Title of Study: The Influence of Noradrenergic Activity on Attentional Control in Younger and Older Adults

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Study Protocol

Increased distractibility is a hallmark of aging and dysregulated processing in the brain (Li et al., 2001; Weeks & Hasher, 2014). The noradrenergic system plays important roles in modulating attention, memory, and decision processes and recent neuroimaging findings suggests that older adults have abnormal tonic noradrenergic discharge (Elman et al., 2017; Zhang et al., 2016). Importantly, elevated tonic noradrenergic activity reduces phasic noradrenergic discharge to task-related information (Aston-Jones & Cohen, 2005), which together may stimulate progression of neurodegenerative diseases (Janitzky, 2020). Thus, understanding the mechanisms by which noradrenergic activity and dysregulation modulates age-related distractibility is a critical need in preventing cognitive decline. For example, it is yet unclear whether noradrenergic hyperactivity or hypoactivity mediates cognitive behavioral impairments such as attentional control. We will increase or decrease tonic noradrenergic activity and investigate the behavioral and neural effects on attentional control. The threat-of-shock paradigm has previously been utilized to investigate the effects of induced negative arousal on attention (Kim & Anderson, 2020a, 2020b; Kim et al., 2021a) and importantly has demonstrated neural evidence of high tonic noradrenergic activity (Balderston et al., 2017). Thus, we will utilize the threat-of-shock paradigm to investigate the consequences of elevating tonic noradrenergic discharge. We will utilize two different types of visual search tasks. The first visual search task will be adapted from Gaspelin et al. (2017). Participants will be asked to search for a specific shape (e.g., diamond) among different shapes (e.g., square, circle, hexagon). The second visual search task will be adapted from Kim & Anderson (2020b). Participants will be asked to search for a unique shape (e.g., circle among diamonds or diamond among circles) among the visual search array. Both visual search tasks are designed to have the participant search for a target while trying to ignore other non-target stimuli. On some trials, a distractor stimulus may be included that can be physically salient (e.g., different color or shape) or associated with a valent outcome (e.g., reward). Participants will be informed of the presence of feedback (if included in the task), but will not be informed of the specific stimulus-outcome pairings, which must be learned in the task. The consequence of this learning on distraction will then be examined when previously outcome-predicting stimuli are presented as task-irrelevant stimuli that participants try to ignore. If stimuli are not associated with any outcome, there will be no feedback provided on that trial (e.g., physically salient distractor stimuli).

Statistical Analysis Plan

Mixed ANOVA (MANOVA) analyses were conducted with age as a between-subjects factor and all other measures as a within-subjects measure. To determine if the threat of shock

differentially modulated the oculomotor suppression effect by, we conducted a 2x2 MANOVA over factors age (young vs. older) and intervention (no shock vs. shock).