



Intertrial variability in emotive reactions to approach-motivated positive pictures predicts attentional narrowing: The role of individual differences

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ARTICLE INFO

Keywords:

Approach motivation
Cognitive scope
Beta suppression
Individual differences
Intertrial variability

ABSTRACT

Previous research has found that high approach-motivated positive affect narrows cognitive scope. Additionally, this narrowing of cognitive scope in high approach-motivated states is related to neural correlates of motor-action preparation, including beta suppression over the motor cortex. However, past studies have only examined these effects averaging across trials, without accounting for individual variability from trial-to-trial. Across two studies, the present research investigated how individual differences in motor-action preparation related to individual differences in cognitive narrowing. Experiment 1 had participants view affective or neutral pictures and then respond to a Navon letters task. Results indicated that there was a more positive relationship between beta suppression to approach-motivated positive pictures and local targets than either beta suppression to approach-motivated positive pictures and global targets or beta suppression to neutral pictures and local targets. Experiment 2 replicated these results using alcohol pictures. These experiments suggest that individual differences in beta suppression predict greater narrowed cognitive scope to appetitive pictures. Assessing individual differences in neurophysiological and emotive responses to pictures reveals individual variations in cognitive processing.

1. Introduction

Past research has found that both positive and negative affective states high and low in approach motivation intensity have differential effects on cognitive scope (Gable & Harmon-Jones, 2010a; Harmon-Jones, Gable, & Price, 2013). More specifically, the motivational intensity model of cognitive scope suggests that high approach-motivated affects (i.e., pregoal states) narrow cognitive scope, while low approach-motivated affects broaden cognitive scope (i.e., postgoal states; Gable & Harmon-Jones et al., 2016). For example, research has found that high approach-motivated affects narrow attentional scope (Domachowska et al., 2016; Gable & Harmon-Jones, 2008a, 2010b), facilitates better memory for centrally-presented information (Gable & Harmon-Jones, 2010c; Threadgill & Gable, 2018a), shortens time perception (Gable & Poole, 2012), and narrows cognitive categorization (Gable, Poole, & Harmon-Jones, 2015). Additionally, narrowing of cognitive scope appears to engage neural circuitry associated with high approach motivation, further suggesting high approach motivation drives narrowing of cognitive scope in positive affect (Arnsten & Rubia, 2012; Gable & Harmon-Jones, 2010d; Harmon-Jones & Gable, 2009). In contrast, other research has found that low approach-motivated affects broadens cognitive scope, including broadening attentional scope

(Gable & Harmon-Jones, 2010b, 2011a) and facilitating better memory for peripherally-presented information (Gable & Harmon-Jones, 2010c; Threadgill & Gable, 2018a).

High approach-motivated affects likely narrow cognitive scope in order to facilitate the pursuit and acquisition of desirable goals by preparing an individual for tenacious goal pursuit (Harmon-Jones, Price, & Gable, 2012; Hart & Gable, 2013; Kaplan, Van Damme, & Levine, 2012; Larsen & Steuer, 2009; Threadgill & Gable, 2018b). A narrow cognitive scope focuses cognitive resources on the desired object or goal and increases the likelihood of goal attainment (Kaplan et al., 2012; Threadgill & Gable, 2016, 2018c). In order to successfully obtain the object or goal, the individual must plan and execute motor actions. Therefore, it seems like high approach-motivated affects would influence neural mechanisms associated with motor-action preparation.

One psychophysiological measure of motor-action preparation is beta band (13–30 Hz) suppression over the motor cortex (Pfurtscheller, Stancák, & Neuper, 1996). Beta suppression occurs while an organism is preparing to make a movement. As preparation for motor activity increases, beta activity decreases (McFarland, Miner, Vaughan, & Wolpaw, 2000; Sanes & Donoghue, 1993). Other research using transcranial alternating-current stimulation has found that decreasing beta suppression over the motor cortex (i.e., more beta activity) slows the

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<https://doi.org/10.1016/j.biopsycho.2018.12.015>

Received 25 June 2018; Received in revised form 1 December 2018; Accepted 28 December 2018

Available online 31 December 2018

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onset of future hand and finger movements (Pogosyan, Gaynor, Eusebio, & Brown, 2009; Wach et al., 2013), while increasing beta suppression over the motor cortex is related to faster motor movement (Meadows, Gable, Lohse, & Miller, 2016a). Together, this past work suggests that beta suppression indexes motor-action preparation, especially in high approach-motivated states (Jenkinson & Brown, 2011).

Recent research has found that high approach-motivated positive affect is related to greater state and trait beta suppression (Gable, Mechin, & Neal, 2016; Meadows et al., 2016a; Meyniel & Pessiglione, 2014; Threadgill & Gable, 2018d). As state or trait approach motivation increases, beta suppression increases. This likely occurs because pregoal positive affects appear to facilitate acquisition of desirable goals (Kaplan et al., 2012; Larsen & Steuer, 2009). High approach-motivated affect should prime organisms to plan and prepare goal pursuit behaviors more efficiently. Consequently, by increasing approach motivation, it may be the case that an organism is better prepared for goal pursuit and increase the likelihood of successfully attaining the goal (Sutton & Barto, 1998).

One problem when studying approach-motivated positive affect is that individuals vary in how they respond to desirable stimuli (Gable & Harmon-Jones, 2008b). For example, individuals may vary in approach-motivational responses to pleasant pictures, such that some pleasant stimuli (e.g., chocolate desserts) may be more approach-motivating than other pleasant stimuli (e.g., fruit desserts; for example of fruit desserts being more approach-motivating than chocolate desserts, see Domachowska et al., 2016). Individuals value various objects of goal pursuit uniquely (Mirabella, 2014). However, relying on measures that utilize aggregate scores of similar, yet unique, picture trials (e.g., desserts) ignores the rich variance within individuals between each trial. Because individuals have different motivational responses to stimuli, even if they are of only one type (e.g., positive pictures), one must examine individual differences in affective responding in order to fully understand how approach-motivated affects impact behavior.

Past research examining beta suppression to high approach-motivated positive affect has relied on cues signaling monetary rewards to evoke greater beta suppression (Gable, Mechin et al., 2016; Meadows et al., 2016a). To account for individual differences in approach-motivation towards rewarding cues, the cues indicated the same monetary across all stimuli. Therefore, each cue evoked the same degree of approach motivation. Using simple shapes associated with the same reward, we found that rewards enhance beta suppression relative to neutral (non-reward) states (Gable, Mechin et al., 2016). Because reward cues elicited the same approach-motivation on every trial, differences in beta suppression were observed between groups.

The present studies sought to build upon this previous work by examining whether individual differences in beta suppression towards emotional pictures relate to the narrowing of cognitive scope associated with increased approach motivation. Because individuals differ in approach-motivation towards pleasant pictures, it is likely the case that individual differences in beta suppression to approach-motivated positive pictures will relate to narrowing of cognitive scope.

At the group level, we predict that there would be a positive relationship between beta suppression and local and global reaction time in both positive and neutral states, because beta suppression generally relates to faster reaction times (Meadows et al., 2016a). However, when accounting for individual differences in approach-motivated motor preparation (beta suppression) for each trial, greater beta suppression to approach-motivated positive pictures should predict faster reaction times to local targets, but not global targets.

Experiment 1 elicited approach-motivated positive affect by using approach-motivated positive pictures (e.g., delicious desserts and cute baby animals; Gable & Harmon-Jones, 2008a, 2010c). Experiment 2 elicited approach-motivated positive affect by using a different set of approach-motivating stimuli (e.g., alcohol pictures; Gable, Mechin et al., 2016b; Hicks, Friedman, Gable, & Davis, 2012; Ryerson, Neal, &

Gable, 2017). In both experiments, attentional scope was measured using the Navon (1977) local-global task, a frequently used measure of breadth of attention (Gable & Harmon-Jones, 2008a, 2010b, 2010d, 2011a; Hicks, Davis, Fields, & Gable, 2015).¹ In the Navon letter task, cognitive narrowing is the relative difference between local target reaction times and global target reaction times. Thus, attentional narrowing may result from faster responses to local targets, slower responses to global targets, or both.

In order to control for individual differences in emotional reactivity to various stimuli, we used procedures by Adolphs et al. (1999) and Meadows, Gable, Lohse, and Miller, (2016b), calculating correlations between beta suppression to pictorial stimuli and its corresponding Navon response for each participant. We then conducted analyses examining whether there were differences in average correlations between conditions. Based on our predictions, we expected general positive approach-motivated and alcohol pictures to elicit a positive relationship between beta suppression during affective pictures and reaction times to local targets. We predicted that this positive relationship would be greater than the relationship between beta suppression during affective pictures and subsequent reaction times to global targets, as well as between beta suppression during neutral pictures and subsequent reaction times to local targets.

2. Experiment 1

In Experiment 1, we examined how individual differences in motor preparation to approach-motivated positive pictures would relate to attentional narrowing. Each trial began by having the participant view either an approach-motivated positive or neutral picture. Then, participants completed a Navon (1977) letters task to measure attentional scope. Because beta suppression relates to motor preparation, we predicted that, on the group level, there would be a general positive correlation between beta suppression to pictures and faster Navon reaction times, regardless of letter type. However, when accounting for intra-individual differences, we predicted that approach-motivated positive pictures would elicit a more positive correlation between beta suppression and cognitive narrowing than neutral pictures.

2.1. Methods

Forty-eight introductory psychology students participated in exchange for partial course credit. Five participants were excluded because they did not have enough error free trials for analysis (see below for full explanation of exclusions), leaving a final sample size of forty-three participants.

A power analysis was conducted with G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). Based upon previous research examining the relationship between cognitive narrowing and neural activity associated with approach motivation, we assumed modest effect sizes ($f = 0.35$). Additionally, alpha was set to .05, and we assumed a correlation among repeated measures of $r = 0.5$ and a non-sphericity correction of 1. To detect a significant result for our repeated-measures ANOVA containing four measurements (correlations between beta

¹ One common question concerning the Navon letters task is whether faster reaction times to local targets following high approach-motivated positive pictures is due to increasing attentional narrowing or decreasing attentional broadening. We suggest that the cognitive narrowing is revealed as the relative difference between local target reaction times and global target reaction times and, thus, may manifest as either faster responses to local targets or slower responses to global targets. Both faster responses to local targets and slower responses to global targets suggest a narrowing of cognitive scope. Because making a movement in high approach-motivated states requires narrowing one's focus to the task at hand, either manifestation may lead to a greater likelihood of success in attaining some goal or object (Gable & Harmon-Jones, 2010a).

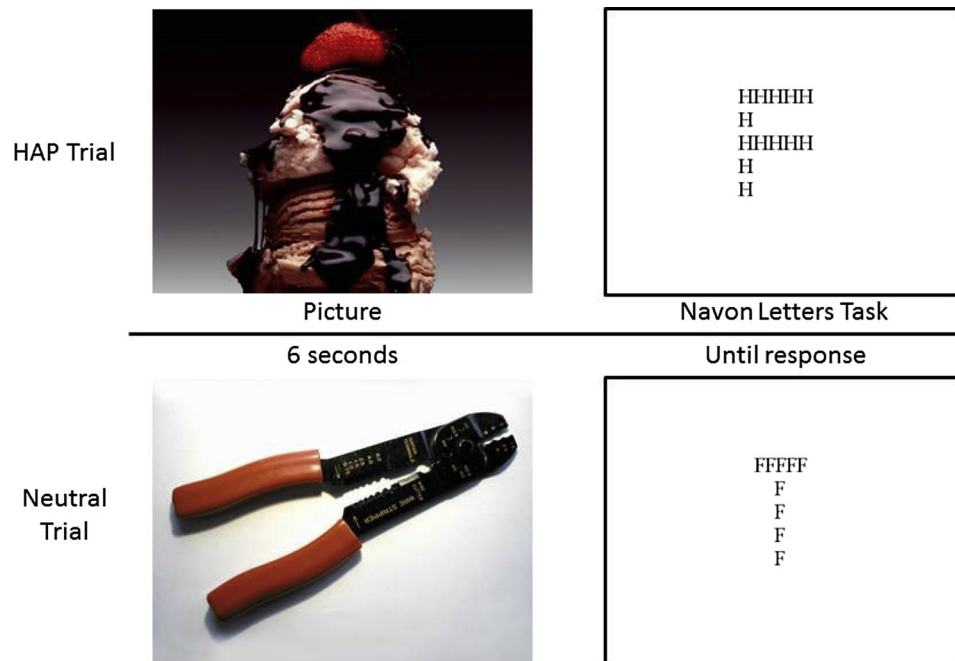


Fig. 1. Experiment example trial.

suppression while viewing high approach positive and neutral pictures and reaction times to local and global targets after the picture), our power was 0.999.

Six practice trials occurred at the beginning of the experiment. The intertrial interval was 3000 ms. Each trial ($n = 64$; see Fig. 1) began with a fixation cross (500 ms), followed by either an approach-motivated positive (appetitive; $n = 32$) or neutral ($n = 32$) picture presented in the center of a 20-inch computer monitor for 6000 ms. Pictures were taken from the Internet and the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005).² Appetitive pictures consisted of desirable images (e.g., delicious desserts, attractive individuals, cute babies, animals), which have been used in previous research to evoke approach-motivated positive affect (Gable & Harmon-Jones, 2008a, 2010c, 2011b; Harmon-Jones & Gable, 2009; Poole & Gable, 2014).³

Next, after another fixation cross (500 ms), a Navon letter was presented in the center of the monitor. The Navon (1977) letters task was used to assess attentional breadth. In this task, stimuli consisted of a large letter composed of smaller letters. Five closely-spaced local letters made up each vertical and horizontal line of the larger letter. For example, a large *T* might be composed of small *F*s. Participants were asked to respond “as quickly as possible,” pressing the left Shift key if the picture contained the letter *T* or the right Shift key if the picture contained the letter *H*. Local targets were those in which a large *L* or *F*

was composed of smaller *T*s or *H*s, while global targets were those in which a large *T* or *H* was composed of smaller *L*s or *F*s. Faster responses to the small letters indicated a local (narrow) attentional scope, while faster responses to the large letters indicated a global (broad) attentional scope. Sixteen local targets and 16 global targets were presented after both appetitive and neutral pictures (32 total targets after each picture type).

2.1.1. EEG assessment and processing

Electroencephalography was recorded with 32 tin electrodes mounted in a stretch lycra cap (Electro-Caps, Eaton, OH) and referenced to the left earlobe. A ground electrode was mounted midway between FPz and Fz. The electrode cap was based on the 10–20 system, and a sodium chloride-based conductance gel was used to assist in the decrease of impedances. Electrode impedances were kept under 5000 Ω . Signals were amplified with a Neuroscan SynAmps RT amplifier unit (El Paso, TX), low-pass filtered at 100 Hz, high-pass filtered at 0.05 Hz, notch filtered at 60 Hz, and digitized at 500 Hz. Artifacts (e.g., horizontal eye movement and muscle) were removed by hand. Then, a regression-based eye movement correction was applied (Semlitsch, Anderer, Schuster, & Presslich, 1986), after which the data were visually inspected again to ensure proper correction.

During the pictures (6000 ms), epochs 1024 ms in duration were extracted through a sinusoidal-shaped Hamming window to reduce spectral leakage (50% taper of distal ends; Davidson, Jackson, & Larson, 2000) and re-referenced using an average ears reference. Consecutive epochs were overlapped by 50% to avoid data loss. Next, power values corresponding to beta (13–30 Hz) were extracted using a Fast Fourier Transformation. Data were then averaged across regions of the head at sites corresponding with the motor cortex (Muthukumaraswamy, Johnson, & McNair, 2004; Pfuertscheller, Neuper, Brunner, & da Silva, 2005). Specifically, beta suppression was examined at sites C3, C4, CP3, CP4, CP5, and CP6. Lower beta activity indicates greater beta suppression.

2.1.2. Statistical analysis

Because reaction times (RTs) were positively skewed, and following recommendations for analyzing RT data (Fazio, 1990), RTs were logarithmically transformed. Trials with incorrect responses or with RTs

² IAPS picture numbers: approach-motivated positive pictures (1441, 1463, 1710, 1750, 1920, 2040, 2070, 2071, 2080, 2091, 2150, 2165, 2340, 2345, 2550, 4608, 4650, 4652, 4660, 4676, 4680, 4687, 4689, 4694, 4695, 7283, 7330, 7340, 7390, 7402, 7410, 7430); neutral pictures (2038, 2214, 2397, 2493, 2890, 5535, 6150, 7002, 7006, 7010, 7020, 7034, 7035, 7038, 7056, 7059, 7160, 7161, 7170, 7175, 7179, 7185, 7187, 7211, 7217, 7233, 7235, 7247, 7640, 7950, 9070); additionally, one picture was used from the internet and was chosen from a larger collection of images because pilot testing showed that it evoked no emotion.

³ Past work has shown that baby animal pictures evoke similar approach-motivated attentional narrowing as desserts pictures (Gable & Harmon-Jones, 2010c) and activate careful caretaking motivations that trigger enhance approach motivation and precise motor behavior (Nittono, Fukushima, Yano, & Moriya, 2012). Therefore, we combined these different categories into a single appetitive picture set.

more than 3 standard deviations from the mean for each stimulus were removed (3.13% of local targets following appetitive pictures, 3.78% of global targets following appetitive pictures, 3.26% of local targets following neutral pictures, and 2.87% of global targets following neutral pictures). To examine whether appetitive pictures caused attentional narrowing at the group level, mean RTs for local targets following appetitive pictures, global targets following appetitive pictures, local targets before neutral pictures, and global targets before neutral pictures for each individual. RTs were then submitted to a 2 (picture type: appetitive vs. neutral) x 2 (target: local vs. global) repeated-measures analysis-of-variance (ANOVA).

To examine how beta suppression relates to attentional narrowing on the group level, mean beta suppression across all trials was calculated for each individual during appetitive pictures before local trials, appetitive pictures before global trials, neutral pictures before local trials, and neutral pictures before global trials. We then ran correlations between mean beta suppression for a given picture type and the mean RT of the following target (four correlations total).

To examine how beta suppression relates to attentional narrowing at the individual level, we used statistical procedures used by Adolphs et al. (1999) and Meadows et al. (2016b). We first correlated beta suppression for each picture with its ensuing Navon letter response for each participant in each of the four conditions. This generated a total of four correlations for each participant: beta suppression during appetitive pictures with subsequent local target, beta suppression during appetitive pictures with subsequent global targets, beta suppression during neutral pictures with subsequent local targets, and beta suppression during neutral pictures with subsequent global targets. For summary statistics of the number of data points in each of the individual correlations, see Table 1. Five participants had less than nine total beta suppression and Navon letter RT pairs within their individual correlation for at least one condition and were removed from analyses, leaving a final sample of 43 for these analyses. Correlations were Fisher-z transformed to approximate a normal distribution (Meadows et al., 2016b). Fisher-transformed correlations were then submitted to a 2 (picture type: appetitive vs. neutral) x 2 (target: local vs. global) repeated-measures ANOVA.

3. Results

3.1. Attentional scope RTs

A 2 (picture type) x 2 (target) repeated-measures ANOVA revealed a main effect of picture type, $F(1, 47) = 10.43, p = .002, \eta_p^2 = .18$; however, there was not a main effect of target, $F(1, 47) = 0.39, p = .534, \eta_p^2 = .01$. Finally, there was a significant interaction, $F(1, 47) = 10.92, p = .002, \eta_p^2 = .19$ (see Fig. 2).

Post-hoc analyses revealed that individuals were faster to identify local targets after appetitive pictures ($M = 6.57, SD = 0.25$) than global targets after appetitive pictures ($M = 6.61, SD = 0.23$), $p = .002$. However, there were no differences between reaction times to local targets after appetitive pictures and local targets after neutral pictures ($M = 6.58, SD = 0.24$), $p = .830$, or between local targets after neutral pictures and global targets after neutral pictures ($M = 6.56, SD = 0.22$), $p = .162$. However, individuals were slower to identify

Table 1
Summary statistics for the number of data points in individual correlations for Experiment 1.

Condition	M	SD	Minimum	Maximum
Appetitive Local	15.11	1.06	12	16
Appetitive Global	15.00	1.24	11	16
Neutral Local	15.23	1.36	11	16
Neutral Global	15.32	0.98	13	16

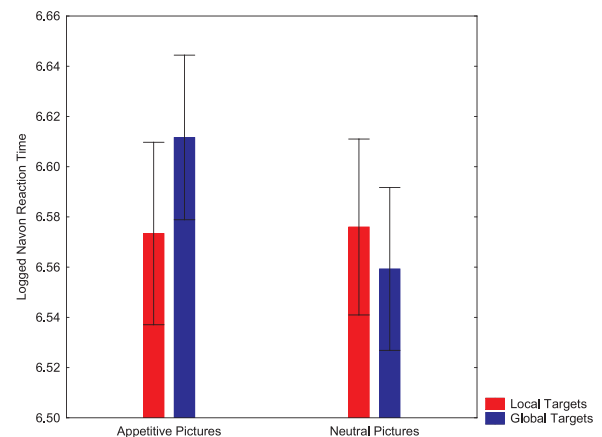


Fig. 2. Log-transformed reaction times for local and global Navon letter targets after viewing appetitive and neutral pictures in Experiment 1. Error bars indicate standard errors.

global targets after appetitive pictures than global targets after neutral pictures, $p < .001$. This is consistent with much previous research finding a global bias when participants are in a neutral state (Gable & Harmon-Jones, 2008a, 2013; Navon, 1981).

3.2. Group correlations

For the group associations, all of the correlations between beta suppression and RT (except for the relationship between beta suppression during appetitive pictures and local RTs) were significant, with all exhibiting a general positive relationship between beta suppression and RTs (see Table 2 and Fig. 3). More specifically, greater beta suppression was generally related to faster reaction times to Navon targets. This suggests that, regardless of picture type or Navon target, there is a general positive relationship between motor-action preparation and Navon reaction time target at the group level.

3.3. Intra-individual correlations

A 2 (picture type) x 2 (target) repeated-measures ANOVA did not reveal a main effect of picture type, $F(1, 42) = 0.10, p = .755, \eta_p^2 = .002$, or a main effect of target, $F(1, 42) = 0.02, p = .896, \eta_p^2 < .001$. However, there was a significant interaction, $F(1, 42) = 7.09, p = .011, \eta_p^2 = .14$ (see Figs. 4 and 5).

Post-hoc analyses revealed that the difference between correlations between local target RTs after appetitive pictures and beta suppression to appetitive pictures ($M = 0.05, SE = 0.04$) and correlations between global target RTs after appetitive pictures and beta suppression to appetitive pictures ($M = -0.06, SE = 0.04$) was non-significant, $p = .082$. Additionally, correlations between local target RTs after appetitive pictures and beta suppression to appetitive pictures were significantly higher than correlations between local target RTs after neutral pictures and beta suppression to neutral pictures ($M = -0.07, SE = 0.04$), $p = .046$. The difference between correlations between local target RTs after neutral pictures and beta suppression to neutral pictures and correlations between global target RTs after neutral pictures and beta

Table 2
Group-level correlations between beta suppression to pictures and Navon reaction time.

Condition	r	p
Appetitive Local	.17	.237
Appetitive Global	.34	.019
Neutral Local	.27	.062
Neutral Global	.31	.029

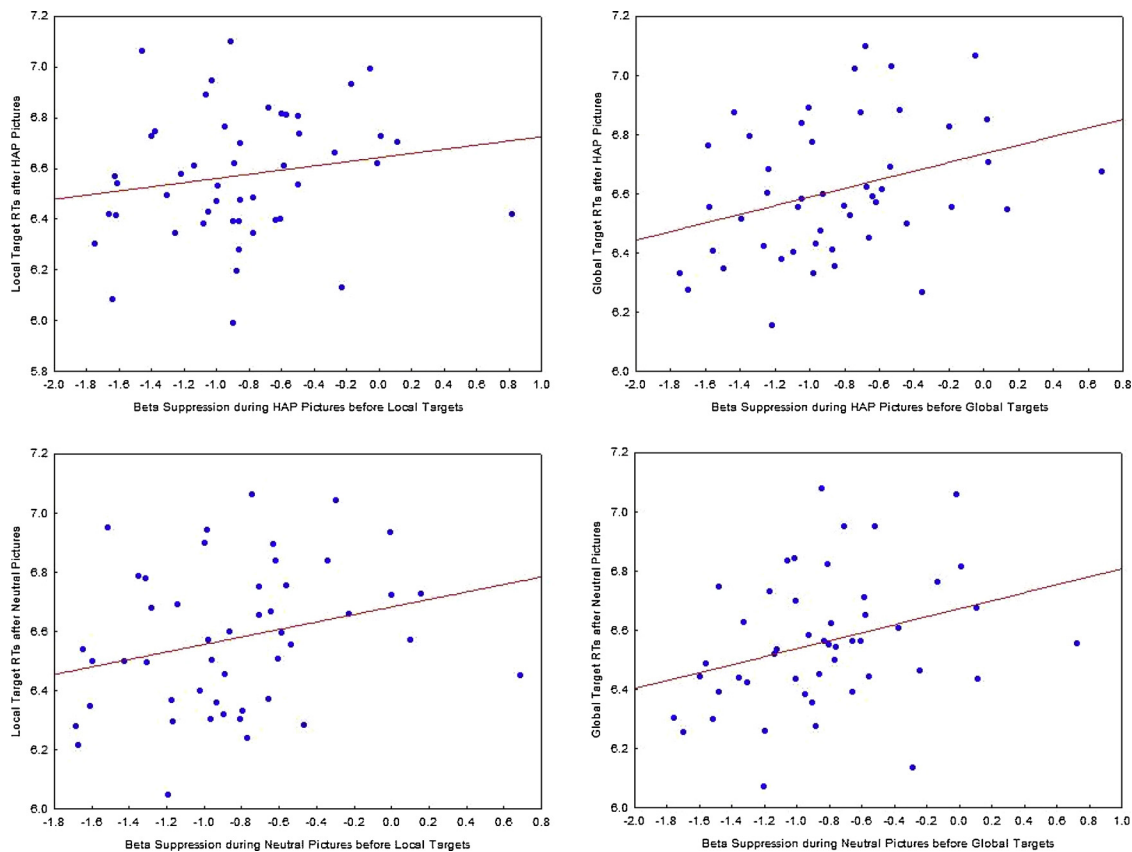


Fig. 3. Group-level correlations between beta suppression to pictures and Navon reaction time.

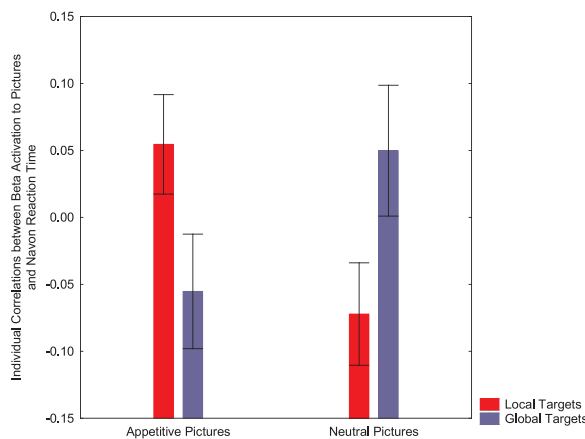


Fig. 4. Individual correlations between beta suppression to pictures and Navon reaction times in Experiment 1. Error bars indicate standard errors. Higher scores indicate that greater beta suppression was associated with faster reaction times to Navon letters.

suppression to neutral pictures ($M = 0.05$, $SE = 0.05$) was non-significant, $p = .054$. Finally, the difference between correlations between global target RTs after appetitive pictures and beta suppression to appetitive pictures and correlations between global target RTs after neutral pictures and beta suppression to neutral pictures was non-significant, $p = .095$.

Importantly, the mean correlation between local target RTs after appetitive pictures and beta suppression to appetitive pictures revealed that, on average, there was a positive relationship between these two variables. This suggests that greater beta suppression was related to greater attentional narrowing when viewing appetitive pictures. In contrast, the mean correlation between global target RTs after

appetitive pictures and beta suppression to appetitive pictures revealed that, on average, there was a negative relationship between these two variables. This also suggests that greater beta suppression was related to greater attentional narrowing when viewing appetitive pictures.

4. Discussion of Experiment 1

When examining the relationship between beta suppression during pictures and cognitive narrowing at the group level, results indicated that there was a generally positive relationship between the two variables in each of the four conditions. However, when examining the variations amongst these two variables at the intra-individual level, results indicated that more beta suppression during appetitive pictures related to more attentional narrowing, with this relationship being stronger than the relationships between affective picture beta suppression and RTs to local targets and neutral picture beta suppression and RTs to local targets. Together, these results suggest that examining the intra-individual differences reveals a relationship between beta suppression to approach-motivated appetitive stimuli and narrowing of attentional scope.

5. Experiment 2

In Experiment 2, we sought to replicate the effects of Experiment 1 using a different set of affective stimuli. More specifically, we sought to investigate whether individual differences in beta suppression to approach-motivated alcohol pictures would elicit the same intra-individual influence on attentional narrowing. Past research has found that individuals high in state and trait approach motivation have greater attentional narrowing to alcohol pictures (Gable, Mechin et al., 2016; Hicks et al., 2012). Additionally, because individuals vary in their desire for specific types of alcohol, it seems likely that individuals would have distinct responses to different alcohol stimuli. We predicted

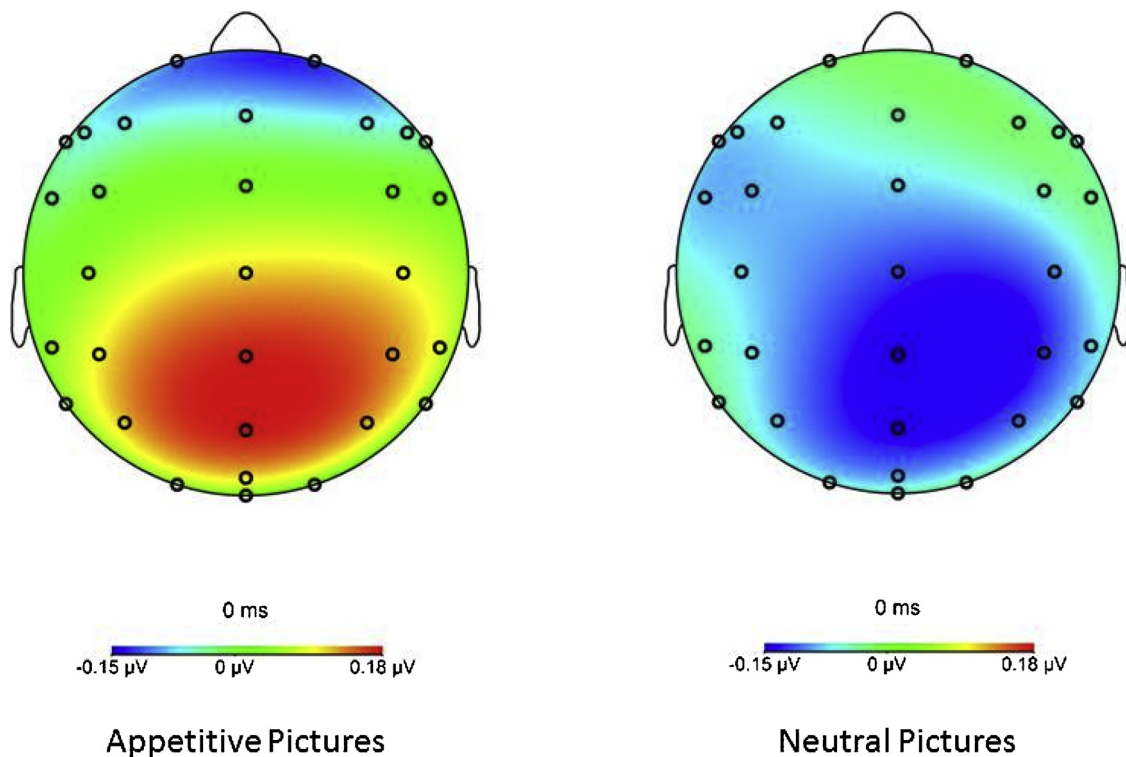


Fig. 5. Scalp topography displaying the difference between beta activity/local target correlations and beta activity/global target correlations for both appetitive and neutral pictures. Difference scores were created by subtracting intra-individual correlations between beta activity and local targets from intra-individual correlations between beta suppression and global targets.

that, on the group level, there would be a general positive correlation between beta suppression to pictures and the following Navon RT, regardless of target scope. However, when accounting for intra-individual differences, we predicted that alcohol pictures would elicit a more positive correlation between beta suppression and cognitive narrowing than neutral pictures.

5.1. Methods

Thirty-eight introductory psychology students participated in exchange for partial course credit. Two participants had less than nine total beta suppression and Navon letter RT pairs within their individual correlation for at least one condition and were removed from analyses, leaving a final sample of 36 for the intra-individual correlation analyses. A power analysis was conducted with G*Power 3.1 (Faul et al., 2007). Using the same metrics used in the power analysis for Experiment 1, to detect a significant result for our repeated-measures ANOVA containing four measurements (correlations between beta suppression while viewing alcohol and neutral pictures and reaction times to local and global targets after the picture), our power was 0.997.

Procedures were identical to Experiment 1, with three exceptions. First, all appetitive pictures were replaced with alcohol pictures. These alcohol pictures have been used in previous research to evoke approach-motivated positive affects (Gable, Mechin et al., 2016; Hicks et al., 2015). Alcohol pictures depicted a variety of alcoholic beverages, including beer, wine, and liquor. Second, instead of 6000 ms, all pictures were shown for 9000 ms. Finally, instead of a 32-channel cap, electroencephalography was recorded with 64 tin electrodes mounted in a stretch lycra cap (Electro-Caps, Eaton, OH). Beta suppression was examined at sites over the motor cortex; more specifically, beta suppression was examined at sites C1, C2, C3, C4, C5, C6, CP1, CP2, CP3, CP4, CP5, and CP6 (Gable, Mechin et al., 2016). All other procedures and statistical analyses were identical to Experiment 1. As in Experiment 1, trials with incorrect responses or with RTs more than 3

standard deviations from the mean for each stimulus were removed (2.78% of local targets following alcohol pictures, 5.76% of global targets following alcohol pictures, 2.47% of local targets following neutral pictures, and 5.59% of global targets following neutral pictures). For summary statistics of the number of data points in each of the individual correlations, see Table 3.

6. Results

6.1. Attentional scope RTs

A 2 (picture type: alcohol vs. neutral) x 2 (target: local vs. global) repeated-measures ANOVA revealed that the main effect of picture type was non-significant, $F(1, 36) = 2.89, p = .098, \eta_p^2 = .07$; there was also not a main effect of target, $F(1, 36) = 0.39, p = .536, \eta_p^2 = .01$. Finally, there was a significant interaction, $F(1, 36) = 11.19, p = .002, \eta_p^2 = .24$ (see Fig. 6).

Post-hoc analyses revealed that individuals were faster to identify local targets after alcohol pictures ($M = 6.63, SD = 0.28$) than global targets after alcohol pictures ($M = 6.68, SD = 0.30$), $p = .004$. However, there were no differences between reaction times to local targets after alcohol pictures and local targets after neutral pictures ($M = 6.65, SD = 0.26$), $p = .273$, or between local targets after neutral pictures and global targets after neutral pictures ($M = 6.63$,

Table 3

Summary statistics for the number of data points in individual correlations for Experiment 2.

Condition	<i>M</i>	<i>SD</i>	<i>Minimum</i>	<i>Maximum</i>
Alcohol Local	15.09	1.22	11	16
Alcohol Global	14.89	1.68	9	16
Neutral Local	14.92	1.56	10	16
Neutral Global	14.86	1.50	10	16

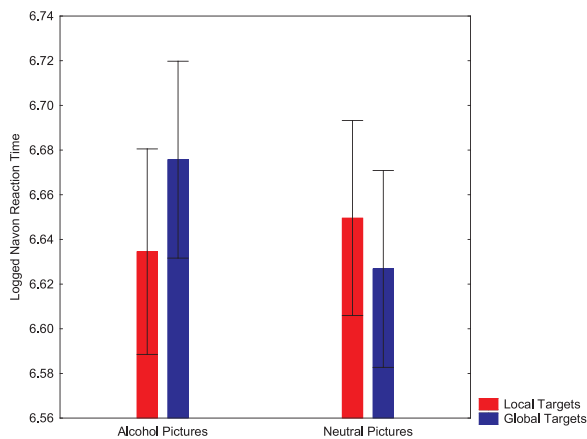


Fig. 6. Log-transformed reaction times for local and global Navon letter targets after viewing alcohol and neutral pictures in Experiment 2. Error bars indicate standard errors.

$SD = 0.27$), $p = .101$. However, individuals were slower to identify global targets after alcohol pictures than global targets after neutral pictures, $p < .001$. Once again, participants displayed a global bias when in a neutral mood (Gable & Harmon-Jones, 2008a, 2013; Navon, 1981).

6.2. Group correlations

For the group associations, none of the correlations between beta suppression and RT were significant; however, all correlations exhibited a general positive relationship between beta suppression and RTs (see Table 4 and Fig. 7). More specifically, greater beta suppression was generally related to faster reaction times to Navon targets. As in Experiment 1, this suggests that, regardless of picture type or Navon target, there is a general positive relationship between motor-action preparation and Navon reaction time target at the group level.

6.3. Intra-individual correlations

A 2 (Picture type: alcohol vs. neutral) \times 2 (Target: local vs. global) ANOVA did not reveal either a main effect of picture type, $F(1, 35) = 0.00009$, $p = .993$, $\eta_p^2 < .001$, or a main effect of target, $F(1, 35) = 1.39$, $p = .246$, $\eta_p^2 = .04$. However, there was a significant interaction, $F(1, 35) = 6.79$, $p = .013$, $\eta_p^2 = .16$ (see Figs. 8 and 9).

Post-hoc testing revealed that correlations between local target RTs after alcohol pictures and beta suppression to alcohol pictures ($M = 0.09$, $SE = 0.06$) were significantly higher than correlations between global target RTs after alcohol pictures and beta suppression to alcohol pictures ($M = -0.08$, $SE = 0.05$), $p = .005$. Additionally, the difference between correlations between local target RTs after alcohol pictures and beta suppression to alcohol pictures and correlations between local target RTs after neutral pictures and beta suppression to neutral pictures ($M = -0.01$, $SE = 0.04$) was non-significant, $p = .075$. There were no differences between correlations between local target RTs after neutral pictures and beta suppression to neutral pictures and correlations between global target RTs after neutral pictures and beta

Table 4

Group-level correlations between beta suppression to pictures and Navon reaction time.

Condition	r	p
Alcohol Local	.24	.152
Alcohol Global	.29	.082
Neutral Local	.30	.067
Neutral Global	.25	.134

suppression to neutral pictures ($M = 0.02$, $SE = 0.06$), $p = .503$. The difference between correlations between global target RTs after alcohol pictures and beta suppression to alcohol pictures and correlations between global target RTs after neutral pictures and beta suppression to neutral pictures was non-significant, $p = .073$.

Importantly, the mean correlation between local target RTs after alcohol pictures and beta suppression to alcohol pictures revealed that, on average, there was a positive relationship between these two variables. This suggests that greater beta suppression was related to greater attentional narrowing when viewing alcohol pictures. In contrast, the mean correlation between global target RTs after alcohol pictures and beta suppression to alcohol pictures revealed that, on average, there was a negative relationship between these two variables. This also suggests that greater beta suppression was related to greater attentional narrowing when viewing alcohol pictures.

7. Discussion of Experiment 2

Results of Experiment 2 conceptually replicated the results of Experiment 1. When examining the relationship between beta suppression during pictures and cognitive narrowing, all conditions exhibited a general positive correlation. However, when examining the variations amongst these two variables at the intra-individual level, results indicated that beta suppression during alcohol pictures related to attentional narrowing, with this relationship being stronger than the relationships between alcohol picture beta suppression and RTs to global targets and neutral picture beta suppression and RTs to local targets. This important extension reveals that, regardless of stimuli, there is a distinct relationship between beta suppression to approach-motivated appetitive stimuli and cognitive narrowing.

8. General discussion

Across two studies, results indicated a positive relationship between individual differences in beta suppression to approach-motivated pictures and individual differences in cognitive narrowing. Experiment 1 and 2 revealed that at the group level, there was a general positive relationship between beta suppression during picture viewing and responses to measures of cognitive scope, regardless of either picture valence or attentional scope target. Consistent with past work, these results suggest that greater beta suppression relates to faster reaction times. However, when examining intra-individual differences, there was a more positive relationship between beta suppression to approach-motivated positive pictures and narrowing of attention than between beta suppression to neutral pictures and narrowing of attention.

Our results found that beta suppression to emotional images related to cognitive narrowing at the individual level. This likely occurred because humans respond to approach-motivated pictures in different ways, depending on how much the individual is motivated by the object in the picture (Glimcher, Dorris, & Bayer, 2005). As individuals experienced increases in approach motivation, there are increases in cognitive narrowing. The current results suggest that greater beta suppression during approach-motivated pictures relates to cognitive narrowing. The present results extend past work by showing that individual differences in neural correlates of approach motivation relate to behavioral measures of cognitive narrowing. Individual differences in responding to appetitive stimuli predicted narrowing of cognitive scope.

Differences in the relationship between beta suppression to pictures and cognitive narrowing were found at the individual level, but not the group level. This likely occurred because the group correlations are not sensitive enough to capture the nature of this relationship within each individual. By creating average beta suppression during pictures and Navon letter reaction time scores, the variance created by each individual's motivational reaction to the pictures disappears. What remains is the simple relationship between beta suppression and reaction

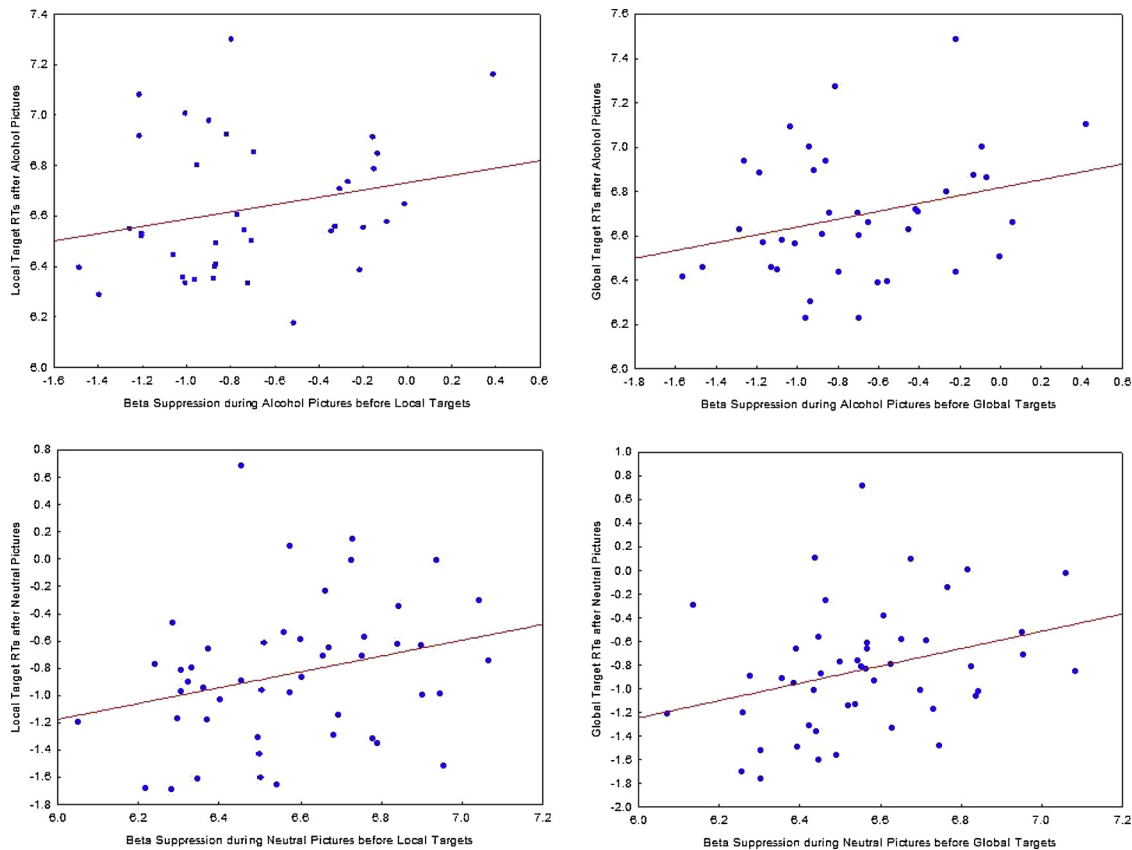


Fig. 7. Group-level correlations between beta suppression to pictures and Navon reaction time.

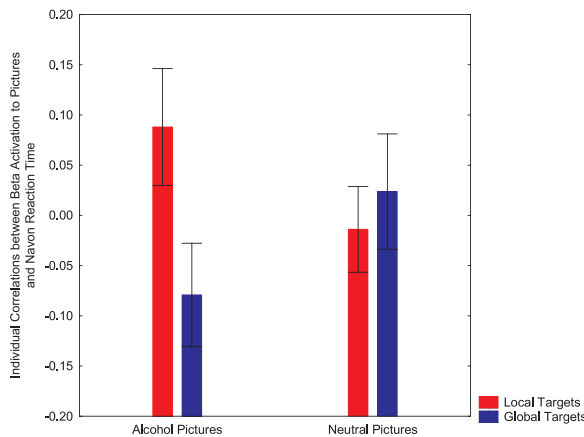


Fig. 8. Individual correlations between beta suppression to pictures and Navon reaction times in Experiment 2. Error bars indicate standard errors. Higher scores indicate that greater beta suppression was associated with faster reaction times.

time. Consistent with past work showing greater beta suppression leads to faster hand and finger movements (Pogosyan et al., 2009), greater beta suppression related to faster reaction times to the Navon letters, regardless of condition. However, this does not indicate whether the relationship between beta suppression and reaction time is the same within an individual. The current findings demonstrate that individual differences in approach motivation relate to slower reaction times to global targets. The group average is not able to capture this negative relationship, requiring one to examine these relationships at the individual level.

Results of the intra-individual correlations revealed a positive correlation between beta activation to affective pictures and local targets

RTs after affective pictures, but a negative correlation between beta activation to affective pictures and global targets RTs after affective pictures. This likely occurred because attentional narrowing and greater beta suppression are associated with high approach motivation. In contrast, global processing and less beta suppression are associated with low approach motivation. Attentional narrowing encourages an organism to zero in on a highly desired goal whereas attentional broadening allows the organism to reflect on previous goal pursuit and look for other previously unforeseen opportunities (Carver, 2003; Gable & Harmon-Jones, 2010a; Threadgill & Gable, 2018a). Greater approach-motivated action preparation, as reflected by less beta activation, should be associated with greater narrowing of attention as the organism prepares to act to acquire the desired object or goal. In contrast, less approach motivation should be associated with greater broadening of attention because the organism does not have a specific action-oriented goal.

This pattern of means was reversed in the neutral condition. This likely occurred because Navon stimuli under neutral conditions appear to elicit a global bias (Navon, 1977). When these participants viewed non-rewarding, neutral object pictures, they may have responded with decreased approach motivation and a reverse of beta activation because of their heightened approach motivation from the appetitive pictures (Gable & Harmon-Jones, 2008b).

The present experiments revealed that intra-individual differences in beta suppression related to cognitive narrowing in high approach-motivated states. These results extend past work linking beta suppression, approach motivation, and cognitive narrowing by demonstrating that individual differences in beta suppression to individual cues relates to cognitive scope. Additionally, this work provides important support for the motivational intensity model of cognitive scope by showing that individuals differences in beta suppression to high approach-motivated pictures relates to greater cognitive narrowing (Harmon-Jones et al., 2013). This is important because past research has only examined

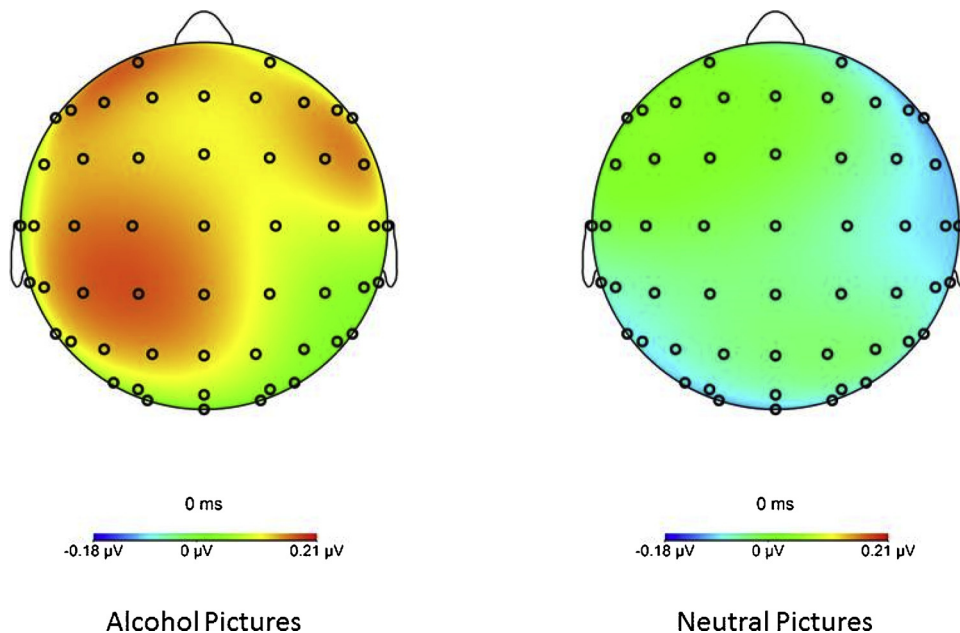


Fig. 9. Scalp topography displaying the difference between beta activity/local target correlations and beta activity/global target correlations for both alcohol and neutral pictures. Difference scores were created by subtracting intra-individual correlations between beta activity and local targets from intra-individual correlations between beta suppression and global targets.

relationships between neural correlates of affective responding and measures of cognitive scope at the group level (Harmon-Jones & Gable, 2009; Kuhr, Schomberg, Gruber, & Quirin, 2013; Liu, Zhang, Zhou, & Wang, 2014). Thus, by demonstrating that psychophysiological correlates of high approach-motivated positive affect relates to cognitive narrowing when examining activity at the individual level, it appears that high approach-motivated positive affect relates to cognitive narrowing when individuals are more motivated (Harmon-Jones & Gable, 2018).

In summary, previous research has found that high approach motivation in general relates to cognitive narrowing (Gable & Harmon-Jones et al., 2016). Our results extend these past results and suggest that the narrowing of attentional scope is not the same for all stimuli within each individual. Rather, because the relationship between beta suppression to approach-motivated pictures and cognitive narrowing is detected at the individual level, it appears that these relationships are amplified by the general dispositions and preferences of the individual. The present work highlights how individual differences in motivational processing to pictures plays an important role in eliciting narrowed cognitive scope. Moreover, these results are part of a growing body of literature examining individual differences in neurological correlates relating to cognitive processes (Ham et al., 2011; Meadows et al., 2016b; Mechin, Gable, & Hicks, 2016; Prause, Staley, & Roberts, 2014). Inter-individual variance in psychophysiological correlates of emotive responses may be key to detecting neural correlates of emotion-cognition interactions.

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