousal to emotional stimuli in schizophrenia have produced mixed results. For example, several studies indicate no differences in arousal between patients and controls, while others find that patients report either higher or lower arousal than controls. These findings are further complicated by inconsistencies in patient and control responses to pleasant, unpleasant, and neutral stimuli, as well as differences in sample size, sample characteristics, rating scale procedures (e.g., whether scales range from low to high or calm to excited), and stimulus type (e.g., photographs, film clips, words). Given these considerations, the current study aimed to elucidate the nature of emotional arousal in schizophrenia via a comprehensive meta-analysis.

2. Method

2.1. Search Strategy and Creation of Database

To identify relevant publications for the current meta-analysis, we conducted a combined MEDLINE and PsycINFO search for all studies having “schizophren*” and “arousal” and “emotion” yielding 59 entries. We also conducted a search on Web of Science (112 entries) and Pubmed (347 entries) with the same search terms. The reference lists from these articles were also examined to identify additional publications. We considered studies for inclusion if: (1) the article was an empirical study published in a peer-reviewed journal, (2) the study included an emotion induction paradigm broadly defined, (3) the study reported sufficient detail on participant subjective arousal ratings in response to the stimulus using a self-report scale following the emotion manipulation, (4) the study compared arousal ratings from a patient group diagnosed with schizophrenia to a non-psychiatric control group, and (5) the study was reported in English. Authors were contacted when there was not sufficient data to allow calculation of effect sizes. When studies appeared to use overlapping samples, we used data only from one of these studies. One study was eliminated on this basis (Herbener, et al., 2008). Studies requiring subjects to rate the “intensity” of their reaction to emotional stimuli were not included, as these ratings conflate valence and arousal. Several studies examined constructs related to arousal (e.g., activation); however, these studies were not included because they did not include a single rating scale and these ratings may reflect a combination of valence and arousal, rather than arousal alone (Earnst & Kring, 1999; Kring & Earnst, 1999). In all, 26 studies were included in the present meta-analysis (see Table 1).

When studies presented data for multiple stimuli (e.g., words, sounds, pictures) (e.g., Dowd & Barch, 2010; Trémeau et al., 2009), valence categories (e.g., Mathews & Barch, 2004), patient groups (e.g., Yee et al., 2010), or sexes (e.g., Kring et al., 2011), the means and standard deviations were averaged together.

2.2. Statistical Analysis

Comprehensive Meta-Analysis version 2 (Borenstein et al., 2000) was used to conduct analyses. Effect sizes were calculated as the mean difference between schizophrenia and healthy control group divided by the pooled standard deviation and adjusted for small sample bias (Hedges g). Effect sizes were weighted and combined by via a random effects model (i.e., weighted by variance). The 95% confidence interval and Q statistics based on chi-squared distributions were calculated to estimate homogeneity of effect sizes across studies. Publication bias was examined via Orwin’s fail-safe N , which is the number of unpublished studies with null effects that would be needed to reduce the obtained effect size to a negligible level (0.20). Publication bias was also examined via funnel plots, which graph Hedges g for individual studies against the standard error. A lack of symmetry around the overall effect size indicates publication bias.

A series of analyses were calculated to examine group differences in self-reported arousal and potential moderator variables. First, we computed effect sizes comparing patients and

controls in their subjective arousal ratings following pleasant, unpleasant, and neutral stimuli for each individual study. Second, weighted mean effect sizes were calculated for the pleasant, unpleasant, and neutral conditions. Third, to examine the degree to which effect sizes varied across studies as a function of stimulus and rating scale type, we divided studies according to stimulus type (pictures, words, faces, sounds, and a virtual reality conversation task) and rating scale type (calm to excited anchors vs. high to low anchors), and re-calculated analyses across valence conditions. Finally, we conducted meta-regressions to determine whether sex (% male) and negative and positive symptoms were possible effect size moderators. Studies typically used the PANSS (Kay et al., 1991), SANS (Andreasen, 1983), SAPS (Andreasen, 1983), and the BPRS (Overall & Gorham, 1962) to assess negative and positive symptoms. To account for the use of multiple measures across studies, a composite score was calculated by dividing the total symptom score by the maximum possible score for that scale/subscale.

3. Results

An initial meta-analysis across 26 studies yielded an effect size of $g = 0.034$. The Q statistic was nonsignificant ($Q(25) = 24.29$, $p > 0.05$) indicating homogeneity no greater than that expected from sampling error alone. Table 1 presents effect sizes and variance scores for individual studies (see Supplementary Materials for figures).

Patient arousal ratings in response to pleasant stimuli were highly variable across studies ranging from $g = -0.65$ to 0.56 . In all, 12 of the 24 studies utilizing pleasant stimuli indicated that patients reported experiencing higher arousal than controls at a small effect size or larger. Second, in 20 of 22 studies using neutral stimuli, patients reported higher arousal than controls at a small effect size or greater (g 's ranged from -0.44 to 1.55). Finally, effect sizes for studies using unpleasant stimuli were more variable ($g = -1.85$ to 0.65), with 18 of 26 studies indicating that patients reported less arousal than controls at a small effect size or larger.

Table 2 contains the weighted mean effect sizes for patients vs. controls from the pleasant, unpleasant, and neutral conditions. Arousal ratings for pleasant and unpleasant stimuli were similar between groups, with mean weighted effect sizes of $g = -0.05$ and $g = -0.14$, respectively. However, patients reported experiencing more arousal than controls in response to neutral stimuli ($g = 0.427$). Nonsignificant Q statistics for each valence condition indicated homogeneity among the effect sizes (all p 's > 0.05 ; Table 2). In summary, arousal ratings were higher in people with schizophrenia than controls in response to neutral stimuli, but the groups were similar in self-reported arousal in response to pleasant and unpleasant stimuli.

Examination of the funnel plots for each valence condition (see Supplementary Materials) showed that most studies were grouped tightly and symmetrically around the overall effect indicating the absence of publication bias. Orwin fail-safe N for each valence condition is presented in Table 2.

Further analyses examined whether stimulus type had an effect on arousal ratings, which was accomplished by dividing studies into those that only used complex picture stimuli ($n = 21$) (e.g., IAPS pictures) and those that used all other stimulus types (i.e., words, faces, sounds, virtual reality conversation tasks). The latter category subsumed all other stimuli because few studies ($n = 8$) employed the use of stimuli other than complex pictures. Patients and controls rated pleasant and unpleasant stimuli similarly for complex pictures or other stimulus types (see Table 2). However, a different pattern of results emerged for neutral stimuli. For complex pictures, neutral images were rated as more arousing by patients ($g = 0.44$), but other neutral stimuli were rated similarly to controls ($g = 0.13$).

Thus, it appears that complex pictures elicit differences among patients and controls while other stimulus types may not.

Studies were also divided based upon rating scale type to determine whether arousal ratings differed based on how participants were instructed to rate stimuli. Studies were categorized based on whether they employed a calm to excited ($n = 17$) versus a low to high ($n = 9$) scale for making arousal ratings in response to stimuli. For pleasant stimuli, patients and controls reported experiencing similar arousal using both scale types. For neutral stimuli, patients rated neutral stimuli higher than controls for both rating scale types ($g = 0.33$ for the calm to excited scale; $g = 0.55$ for the low to high scale). For unpleasant stimuli, people with schizophrenia rated stimuli as less arousing than controls when making ratings based on the calm to excited scale, ($g = -0.24$), but reported experiencing the stimuli similarly to controls using the low to high scale ($g = 0.02$). Thus, scale type appeared to have differential effects on arousal ratings for unpleasant stimuli.

Moderator analyses were conducted to examine the role of sex and negative and positive symptoms. Sex was a significant moderator for neutral stimuli ($n = 26$, $Z = 2.17$, $p = 0.03$), such that males report higher arousal for neutral stimuli, but not for pleasant or unpleasant stimuli, ($ps = 0.34$ and 0.36 respectively). Positive and negative symptoms were not significant moderators for any of the stimulus conditions (studies reporting positive symptoms $n = 15$; negative symptoms $n = 18$; $ps > 0.38$).

4. Discussion

In general, results indicated that individuals with schizophrenia and controls reported similar levels of arousal in response to evocative stimuli. However, there were important differences noted for neutral stimuli, and these were moderated by methodological factors and sex. These findings extend the recent meta-analysis on valence (Cohen & Minor, 2010) by indicating that patients also do not display a deficit arousal, the second major component of emotional experience, which could potentially be expected if they are in fact anhedonic.

With regard to unpleasant stimuli, the primary analysis indicated a trend toward patients reporting less arousal than controls. However, subsequent analyses examining the role of methodological factors indicated that rating scale type may have a crucial influence on reported arousal, as people with schizophrenia reported experiencing less arousal than controls when studies used rating scale anchors ranging from calm to excited, but not with low to high anchors. There are several potential explanations for why people with schizophrenia reported less arousal using the calm to excited scale, but not the high to low scale. Arousal ratings that are made using the calm to excited scale presumably require participants to access their physiological states to determine how agitated/keyed-up stimuli make them feel (Schachter & Singer, 1962), especially when made using the commonly employed Self Assessment Manikin (SAM) procedure. Lower arousal to unpleasant stimuli may reflect that patients do not feel as agitated or excited internally when exposed to unpleasant stimuli. Unfortunately, very few studies have included both self-report and physiological measures of emotional response and these have produced inconsistent results (Hempel et al., 2005; Taylor et al., 2002; Volz et al., 2003; Williams et al., 2004, 2007; Yee et al., 2010; Hempel et al., 2005, 2007; Schlenker et al., 1995). Thus, it will be important for future studies to directly examine the correspondence between physiological measures and self-reported arousal.

Another important finding was that patients reported higher arousal than controls when exposed to neutral stimuli ($g = 0.43$). This was true in relation to both complex pictures and other stimulus types, as well as across both sets of rating scale instructions (i.e., calm-excited and low-high). These findings parallel those of the meta-analysis on valence (Cohen

& Minor, 2010), which also noted abnormalities in relation to neutral stimuli such that patients report greater negative emotions than controls when exposed to neutral stimuli. It is currently unclear whether these two findings are related; however, it is certainly possible. One interpretation of this result is that people with schizophrenia are in a higher state of arousal at rest, and it is not until they are processing arousing emotional stimuli that they appear similar to controls in their self-reported arousal ratings. If future studies obtaining “pre-stimulus” exposure baseline arousal ratings find this to be true, such evidence would be consistent with elevated “trait” arousal in schizophrenia. Another potential explanation, which has been suggested by prior research, is that people with schizophrenia may misattribute affective meaning to a range of neutral stimuli and that this may result from increased emotional arousal- this may particularly be true of patients meeting criteria for the paranoid subtype (Haralanova et al., 2011). Overarousal to neutral stimuli has been postulated to be a core concept in theories of psychosis as a state of aberrant salience (Kapur, 2003; Kapur, Mizrahi, & Lee, 2005) and emotional dysregulation (Aleman & Kahn, 2005). Finally, it may be the case that patients show abnormal self-reported arousal in response to images that are relatively low in arousal regardless of emotional valence. Studies using IAPS images do not typically match positive and negative picture conditions with a neutral condition on normative levels of self-reported arousal, so it is unclear whether this is true.

We also examined possible demographic and clinical moderators of arousal. Sex was a significant moderator, such that males were more likely to report higher arousal for neutral stimuli; however, negative and positive symptoms were not significant moderators. It may not be surprising that negative symptoms did not correlate with in-the-moment arousal ratings given that some clinical rating scales do not include anhedonia items in their negative symptom subscales (e.g., PANSS), and the ones that do primarily assess *pleasure-seeking* behavior (e.g., SANS). One would not necessarily expect in-the-moment subjective feelings to relate to these aspects of negative symptoms since such items do not reflect self-reported emotional experience. Results of the moderator analyses have several practical implications: future studies should examine sex differences; decisions regarding rating scale type should be made knowing that low/high and calm/excited scales produce different results; stimulus selection is important since effects may differ between complex photographs and other induction methods; and equating valence categories on lower-level visual features and other factors such as sociality, as done in Haralanova et al (2001) will also be important.

The current meta-analysis does not address several limitations in our understanding of self-reported emotional arousal in schizophrenia. Arousal ratings may differ across various manifestations of the disorder. For example, some studies considered in this meta-analysis included people in the chronic phase of the illness, whereas others examined patients earlier in the course of the disease. Prospective longitudinal studies would be informative in this regard. Studies should also examine whether arousal ratings differ across subtypes of schizophrenia. Additionally, all studies in this meta-analysis included medicated patients; therefore it is not clear to what degree emotional arousal varies as a function of antipsychotics or D2 blockade.

In summary, the current meta-analysis found that people with schizophrenia report higher arousal ratings in response to neutral stimuli compared to controls, but the groups experience pleasant and unpleasant stimuli similarly. However, these effects are moderated by methodological factors (rating scale and stimulus type) and sex. Future studies are needed that examine the correspondence between valence and arousal, as well as how subjective arousal predicts whole-body response across multiple channels of emotional responding (e.g., peripheral and central nervous system response, behavioral response).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Descriptive Data, ES, and VAR for Self-Report Arousal Ratings from Positive, Neutral, and Negative Emotion Induction Conditions

Study Citation	Stimulus Type	Rating Scale Type	Medicated?	Patient Control, n	% Male	ES ± VAR: Positive	ES ± VAR: Neutral	ES ± VAR: Negative
Aminoff et al. (2011) ^a	Pictures	Low to High	Yes	102 – 135	53%	---	0.06 ± 0.02	-0.50 ± 0.02
Dowd & Barch (2010)	Pictures, words, faces	Low to High	Yes	40 – 32	65%	-0.26 ± 0.06	0.48 ± 0.24	-0.06 ± 0.06
Horan et al. (2010)	Pictures	Low to High	Yes	38 – 36	78%	0.23 ± 0.05	-0.44 ± 0.05	0.65 ± 0.06
Linden et al. (2010)	Faces	Calm to Excited	Yes	34 – 34	82%	-0.02 ± 0.07	0.51 ± 0.07	-0.22 ± 0.07
Yee et al. (2010)	Pictures	Calm to Excited	Yes	75 – 74	84%	-0.38 ± 0.03	0.05 ± 0.03	-0.20 ± 0.03
Tréneau et al. (2009)	Pictures, faces, sounds	Low to High	Yes	64 – 32	83%	-0.58 ± 0.05	0.79 ± 0.22	0.26 ± 0.05
Weber et al. (2009) ^b	Pictures	Calm to Excited	Yes	15 – 20	69%	0.56 ± 0.12	0.39 ± 0.12	-0.11 ± 0.12
Strauss & Herbener (2011)	Pictures	Calm to Excited	Yes	49 – 50	50%	-0.14 ± 0.04	---	-0.47 ± 0.04
Heerey & Gold (2007)	Pictures	Calm to Excited	Yes	41 – 31	57%	0.03 ± 0.06	0.34 ± 0.06	-0.07 ± 0.06
Hempel et al. (2007)	Pictures	Calm to Excited	Yes	26 – 21	100%	0.26 ± 0.08	---	-0.48 ± 0.09
Burbridge & Barch (2007)	Pictures, words, faces, sounds, film clips	Calm to Excited	Yes	49 – 47	56%	0.56 ± 0.04	0.00 ± 0.04	0.56 ± 0.04
Lee et al. (2006)	Pictures	Calm to Excited	Yes	21 – 20	44%	0.00 ± 0.31	---	-0.04 ± 0.09
Rockstroh et al. (2006)	Pictures	Calm to Excited	Yes	11 – 12	100%	0.42 ± 0.17	0.71 ± 0.42	-0.02 ± 0.16
Hempel et al. (2005)	Pictures	Calm to Excited	Yes	28 – 30	81%	-0.28 ± 0.07	1.55 ± 0.09	-1.85 ± 0.10
Quirk & Strauss (2001)	Pictures	Calm to Excited	Yes	20 – 10	100%	0.27 ± 0.14	0.03 ± 0.14	0.49 ± 0.15
Quirk et al. (1998) ^c	Pictures	Calm to Excited	Yes	30 – 10	100%	-0.01 ± 0.13	0.44 ± 0.13	-0.16 ± 0.13
Volz et al. (2003)	Pictures	Calm to Excited	Yes	49 – 46	42%	-0.29 ± 0.04	0.16 ± 0.04	-0.05 ± 0.04
Ursu et al. (2011)	Pictures	Low to High	Yes	23 – 24	72%	0.05 ± 0.08	0.64 ± 0.29	-0.28 ± 0.08
Kring et al. (2011)	Pictures	Calm to Excited	Yes	31 – 28	64%	-0.44 ± 0.07	0.31 ± 0.07	-0.15 ± 0.07
Wynn et al. (2010)	Pictures	Low to High	Yes	34 – 36	73%	0.02 ± 0.06	0.86 ± 0.06	-0.24 ± 0.06
Choi et al. (2010)	Virtual reality conversation task	Calm to Excited	Yes	26 – 26	42%	-0.08 ± 0.08	---	-0.63 ± 0.08
Schlenker et al. (1995)	Pictures	Low to High	Yes	34 – 24	100%	0.22 ± 0.07	0.66 ± 0.07	0.44 ± 0.07
Mathews & Barch (2004)	Pictures	Calm to Excited	Yes	27 – 28	64%	-0.37 ± 0.07	-0.11 ± 0.07	0.01 ± 0.07
Park et al. (2009)	Virtual reality conversation task	Calm to Excited	Yes	27 – 27	52%	-0.65 ± 0.08	0.36 ± 0.07	-0.63 ± 0.08
Haralanova et al. (2011)	Pictures	Low to High	Yes	30 – 30	100%	---	1.70 ± 0.09	0.04 ± 0.07
Hall et al. (2007)	Pictures	Low to High	Yes	20 – 20	65%	0.46 ± 0.09	0.39 ± 0.10	0.00 ± 0.10

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Note: ES: effect sizes (Hedges' g); VAR: variance scores.

- ^a Sample size excludes patients with bipolar disorder.
- ^b Sample size excludes patients with major depression, substance use disorders, and borderline personality disorder.
- ^c Control group had a past diagnosis of substance use disorders.

Table 2
Mean Weighted Effect Sizes for Arousal Ratings from Positive, Neutral, and Negative Emotion Induction Conditions

Emotion Induction Condition	Total Number of Studies	Total Number of Patients	Total Number of Controls	Mean Weighted Effect Size	95% Confidence Interval	Q_{total}	Orwin Statistic
Positive	24	812	718	-0.05	-0.19 – 0.09	22.19	0
Neutral	22	822	766	0.43***	0.23 – 0.63	22.29	16
Negative	26	944	883	-0.14	-0.32 – 0.04	26.93	0
Rating Scale							
Low – High							
Positive	7	253	202	-0.01	-0.27 – 0.26		
Neutral	9	385	367	0.55***	0.18 – 0.93		
Negative	9	385	367	0.02	-0.26 – 0.30		
Calm – Excited							
Positive	17	559	514	-0.07	-0.21 – 0.10		
Neutral	13	437	397	0.33***	0.11 – 0.55		
Negative	17	559	514	-0.24*	-0.47 – -0.00		
Stimulus Type							
Pictures							
Positive	19	683	591	0.05	-0.09 – 0.19		
Neutral	18	739	685	0.44	0.19 – 0.70		
Negative	21	815	756	-0.13	-0.32 – 0.07		
Other							
Positive	6	218	179	-0.02	-0.40 – 0.36		
Neutral	5	192	153	0.13	-0.29 – 0.55		
Negative	6	218	179	-0.12	-0.47 – 0.24		

Note:

* = $p < .05$.

** = $p < .01$.

*** = $p < .001$.