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Correlation of the Anterior Salience Network with Attention: A Resting-state fMRI Analysis

Matthew Brooks
University of Nebraska-Lincoln, mbrooks5@huskers.unl.edu

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by

Matthew E. Brooks

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Matthew E. Brooks, M.A.

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Advisor: Hideo Suzuki

Background: Some studies have broadened our understanding of attention while other studies have used resting-state functional magnetic resonance imaging (fMRI) analyses to identify brain regions that are functionally connected and may be associated with salience processing. This thesis sought to examine the relationship between the anterior salience network and attentional control. The current study hypothesized that resting-state functional connectivity between regions of the anterior salience network would be associated with attentional control ability. **Methods:** Forty-eight college-aged students completed the affective Stroop task to assess attentional regulation ability. Accuracy on trials of the task was examined in correlation with resting-state functional connectivity values of seven regions of the anterior salience network. **Results:** Some correlations were identified between performance accuracy and the anterior salience network. Noteworthy, when attentional control was required (i.e., "incongruent" trials of the task), performance accuracy was positively correlated with functional connectivity between the dorsal anterior cingulate cortex and the dorsolateral prefrontal cortex, as well as the anterior insula. **Conclusions:** These findings suggest that intrinsic functional connectivity in the anterior salience network might be able to indicate elements of attentional control.

Keywords: attention; salience network; fMRI; affective Stroop task; intrinsic connectivity.

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Introduction

Our friend stands at the edge of a busy crosswalk in a bustling part of a large city. Conversations swarm and mingle with the sounds of the city. The friend, however, is pulled into the podcast being relayed through a headphone into one of their ears. The summer heat radiating from the cement is stifling and the glare of the sun kisses off the glass-paneled buildings. Our friend is partially blinded by this and must squint to see the stoplight signal across the street. Distinguishing the signal is made more difficult by the bright signs of a nearby protest and the flashes of an emergency police vehicle that has pulled up along the far curb. The rotating blue and red lights of the vehicle bring back a memory for our friend of the time they had been in a bicycling accident. At this thought, the chronic soreness in their right hip where steel plates had to be inserted makes itself known. The crossing signal turns to "WALK" and our friend steps into the street, ready to cross quickly to get ahead of the pressing queue of folks behind them. Suddenly, their senses are overtaken by the piercing sound of a horn and the flashing lights of an ambulance that has sped through the intersection toward the emergency vehicle. Our friend's body tenses and stops its motion into the street, narrowly avoiding a certain collision with the ambulance.

Defining Salience

To navigate the ocean of stimuli present at almost every moment of our lives, our brains have evolved the ability to sift quickly through these stimuli and select only important information needed for a given context. Salient information is likely to be selected because it is any physically or psychologically noticeable stimulus that reorients and redirects individual attention (Uddin, 2017). While the definition of salience is nuanced and can vary depending on the field of research, this thesis adopted the above definition for use throughout this text.

Salience processing may be performed through either bottom-up or top-down processing (Itti & Koch, 2001). That is, physically salient sensory stimuli tend to attract our attention, enabling further processing and subsequent encoding by cognitive systems via bottom-up processing whereas psychologically salient features—such as personally relevant information—tend to be preferentially encoded through existing knowledge and schema via top-down processing. By these mechanisms, salience is a key component of attentional processes.

The Salience Network

To advance our understanding of salience processing, previous neurobiological work has explored which brain regions contribute to the functioning of salience processing. For example, the insula is reported to have a wide-range of functions that include emotional, cognitive, interoceptive, and salience processing, as it seems to be a hub of integration of bottom-up sensorimotor stimuli and top-down executive control (Nomi et al., 2016). Interestingly, the insula can show strong temporal correlation of spontaneous functional activation (i.e., resting-state functional connectivity) with the dorsal anterior cingulate cortex (dACC), dorsomedial thalamus, hypothalamus, periaqueductal gray, sub-lenticular extended amygdala, substantia nigra, ventral tegmental area, and temporal pole (Seeley et al., 2007; Uddin, 2017). Because these brain regions commonly play primary or supplementary roles in salience processing, this specific functional network was called the salience network (Seeley et al., 2007). Alternatively, Shirer et al. (2012) identified the voxel-based (rather than anatomically-based) functional networks, each of which consists of several functional regions of interest (fROIs). One of their identified functional networks, called the *anterior salience network*, consists of seven fROIs that are theoretically involved in salience processing: they are roughly located around the left and right dorsolateral prefrontal cortex (dlPFC), the left and right anterior insula (AI), the dACC

(extending to the medial prefrontal cortex and supplementary motor area), and the lobule IV-Crus I of the left and right cerebellum (CB IV-Cr I) (Shirer et al., 2012). The anterior salience network specifically comprises functional connectivity with more frontal subareas of Seeley et al.'s (2007) larger scale salience network. The anterior salience network is particularly implicated in attentional networks (Corbetta, Patel, & Shulman, 2008; Petersen & Posner, 2012; Nigg, 2017).

Understanding Attentional Control

In 2012, Petersen and Posner updated their previous work to consider perhaps 4,000-6,000 articles on attention. This document has been massively influential and stands as a solid foundation for understanding attention. Crucially, while attention is a nebulous term that is hard to identify, Petersen and Posner's (2012) work began to break down this umbrella concept in to more specific, parsimonious understandings that could perhaps have a neurobiological basis. The authors articulate three aspects of the attention system. That is, 1) the attention system is anatomically separate from other cognitive processing systems, 2) attention results from a network of brain areas, and 3) these brain areas have separate functions that can be allocated specific cognitive operations of attention (Petersen & Posner, 2012). Furthermore, the authors offered a distinction between three attention systems: alerting, orienting, and executive systems. Of particular interest for the scope of this thesis was the defining of the executive attention control system as two neurobiological systems: a frontoparietal control system that handles moment-to-moment tasks and a cingulo-opercular system that concerns task set maintenance (Dosenbach et al., 2008; Petersen & Posner, 2012; Nigg, 2017). The former system is implicated in what is referred to as transient attention whereas the latter is implicated in sustained attention (Petersen & Posner, 2012). Both neurobiological systems of executive attention control involve

regions of the brain that have overlap with those that are associated with the anterior salience network, namely the dlPFC, dACC, and the AI.

Executive attentional control should guide individuals to attend to psychologically salient target stimuli and ignore irrelevant, interfering stimuli concurrently. To measure this type of attentional control, a Stroop task is useful (MacLeod, 1991). Recently, the affective Stroop task has been used to assess cognitive capacities such as attentional control (as well as emotional control) of patients with disruptive behavior disorders (Blair et al., 2007; Fehlbaum et al., 2018) and attention deficit hyperactivity disorder (ADHD) (Hwang et al., 2015). In the affective Stroop task, a participant must inhibit encoding what a given numerical symbol means (as well as an image with emotional valence) and instead concentrate on how many numerical symbols are displayed on the screen (see Figure 1). This thesis refers to *attentional control* to mean this type of interference control, which can be observed on the affective Stroop task.

Anterior Salience Network and Attentional Control

Previous research has identified a functional network that is intrinsically connected at rest but is also comprised of brain regions that are regularly involved in salience processing (i.e., anterior salience network) (Shirer et al., 2012). In response to stimuli, this large-scale network might control attentional performance and selectively process salient stimuli that change dynamically as we encounter the world. Seeley et al. (2007) suggest that it is important to identify whether intrinsic connectivity of brain regions at rest is correlated with several abilities such as attentional control that impact how people behave in their daily lives. This represents the substantial knowledge gap regarding the relationship between the anterior salience network and attentional control. In an effort to address this gap, this thesis aimed to explore whether the pattern of functional connectivity within the anterior salience network indicated any significant

relationship with a measure of attentional control. More specifically, this thesis questioned whether individual differences in the pattern of the anterior salience network correlated with performance on the affective Stroop task. The hypothesis for this study was that resting-state functional connectivity values within the anterior salience network would be associated with task accuracy during the affective Stroop task, which represented attentional control performance. This study is significant to increasing our understanding of the relationship between the salience network and attention.

Methods

Participants

Data from the current study was a part of a neuroimaging project investigating neurobiological effects of individuals with a history of bullying behavior and peer victimization. Convenience sampling was used to recruit a sample of the population at a large university in the Midwest. Following recruitment, 352 college-aged students participated in an online screening either voluntarily or for a course credit. In this screening process, students' eligibility for magnetic resonance imaging (MRI) and behavioral history of bully involvement was checked as the primary purpose of the larger neuroimaging project.

The screening process identified fifty-one participants to be selected and enrolled for further MRI study. One participant indicating a brain abnormality was excluded. All remaining participants did not indicate any major neurological illness, cognitive or developmental delay, or severe vision/hearing loss. Written informed consent was obtained from participants prior to the online screening and MRI scan which were approved by the university's Institutional Review Board. All participants in the MRI study received a gift card for compensation.

From the fifty-one qualified participants, one showed severe head motion during the scan, resulting in poor quality of neuroimages; this participant was excluded from subsequent analyses. In addition, two other participants were identified as outliers (defined as scores falling outside more than three standard deviations) in their performance on the affective Stroop task (i.e., extremely low task accuracy during incongruent trials, to be discussed in the *Measures* section). These participants were also excluded from subsequent analyses. As a result of these preliminary exclusions, the total sample size for the current study was N = 48. The mean age of participants was 22.6 years (SD = 4.7). There were twenty four females and twenty four males in the sample. Thirty-four participants identified as White, five as Black, five as Asian, two identified as mixed, and two identified as some other race.

Measures

To assess participant suitability for our MRI study, an online screening was used, consisting of several questions regarding MRI eligibility (e.g., no magnetic object in their body). The qualified participants were further asked to complete an online demographic and psychological assessment battery.

Affective Stroop task (AST): During the functional scans, participants were asked to perform the affective Stroop task (Blair et al., 2007). The affective Stroop task assesses emotional and attentional regulation by presenting participants with emotional images and Arabic numerical symbols arranged in a pattern. In sequence, a central fixation point was presented (400 ms) followed by an emotional distractor (positive, negative, or neutral image) (400 ms), numerical symbols (or a blank screen) (400 ms), the same emotional distractor previously displayed (400 ms), and a blank screen (1300 ms). Participants were instructed to press buttons corresponding to the number of symbols (three to six) as quickly as possible; they

were able to respond at any time by the end of the blank screen (1700 ms). One hundred forty-four emotional images were selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008) for presentation to participants during trials. Of these emotional distractors, forty-eight were positive, forty-eight were negative, and forty-eight were neutral.

In addition, the trials consisted of *congruent*, *incongruent*, and *view* patterns. For *congruent* trials, a numerical symbol matched the number of symbols displayed in a pattern (e.g., five 5's). For *incongruent* trials, a numerical symbol did not match the number of symbols displayed in a pattern (e.g., three 5's). For incongruent trials, participants were required to control their attention by ignoring what a given symbol indicates and focusing on counting symbols. In this way, high attentional control is required for incongruent trials. Beyond congruent and incongruent trial patterns, participants were also presented with view trials, which comprised a blank screen. Participants completed two runs involving one hundred forty-four trials (sixteen trials in each of nine conditions, congruent, incongruent, or view trials with positive, negative, or neutral images) and forty fixation presentations. The trial order was randomized across all participants. Figure 1 illustrates the sequence of each trial. In consideration of the purpose of the current study, I focused only on task performance during the congruent and incongruent trials. A higher accuracy rate for correct responses on incongruent indicated better attentional control.

Procedure and Imaging Data Acquisition

The qualified participants first underwent an MRI scan. Neuroimaging data were acquired on 3 Tesla Siemens Skyra MRI scanner (Siemens Medical Solutions) equipped with a 32-ch head coil MRI receiver. The MRI study involved (1) a localizer scan for prescribing the following scans, (2) a 6-min resting-state functional scan, (3) two 8.5-min functional scans

during the affective Stroop task, (4) a 5-min anatomical T1-weighted (T1w) scan, (5) the other two 4.5-min functional scans during the face looming task, (6) two diffusion-weighted scans, (7) a 1.5-min scan of T2-weighted turbo spin echo (TSE), and (8) a 1.5-min gradient echo field-mapping scan in the order. The current study used resting-state functional images, which were sensitive to blood oxygen level-dependent (BOLD) acquired with a 2D multiband (MB) gradient echo recalled (GRE) echo-planar imaging (EPI) series (TR = 1000 ms, TE = 29.80 ms, multi-band acceleration factor = 3, flip angle = 60°, FOV = 210 mm, voxel size = 2.5 mm^3); 346 sets of 51 contiguous axial images with isotropic voxels (2.5 mm^3) were acquired parallel to the anterior-posterior commissure plane. During the resting-state functional scan, participants were instructed to stare at a cross-hair fixation and to try not to think about anything. In addition, the anatomical T1w images were used for registering the functional images; the T1w images were acquired in the sagittal plane by a three-dimensional magnetization prepared rapid gradient echo (MPRAGE) scan (TR = 2200 ms, TE = 3.37 ms, flip angle = 7°, FOV = 256 mm, sagittal slices per slab = 192, voxel volume = 1.0 × 1.0 × 1.0 mm^3, acceleration factor PE = 2, sampling band-width = 200 Hz/Px). The total amount of time for MRI scans was less than one hour. Following the MRI scan, participants completed the demographical and psychological assessment battery through an online survey management program.

Image Preprocessing

The anatomical images were automatically segmented into gray matter, white matter, and ventricles using FreeSurfer image analysis suite (http://surfer.nmr.mgh.harvard.edu/). In addition, the resting-state functional data were preprocessed using AFNI (https://afni.nimh.nih.gov/afni), including: despiking, aligning slices to the beginning of the TR (slice-timing correction), registering the structural volume (T1w) to the Montreal Neurological

Institute (MNI) standard template using a nonlinear transformation, co-registering the structural volume to the functional data, warping the functional data to the standard template, and smoothing the warped functional data spatially within the whole brain volume (identified by FreeSurfer). The first three TRs were censored, and then a general linear model (GLM) was used to eliminate variables of no interest from the time series, such as the mean signals in the white matter and ventricle (identified by FreeSurfer), global mean signal in the whole brain, and de-meaned and derivatives of motion parameters. Participants with excessive head movement (greater than 3.0 mm displacement) were excluded from further analysis. A band pass filter was also applied to the time series to eliminate frequencies greater than 0.1 Hz and less than 0.01 Hz.

After the time series BOLD signals per voxel were estimated by the GLM, they were extracted within the anterior salience network as identified by Shirer et al. (2012). The mask images of these functional clusters were obtained online (http://findlab.stanford.edu/functional_ROIs.html), and they were resampled to a standard template and applied to the functional data. The seven fROIs that functionally connected with each other at rest correspond to regions that include the bilateral dlPFC, the bilateral AI, the dACC, and the bilateral CB IV-Cr I (see Figure 2). Then, the mean BOLD signals across voxels comprising each of the seven fROIs were extracted through 346 timepoints by AFNI's 3dROIstats command. Finally, Pearson's correlations were used to generate a correlation matrix between the seven fROI clusters of the anterior salience network (i.e., twenty-one correlation coefficients or functional connectivity values) within each participant, and these correlations were then converted to z-scores by using the Fisher r-to-z transformation so that the correlation coefficients become normally distributed.

Statistical Strategy

Descriptive statistics were conducted for average task accuracy (with standard deviations) during the congruent and incongruent trials of the affective Stroop task. Individual task accuracy rates in the congruent trials and the incongruent trials respectively were assessed in relation to the z-transformed functional connectivity values of the anterior salience network, using Pearson's correlations.

Results

Accuracy Rates

During two runs of the affective Stroop task, participants responded to 192 total congruent and incongruent trials. Participant accuracy rate indicated a mean score of .929 (*SD* = .040) across all trials. Participant accuracy rate for congruent and incongruent trials indicated a mean score of .943 (*SD* = .042) and .916 (*SD* = .049), respectively.

Relationship between Accuracy Rates and Resting-State Functional Connectivity

There were several significant relationships between accuracy rates and resting-state functional connectivity of the anterior salience network (see Table 1). When considering overall task accuracy, accuracy rates were correlated with functional connectivity of the dACC-left dlPFC (r = .293) and the dACC-left AI (r = .298) positively and functional connectivity of the left-right CB IV-Cr I negatively (r = -.298). Accuracy rates on congruent trials were negatively correlated with functional connectivity of the right dlPFC and the left CB IV-Cr I (r = -.293). Finally, accuracy rates on incongruent trials were positively correlated with functional connectivity of the dACC-right dlPFC (r = .285), the dACC-left AI (r = .308), and the left-right

dlPFC (*r* = .305) whereas functional connectivity of the left AI-right CB IV-Cr I was negatively correlated with accuracy rates (*r* = -.313). All other correlations were not significant.

Discussion

The current study sought to discern whether resting-state functional connectivity of the anterior salience network could be associated with measures of attentional control. It was specifically hypothesized that some anterior salience network functional connectivity patterns would be associated with accuracy rates on the affective Stroop task. This hypothesis was supported in respect to the connectivity values between several pairings of brain regions that comprise the anterior salience network.

Notable in these data was the functional connectivity between the dACC and the right dlPFC as well as the functional connectivity between the dACC and left AI. As these functional connectivity values increased, participants showed better attentional control (i.e., increased accuracy rates on the incongruent trials). These findings echo and expand previous work done with different attentional tasks, which suggests that the anterior cingulate cortex (Sridharan, Levitin, Menon, 2008; Dosenbach et al., 2006; Crottaz-Herbette & Menon, 2006) and the AI (Sridharan, Levitin, Menon, 2008; Dosenbach et al., 2006) play key roles in attentional processing. The dlPFC is important for top-down processing and crucially involved in working memory, as well as attention (Osaka et al., 2007). Thus, the current findings suggest that strong synchronization between the dACC, the AI, and the dlPFC may contribute to the coordination and management of controlled attention. Interestingly, with respect to the involvement of the dlPFC as an important region of another functional network, called the central executive network (CEN), there may be an integrated relationship between the anterior salience network and the CEN (Goulden et al, 2014). Other research implies that the insula causally influences the CEN

(Dronkers, 1996; Baldo et al., 2011), and Uddin (2017) further suggests that the anterior salience network might serve as the mediator for the integration of other large networks such as the CEN and the default mode network. Taken together, the current findings suggest that high functional synchronization between the anterior salience network and the CEN via the dlPFC may optimize attentional control although this is speculative. Future research is needed to confirm this model.

Beyond lateralized associations with other regions of the anterior salience network, the data in this study revealed a significant correlation between attentional control and interhemispheric dlPFC functional connectivity. This bilateral intrinsic connectivity at rest may mirror some results of task-related fMRI studies, where increased/decreased functional activation of the bilateral dlPFC during attentional control (Lippelt, Hommel, & Colzato, 2014), inhibitory control (Aron, Robbins, & Poldrack, 2014), and working memory performance (Barbey, Koenigs, & Grafman, 2013). Lesion studies (Cipolotti et al., 2016) and studies employing functional near-infrared spectroscopy (fNIRS) (Yamaya et al., 2021) offer additional converging evidence for the role of the bilateral dlPFC in higher-order cognitive processing and top-down attentional control. In other words, the bilateral dlPFC is necessary to perform these cognitive tasks, and my results expand that increased functional connectivity between the left and right dlPFC may additionally play an important role in attentional control.

Data also indicated a negative correlation between attentional control and resting-state functional connectivity between the left AI and the right CB IV-Cr I. Prior work from Koziol et al. (2014) suggests that the cerebellum plays a larger role beyond pure motor processing and, in fact, may also be involved in cognition and emotion. While research that implicates attentional roles of these two regions is limited, on relevant study was conducted by Kuyci et al. (2015). They found differences in the patterns of resting-state functional connectivity between

participants with ADHD and healthy controls. One of these differences included stronger positive functional connectivity between the bilateral insula and the cerebellar areas for individuals with ADHD, in contrast to the negative connectivity in healthy controls (Kuyci et al., 2015). While ADHD participants were not used in this study, my results seemed to be consistent with Kuyci et al.'s (2015); increased functional connectivity between the AI and the CB IV-Cr I was related to decreased attentional control. Furthermore, the current results also indicated a negative correlation between attending to the congruent trials and the functional connectivity of the right dlPFC and the left CB IV-Cr I. This finding also yielded that the functional connectivity with the cerebellum may contribute to attentional performance. However, the qualitative interpretation of this association within this study is speculative and cannot be addressed with the results of this thesis. Interestingly, Kelly and Strick's (2003) primate study found afferent connections between the cerebellum and the dlPFC, and this association may be implied in the results of this work. Future research should explore the relationship among the insula, the dlPFC, and the cerebellum.

Implications

Seeley et al. (2007) raised an important question about how intrinsic functional connectivity values might impact individual cognitive attributes and abilities. This thesis may contribute to potential answers to this question. Results suggest that positive functional connectivity in the frontal and insular areas of the cortex and negative functional connectivity between these areas and the cerebellum may indicate improved attentional control. Developing a comprehensive understanding of the relationship between attentional control, attention-related brain regions, and resting-state functional synchronization in the brain may have implications for more accurately assessing an individual's attentional capacities. This may, in turn, have clinical

applications for the diagnosis of attention disorders such as ADHD, or in evaluating educational interventions designed to improve student attentional control. Studies are starting to explore how intrinsic brain connectivity may hint at individual brain function and might be used in assessment or treatment (Rosenberg et al., 2016; Poole et al., 2016; O'Halloran et al., 2018).

Limitations

No study is without limitations and there are several that should be considered concerning the current study. First, this study may be critiqued for its small sample size which may result in a lack of statistical power. However, it should be noted that the sample size (N = 48) was larger than other, highly cited neuroimaging studies (Szucs & Ioannidis, 2020). Additionally, it would be interesting to replicate this experiment using an alternative task for attention in order to compare results. In addition, it should also be considered that regions such as the dACC and AI have high base-rate activation. This means that it is easy to make misleading inferences, such as the determination that these regions play key roles specifically in cognition or emotion (Yarkoni et al., 2011). Indeed, it is further difficult to even demonstrate that salience and the CEN are distinct as was noted by Seeley et al. (2007), although more recent work from Uddin (2015) offers more evidence for a separate salience network that takes into consideration specialized von Economo Neurons (VENs) that are specific to the human ACC and insula. These VENs may facilitate the integration of these brain regions with others. Seeley et al. (2007) also mentioned the difficulty of interpreting "resting states" as the brain is never fully at rest. Discerning specific mental states is difficult and tasks that require subjects to engage in purposeful internal processing may also engage similar networks activated at rest, confounding results. This discernment between task and task-free network activation is an important implication to consider when interpreting the correlational results of this thesis. Still another

limitation of this work was its specific focus only on the anterior salience network. Data from other resting-state networks such as the posterior salience network, the central executive networks, and the default mode network, might be additionally important for understanding, more fully, attentional control. Finally, it is important to note that, as a correlational study, there is a lack of causal inference for these data and, as such, any interpretations or conclusions must be addressed accordingly and with appropriate caution.

Conclusions

In conclusion, the data gathered in this study supported the finding of several significant correlations between measures of attentional control and resting-state functional connectivity within regions of the anterior salience network, suggesting that intrinsic connectivity of the brain might be able to indicate elements of attentional control ability. Increased attentional control was associated with increased functional connectivity between the dACC and the right dlPFC and between the dACC and the left AI, as well as the interhemispheric connectivity of the dlPFC. In contrast, attentional control was diminished as functional connectivity between the cerebellar region and the right dlPFC as well as the left AI, decreased. These findings could have implications for the evaluation of educational interventions that seek to improve the attentional capacities of students or remediate attention-related disorders such as ADHD.

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Table 1

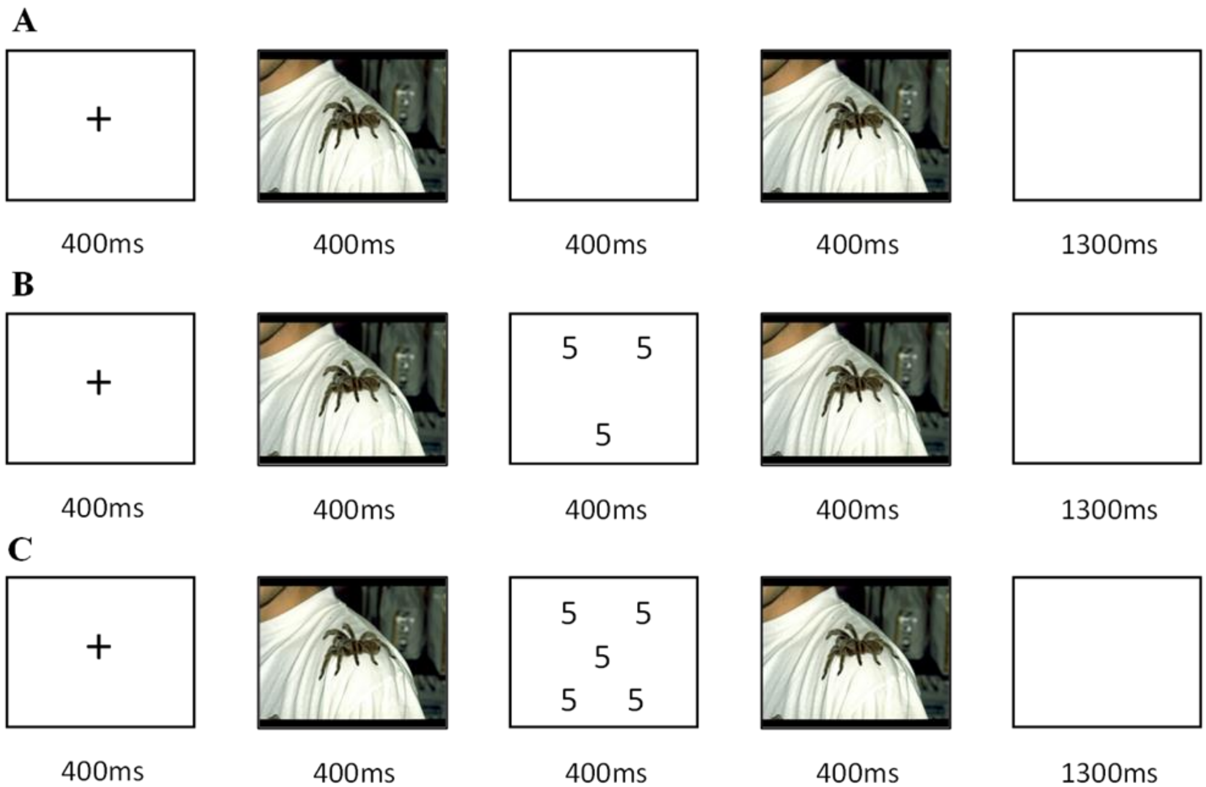
Relationship between Accuracy Rates and Resting-State Functional Connectivity Values (N = 48)

Functional Connectivity		Congruent	Incongruent	All Trials
dACC	L dlPFC	.250	.269	**.293***
	R dlPFC	.170	**.285***	.262
	R AI	-.013	.014	.002
	L AI	.213	**.308***	**.298***
	L CB	-.001	.064	.038
	R CB	-.076	.000	-.039
L dlPFC	R dlPFC	.030	**.305***	.201
	R AI	.124	.153	.157
	L AI	-.180	.124	-.017
	L CB	-.099	-.008	-.056
	R CB	-.112	-.184	-.170
R dlPFC	R AI	-.122	.071	-.019
	L AI	-.024	.212	.117
	L CB	**-.293***	-.018	-.162
	R CB	-.240	-.117	-.195
R AI	L AI	.161	.189	.199
	L CB	-.042	.014	-.013
	R CB	-.092	-.087	-.100
L AI	L CB	-.089	-.199	-.167
	R CB	-.123	**-.313***	-.254
L CB	R CB	-.271	-.260	**-.298***

*$p < 0.05$.
Note. dACC = dorsal anterior cingulate cortex; dlPFC = dorsolateral prefrontal cortex; AI = anterior insula; CB = lobule IV-Crus I of the cerebellum; L = left; R = right.

Figure 1

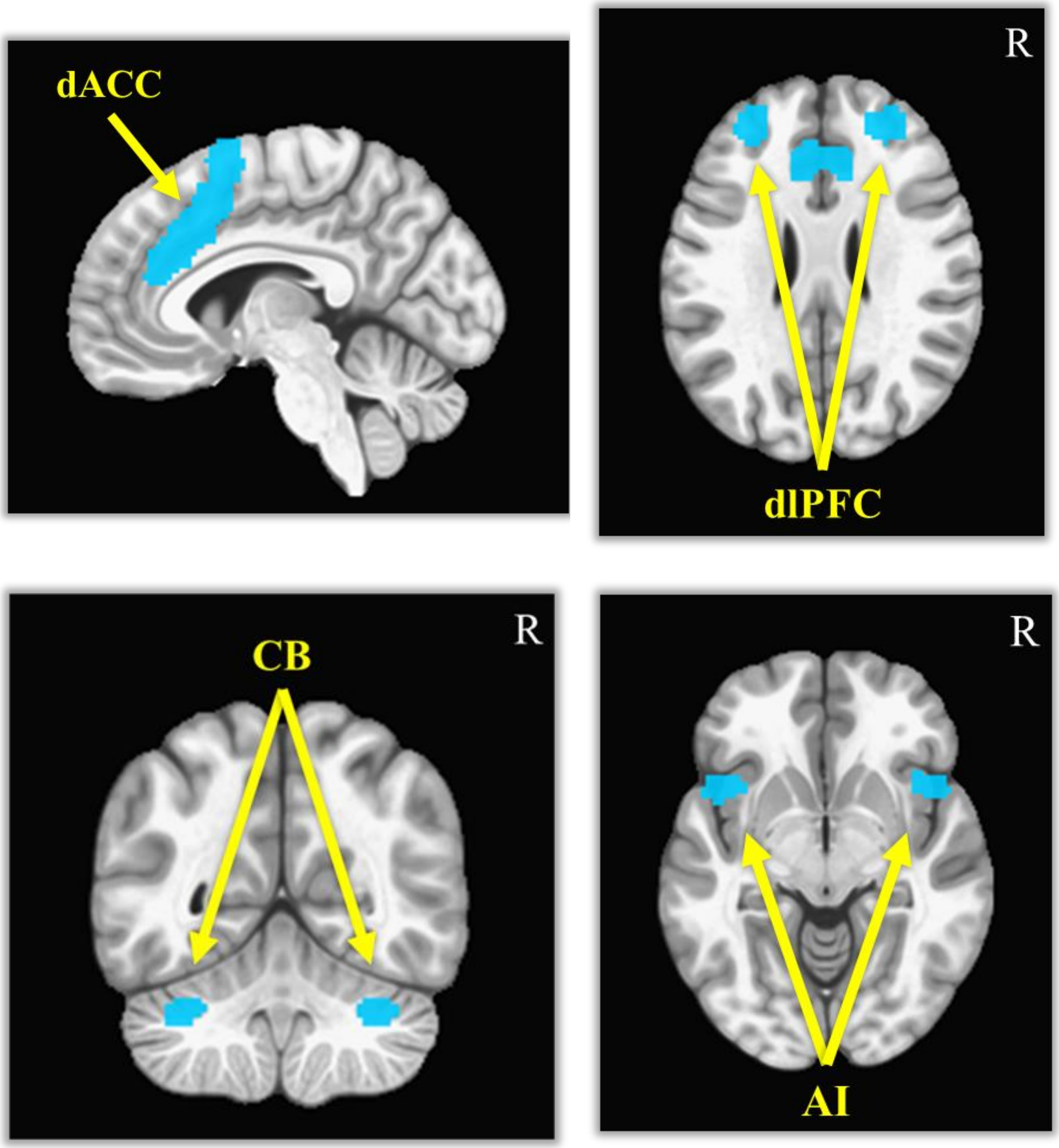
Experimental Trial Sequence



Note. Of 288 total trials, ninety-six were view trials (A), ninety-six were incongruent trials (B), and ninety-six were congruent trials (C). The image of the spider above is an example of an image that has negative emotional valence. Images with positive and neutral valence were also included.

Figure 2

The Anterior Salience Network



Note. dACC = dorsal anterior cingulate cortex; dlPFC = dorsolateral prefrontal cortex; AI = anterior insula; CB = lobule IV-Crus I of the cerebellum; R = right.