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Research Article

Attentional Bias Among Adolescents Who Stutter: Evidence for a Vigilance–Avoidance Effect

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Purpose: The purpose of this study was to examine group and individual differences in attentional bias toward and away from socially threatening facial stimuli among adolescents who stutter and age- and sex-matched typically fluent controls.
Method: Participants included 86 adolescents (43 stuttering, 43 controls) ranging in age from 13 to 19 years. They completed a computerized dot-probe task, which was modified to allow for separate measurement of attentional engagement with and attentional disengagement from facial stimuli (angry, fearful, neutral expressions). Their response time on this task was the dependent variable. Participants also completed the Social Anxiety Scale for Adolescents (SAS-A) and provided a speech sample for analysis of stuttering-like behaviors.
Results: The adolescents who stutter were more likely to engage quickly with threatening faces than to maintain attention on neutral faces, and they were also more likely to disengage quickly from threatening faces than to maintain attention on those faces. The typically fluent controls did not show any attentional preference for the threatening faces over the neutral faces in either the engagement or disengagement conditions. The two groups demonstrated equivalent levels of social anxiety that were both, on average, very close to the clinical cutoff score for high social anxiety, although degree of social anxiety did not influence performance in either condition. Stuttering severity did not influence performance among the adolescents who stutter.
Conclusion: This study provides preliminary evidence for a vigilance–avoidance pattern of attentional allocation to threatening social stimuli among adolescents who stutter.

Stuttering is a social phenomenon. For instance, people who stutter typically do not stutter when they talk to themselves (Miller et al., 2020), and stuttering severity is often impacted by the interpersonal dynamics of an interaction such as how listeners react to a moment of stuttering (Plexico et al., 2009b). The social cues that people who stutter pay attention to in their environment, such as adverse listener reactions, can greatly influence how they maneuver and make meaning of their social world. This may be particularly true for adolescents where the occurrence of protracted maturation of social and emotional brain circuits renders them more sensitive to their social environment than at other developmental junctures (Guyer et al., 2016; Kilford et al., 2016; Steinberg, 2005). Examining how adolescents who stutter process social information, particularly how they prioritize focusing on threatening versus benign aspects of that information, can inform our understanding of how they respond to and behave in social situations. The tendency to pay greater attention to threatening cues in one's environment, over benign cues, is known as threat-based *attentional bias.* As stuttering is bound to social interactions, this study compared attentional bias toward socially threatening information in the form of angry and fearful facial expressions in a group of adolescents who stutter and typically fluent controls.

Adolescence is a period of transition—one of opportunity but also one of great vulnerability (Eiland & Romeo, 2013; Tottenham & Galván, 2016). While cascading hormonal effects on their social information processing abilities reflect age-typical changes for many young people, for a small minority, the interplay of heritable and environmental stress factors (particularly those that are affective

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in nature) can be especially tumultuous and associate with maladaptive patterns of social behavior including psychopathology. The inter- and intrapersonal dynamics of stuttering can serve as an environmental stressor with effects on emerging patterns of social behavior. Interpersonally, adolescents who stutter frequently experience negative listener reactions and stereotyping, not to mention higher rates of teasing and bullying (Blood & Blood, 2007, 2016; Blood et al., 2011), peer rejection (Adriaensens et al., 2017), and romantic rejection (Van Borsel et al., 2011) when compared to their nonstuttering peers. Repeated exposure to challenging social interactions could amplify their social fears and promote a variety of adverse intrapersonal effects such as negative attitudes toward communication (Guttormsen et al., 2015), poor self-perceived communication competence, apprehension toward talking (Beilby et al., 2012b; Blood et al., 2001; Erickson & Block, 2013; Mulcahy et al., 2008), and diminished self-esteem (Adriaensens et al., 2015). These psychosocial ramifications of stuttering could make adolescents who stutter vulnerable to developing psychopathology symptoms too. Indeed, several reports have revealed higher levels of social anxiety (Blood et al., 2001; Erickson & Block, 2013; Hollister, 2015; Mulcahy et al., 2008), state anxiety (Davis et al., 2007; Mulcahy et al., 2008), and general anxiety (Blood et al., 2007; Gunn et al., 2014) among adolescents who stutter than typically fluent peers. However, there are conflicting findings from other studies that have shown comparable levels of state and trait anxiety (Craig & Hancock, 1996; Hancock et al., 1998) and general anxiety (Iverach et al., 2017; Messenger et al., 2015) between groups. Regardless of whether differences in psychopathology manifest between adolescents who do and do not stutter, that stuttering is associated with other negative outcomes underscores a need to identify factors that contribute to the onset and maintenance of stuttering-specific social concerns (Iverach et al., 2017).

A ubiquitous component of the stuttering experience that often complicates social interactions for people who stutter is anticipating and coping with adverse reactions from conversational partners (Plexico et al., 2009a; Tichenor & Yaruss, 2018). In everyday interactions, people who stutter commonly encounter looks of confusion, impatience, embarrassment, pity, and shock (Irani & Richmond, 2012; Yovetich & Dolgoy, 2001). When people who stutter perceive adverse listener reactions, whether subtle or blatant, they commonly construe undesirable conclusions about what the listener is thinking about them (Bloodstein, 1967; Healey, 2010). Associative learning processes yoke together observable listener reactions, the speaker's negative interpretations of those reactions, and the anticipation of difficulty and negative evaluation in future interactions (Garcia-Barrera & Davidow, 2015). This cycle establishes a complex topography of external social penalties for stuttering and internal anxiety related to social interactions. The impact of listener reactions is at least partially dependent on the speaker's ability to visually perceive those reactions in the first place. Although speakers who stutter, even young children near the onset of stuttering, often avoid eye contact with their conversational partners during a moment of stuttering (Bloodstein & Bernstein Ratner, 2008; Schwartz et al., 1990), they are highly adept at noticing listener reactions. This is likely a function of covert attentional processes; if they expect and fear negative social evaluations during difficult moments of speaking (Iverach, Rapee, et al., 2017), they are likely attuned to even subtle reactions that their listeners produce. Importantly, previous reports suggest that children who stutter demonstrate comparable attentional abilities to nonemotional cues when compared to typically fluent peers on behavioral tasks (Ofoe et al., 2018), including covert visual attention (Johnson et al., 2012).

Preferential allocation of attention toward threatening social cues, particularly those implicating social-evaluative threat, has been commonly linked to anxiety in general and social anxiety in particular (Wong & Rapee, 2016). That is, some individuals tend to pay greater attention to threatening social information in their environment over neutral or positive information—a phenomenon known as attentional bias (see review in Bantin et al., 2016). Two primary hypotheses are commonly cited in explaining attentional bias: the *vigilance–avoidance (VA) hypothesis* and the *attention maintenance hypothesis*. The VA hypothesis posits that some individuals are highly efficient at detecting threatening cues and then quickly shifting their attention away from that cue to avoid detailed processing of the possible threat, thus reducing their subjective discomfort (Mogg & Bradley, 1998). This VA pattern is spurred by bottom-up, stimulus-driven shifts in attention that rely on the sensory salience of the cues in one's environment (Corbetta & Shulman, 2002). For example, some people who are arachnophobic may be on high alert scanning for cues that are suggestive of spiders around them (e.g., spiders, webs), but once they see such a cue, they may try to avoid looking at it or even leave the room to minimize their discomfort. The attention maintenance hypothesis, on the other hand, proposes that attention is not necessarily quickly drawn toward threatening cues, but once a threatening cue is identified, some individuals have difficulty disengaging their attention from it (Fox et al., 2001). For example, some people who are arachnophobic might have difficulty shifting their attention away from the spider or web that they noticed.

There are several experimental paradigms that are used to assess attentional bias within these two theoretical frameworks. Most commonly, researchers in experimental psychopathology have utilized the emotional Stroop task and the dot-probe task. In the emotional Stroop task, socially anxious individuals tend to take longer to name the color of threatening words (e.g., hate, bully, shame) than neutral words (e.g., table, street, path), suggesting the presence of attentional bias (Amir et al., 2002; Becker et al., 2001; Mattia et al., 1993). Limited samples of adults who stutter have demonstrated an emotional Stroop effect, regardless of their state or trait anxiety status (Beita-Zuk, 2013; Hennessey et al., 2014; van Lieshout et al., 2014). One relevant criticism of the emotional Stroop task is that threatening *words* may be less salient and ecologically valid than threatening *faces* in the study of social anxiety,

as facial expressions commonly alert individuals about negative listener evaluation in a more realistic context (Rapee & Heimberg, 1997).

As an alternative, dot-probe paradigms are frequently used to assess individuals' attentional deployment to threatening visual stimuli. Dot-probe tasks are thought to tap into more involuntary attentional processes than emotional Stroop tasks, although this is highly dependent on the timing parameters of the task (e.g., how long stimuli are presented for). In the traditional dot-probe task, two stimuli (e.g., faces, objects) are briefly presented together in two different locations on a computer screen to compete for attention. These two stimuli typically differ in emotional valence (e.g., threat, neutral) and/or salience for the disorder of interest (e.g., emotional faces for social phobia, spiders for arachnophobia). Following the offset of the stimuli, a small probe such as a dot or small arrow appears in one of the two stimuli locations. Respondents are pre-instructed to indicate a specific feature of the probe, such as its location or direction, as quickly and accurately as possible. Anxious individuals tend to respond faster when the probes are presented in the location of the threatening stimulus than when presented in the location of the neutral stimulus (Bar-Haim et al., 2007). Because they were already looking at the threatening stimulus when the probe appeared, they are able to quickly specify where the probe appeared and, as such, they are said to demonstrate an attentional bias toward the threatening stimulus. This was the case for the socially anxious children and adolescents who stutter who demonstrated attentional bias toward schematic line drawings of sad faces (but not neutral, happy, or angry faces) in a study by McAllister et al. (2015). A similar finding was also reported by Lowe et al. (2016) who found that trait-anxious (but not socially anxious) adults who stutter demonstrated attentional bias toward negative faces over household objects. However, there are methodological caveats related to both of those studies that limit generalization of their findings. In the McAllister et al. study (2015), the stimuli were schematic line drawings of faces that were fairly unrealistic portrayals of human emotions. In the Lowe et al. study (2016), the pair of images that appeared on the screen included a negative face paired with a neutral household object; there is evidence that socially anxious individuals tend to only show heightened vigilance when emotional faces are compared to a neutral face, but not when compared to a neutral object (see review in Bar-Haim et al., 2007). Furthermore, there was a pretask threat induction in that study whereby participants were told that they would speak to a small group of people after the task. This pretask threat induction could have potentially modulated socially anxious participants' threat detection system such that the harmless household stimuli on the dot-probe task were perceived as threatening, thereby reducing the relative difference between threat and neutral stimuli (Helfinstein et al., 2008). Overall, this line of inquiry of attentional bias and stuttering is in its infancy; unanswered theoretical and applied questions still remain.

Purpose of This Study

During social interactions, where people look (and do not look) can tell a great deal about what they are attending to and their emotional and cognitive states (Frischen et al., 2007; Lowe et al., 2012). This, in turn, affects their social behaviors. Experimental tasks that include realistic social stimuli allow us to systematically assess visual social attentional patterns that can help us understand how young people who stutter maneuver their social world at a time in their life when these attentional patterns matter for their long-term psychosocial development. In this study, we compared how stuttering and nonstuttering adolescents allocated their attention toward and away from threatening facial expressions. Although the traditional dot-probe task does not allow for close examination of the mechanism underlying attentional bias, we utilized a modified dot-probe task that was established by Rudaizky et al. (2014) to study attentional bias and trait anxiety and subsequently adopted by Grafton and Macleod (2016) to examine attentional bias and social anxiety. This modified task combined the benefits of the traditional dot-probe paradigm where threatening and neutral stimuli compete for attention, with spatial cueing parameters where attention is purposefully drawn to a specific location on the screen. With these modifications, attentional allocation *toward* versus *away* from socially threatening stimuli could be differentially assessed. Grafton and MacLeod (2016) reported that, in their sample of 88 young adults with low and high social anxiety, highly socially anxious participants demonstrated rapid attentional engagement with and trended toward rapid disengagement from threatening faces. These methods and results served as the foundation for this study. Based on the existing literature on stuttering and social anxiety, our first hypothesis was that the adolescents who stutter would be more likely to report higher levels of social anxiety than the typically fluent controls. Our second hypothesis was that the adolescents who stutter would demonstrate rapid engagement with and rapid disengagement from socially threatening faces to a greater degree than the controls; although this attentional behavior is typical of socially anxious individuals (per Grafton & MacLeod, 2016), there is evidence to suggest that the negative impact of stuttering extends beyond the confines of social anxiety. In our auxiliary analyses, we explored the effects of individual differences in social anxiety on performance for all participants, as well as the effect of stuttering severity on performance for the adolescents who stutter.

Method

Participants

A total of 102 participants between 13 and 19 years of age were recruited for this study (69 males, 33 females), including 49 adolescents who stutter (33 males, 16 females) and 53 controls (36 males, 17 females). This sex ratio mirrors the 2.3:1 ratio of males to females who stutter reported in

the literature (Craig et al., 2002). A total of 16 participants (six stuttering, 10 controls) were excluded from the analysis due to achieving lower than 85% accuracy. This accuracy criterion was adopted from the Grafton and MacLeod (2016) study to ensure that participants' response time (RT) performance on accurate trials was an adequate reflection of their overall on-task focus during the activity. This 15.7% exclusion rate was higher than that in the Grafton and MacLeod study, possibly due to the younger age of our cohort. Indeed, the 16 participants in the current sample that were excluded from the analysis due to < 85% accuracy were, on average, 0.95 years younger than the remaining 86 participants who demonstrated adequate accuracy.

All forthcoming data are from 43 adolescents who stutter (28 males, 15 females) and 43 controls (29 males, 14 females). The stuttering group had a mean age of 15.75 years (Mdn = 15.75, SD = 1.94), and the control group had a mean age of 15.84 years (Mdn = 15.50, SD = 1.68), which did not differ significantly between groups, $t(84) = 0.23$, $p = .82$. All participants were native English speakers, had normal or corrected-to-normal vision and hearing, and had no concomitant neurological, intellectual, language, or speech concerns (except for stuttering among the stuttering group). Table 1 details rates of caregiver-reported attention-deficit/hyperactivity disorder, anxiety, and depression in this sample, of which none differed significantly between groups, $\chi^2(1, N = 86) = 0.29$, $p = .59$; $\chi^2(1, N = 86) = 0.09$, $p = .76$; and $\chi^2(1, N = 86) = 0.20$, $p = .65$, respectively. To be included in the stuttering group, the participant's parent/caregiver had to report that the adolescent stuttered in early childhood and currently stutters. The researchers did not rely on the criterion of at least 3% stuttered syllables (% SS) to determine group membership because that is not necessarily a reliable indicator of stuttering; adolescents who stutter very mildly (< 3% SS) may still identify as a person who stutters, or they may successfully hide stuttering and thus their < 3% SS would not be a true reflection of their stuttering severity. To be included in the control group, the participant's parent/caregiver had to self-report a negative personal history of stuttering.

Socioeconomic status (SES) was calculated using the Hollingshead Four Factor Index (Hollingshead, 1975). Parental education and occupation were used to calculate a weighted SES score ranging from 8 to 66. SES did not differ between the stuttering group (M = 53.51, Mdn = 54.50, SD = 9.64) and control group (M = 54.54, Mdn = 55.50, SD = 9.01), $W = 1382$, $p = .58$.

Table 1. Rates of caregiver-reported attention-deficit/hyperactivity disorder (ADHD), anxiety, and/or depression diagnoses.

Group	ADHD	Anxiety	Depression
Stuttering	8/43	6/43	3/43
Control	6/43	5/43	2/43

Note. A total of 12 adolescents who stutter and nine controls had one or more of these diagnoses; some participants had co-occurring diagnoses.

Participants were from a variety of geographic locations in the United States including the Midwest (n = 46), East Coast (n = 19), South (n = 15), and Rocky Mountains (n = 6). The adolescents who stutter were recruited from speech-language pathology clinics and stuttering specialists (as identified from the referral lists available online by the Stuttering Foundation of America and the American Board of Fluency and Fluency Disorders). The controls were recruited through snowball sampling from participating adolescents who stutter as well as recruitment e-mails distributed locally.

Procedure

The study protocol was approved by the University of Iowa's Institutional Review Board. Data collection occurred during one in-person visit with the participant at a private location such as the participant's home or school. The data presented here represent a subset of data collected from this cohort for a larger study of information processing among adolescents who do and do not stutter. The visit lasted approximately 1 hr.

After obtaining consent from participants and their parent, the participant and the first author worked individually for the remainder of the session. The participant first completed the computerized attentional bias task followed by another computerized information processing task (not yet reported) and several paper–pencil self-report questionnaires. The visit concluded with collecting a video-recorded speech sample between the participant and the first author, which was later analyzed off-line to assess stuttering severity. The participant was then debriefed and compensated for their time.

Attentional Bias Task

Overview of the Task

The task structure was closely adapted from Rudaizky et al. (2014) and Grafton and MacLeod (2016). Participants first saw two rectangles on the screen—one on the left side of the screen and one on the right. Inside one of these rectangles was a small red square. Participants were instructed to look at the red square because that is where the anchor probe would appear next. The anchor probe was a small red line facing either horizontally or vertically that was presented very briefly in the middle of this red square. Immediately following, two faces appeared—one with a neutral expression and one with an angry or fearful expression; these faces were randomly allocated to the left or right side of the screen. As soon as those faces went away, a target probe appeared (a small red line, just as the anchor probe, facing either horizontally or vertically). Once the target probe appeared on the screen, the participants were prompted to press the "f" key as fast as possible if the anchor and target probes faced the same direction (i.e., both horizontal or both vertical) or the "j" key if the anchor and target probes faced opposite directions (i.e., one horizontal and one vertical). The target probe stayed on the screen until the participant pressed

one of the keys. For each trial, the participant's RT and accuracy were recorded by the experimental software (Paradigm). Per Grafton and MacLeod's methodology, participants who performed with less than 85% overall accuracy were omitted from the analysis.

The important elements of this task structure were (a) the location of the anchor probe that appeared immediately before the faces and (b) the location of the target probe that appeared immediately after the faces. Presenting the anchor probe on the left or right side of the screen allowed the participant's attention to be intentionally drawn to that side of the screen. Then, by strategically presenting the threatening face on the opposite or same side of where their attention was, we could measure how quickly they shifted their attention toward or away from the threatening faces, respectively.

Attentional engagement trials were those in which the threatening face appeared distal to the anchor probe (i.e., away from where the participant's attention was initially fixated on the neutral face). That is, when the neutral and threatening face both appeared and competed for the participant's attention, we were assessing whether the threatening face prompted the participant to override their initial locus of attention on the neutral expression to look toward, or engage with, the threatening emotion on the other side of the screen (see Figure 1). On half of these engagement trials, the target probe appeared in the same location as the neutral face. On the other half of these engagement trials, the target probe appeared in the location of the threatening face. Rapid attentional engagement with threatening faces was implicated if RTs were relatively shorter for these latter trials than for the former trials, as that meant that the participant's attention quickly shifted to the threatening face.

Attentional disengagement trials were those in which the threatening face appeared proximal to the anchor probe (i.e., same location as where the participant's attention was initially fixated). That is, we were assessing whether the participant avoided the threatening face and thus were quick to shift their attention away from, or disengage from, the threatening emotion and toward the neutral expression on the other side of the screen (see Figure 2). On half of these disengagement trials, the target probe appeared in the same location as the threatening face. On the other half of these disengagement trials, the target probe appeared in the location of the neutral face. Rapid attentional disengagement from threatening faces was implicated if RTs were relatively short for these latter trials than for the former trials, as that meant that the participant's attention quickly shifted away from the threatening face and toward the neutral face.

Details of the Task Structure and Stimuli

This task was programmed and administered on a Dell Latitude E6420 laptop with a 14-in. color screen using Paradigm Stimulus Presentation v2.5 software (Perception Research Systems, 2007). Participants were seated 60 cm from the computer screen, and they provided their responses on the laptop keyboard. After reading through the task instructions, participants completed 16 practice trials with accuracy feedback provided after each response. Then, participants completed 128 trials of the task with accuracy feedback provided only after incorrect responses. The task was divided into four blocks of 32 trials each to prevent participant fatigue, with a brief self-timed break offered after each block. Participants were instructed to rest their hands on the home row keys of the keyboard as they were to press the "f" and "j" keys with their left and right pointer fingers, respectively, during the task. The task took 5–7 min to complete.

Each trial began with a 1,000-ms presentation of two white outlines of vertical rectangles against a black background. Each rectangle measured 6 × 8 cm (subtending a visual angle of 5.72° × 7.63°), positioned on the left and right sides of the screen equidistant from the center of the screen, with 16 cm between the centers of the two rectangles. These rectangular outlines indicated the two locations where the facial images would appear. Centered inside one

Figure 1. Sample task sequence for the attentional engagement bias trials. For the engagement bias trials, the neutral emotion always appeared in the location of the anchor probe, which cued the participant to start the trial by attending there. Facial images from Model WF-011 reproduced with permission from the Chicago Face Database (Ma et al., 2015).

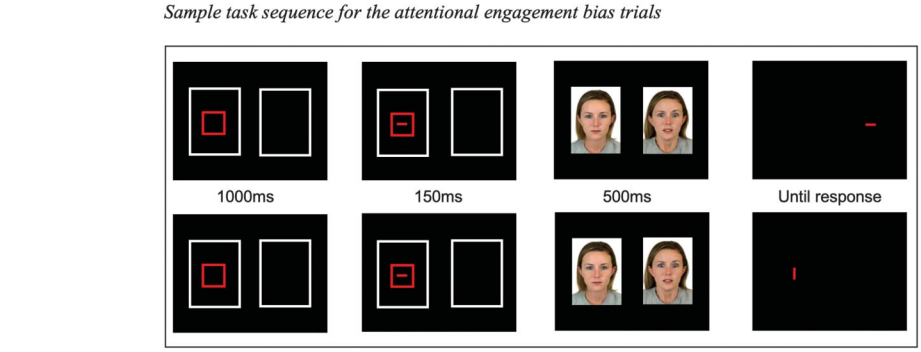
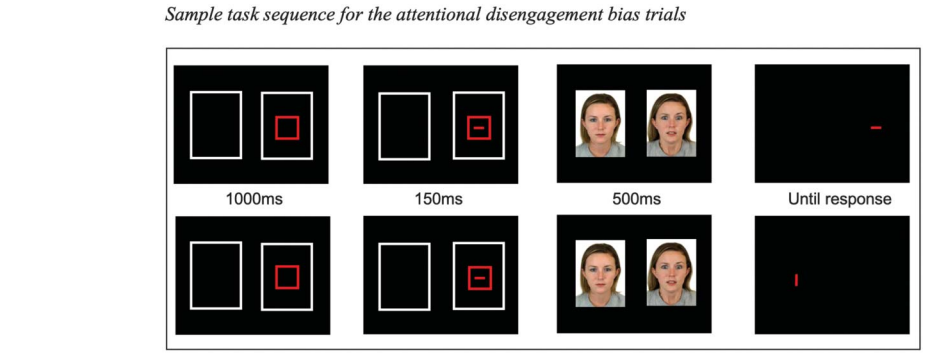


Figure 2. Sample task sequence for the attentional disengagement bias trials. For the disengagement bias trials, the negative emotion always appeared in the location of the anchor probe, which cued the participant to start the trial by attending there. Facial images from Model WF-011 reproduced with permission from the Chicago Face Database (Ma et al., 2015).



of these rectangles was a red outline of a small square measuring 1.5 × 1.5 cm (subtending a visual angle of 1.43° × 1.43°). The location of this red square appeared randomly in the center of the left or right rectangle for the entire 1,000-ms duration. Participants were instructed to look at the red square at the beginning of each trial to ensure their attention remained on the location where the subsequent presentation of the anchor probe and facial stimulus would appear.

Following the presentation of the white rectangles and the red square, an anchor probe appeared centrally in the red square for 150 ms. The anchor probe was a red line measuring 0.5 mm long (subtending a visual angle of 0.48°) that was randomly positioned either horizontally or vertically inside the red square. The anchor probe was displayed for 150 ms so that its orientation could only be apprehended if the participant's attention was already fixated at that location as initially prompted.

Immediately following the offset of the anchor probe, a 500-ms presentation of two faces appeared on the screen—one in the left rectangle and one in the right rectangle. One of the faces displayed a neutral emotional expression, and the other face was the same actor displaying a threatening emotional expression of either anger or fear. The location of the neutral versus threatening faces (i.e., on the left or right side of the screen) was randomly allocated.

Following the offset of the two faces, a target probe was presented randomly in one of the two screen locations. The target probe was a 5-mm red line (identical to the anchor probe), oriented either horizontally or vertically. Participants were prompted to indicate whether the orientation of the target probe matched that of the anchor probe as quickly as possible by pressing the "f" key to indicate a match and the "j" key to indicate a mismatch. The target probe remained on the screen until the participant responded. Participants were provided accuracy feedback on incorrect trials. There was an intertrial interval of 1,000 ms before the next trial began.

Facial images expressing anger and fear were selected as they are commonly used in child and adolescent attentional bias work (Cohen Kadosh et al., 2014; Stirling et al., 2006; Sylvester et al., 2019), and they are also relevant emotions to the experience of stuttering. The standardized facial stimuli were selected from the Chicago Face Database (Ma et al., 2015). The initial selection criteria for the actors included (a) Caucasian; (b) between the ages of 18 and 30 years; and (c) neutral, angry, and fearful images for that actor were provided. Once a subgroup of actors that met those criteria were identified, 16 actors of each sex with the highest provided suitability ratings (as rated by experts in social psychology) were selected to be included in the stimulus set. Only Caucasian individuals were selected to minimize any confounding influence of race. The age range was limited to select actors that were close in age to the participants themselves. The selected female actors had a mean age of 25.30 years (SD = 3.30). The selected male actors had a mean age of 24.51 years (SD = 2.83). For each of the 32 actors, two neutral-threat face pairs were created: one neutral-anger pair and one neutral-fear pair. This generated a total of 64 stimuli pairs. All images were scaled to 230 × 305 pixels and converted to bitmap format. On each trial, one of these neutral-threat pairs was presented with the location of the neutral and threat faces randomly allocated. The face pairs were presented in random order across trials and blocks. Only photographs of the same actor were presented in each trial in an attempt to control for other factors that may have affected attentional preference such as differences in sex, attractiveness, or trustworthiness.

Outcome Measure

RT and response accuracy to each target probe were automatically recorded by the experimental software (Paradigm). Following standard recommendations for addressing errors and outliers in RT-based tasks (Ratcliff, 1993), three types of trials were excluded from the analysis: (a) inaccurate trials in which

the participant incorrectly pressed the match ("f") or mismatch ("j") keys, (b) trials with RTs that fell outside 1.96 *SD*s from the participant's mean RT for that experimental condition (i.e., engagement, disengagement), and (c) any RTs that were less than 250 ms as this is commonly regarded as the fastest time in which a purposeful response can be provided.

Measures

Social Anxiety

Self-reported social anxiety was measured using the Social Anxiety Scale for Adolescents (SAS-A; La Greca & Lopez, 1998). The SAS-A is a widely used social anxiety measure intended for use with adolescents between 13 and 18 years of age. It contains 22 items (including four filler items) that evaluate three aspects of social anxiety: eight items related to fear of negative evaluation from peers, six items related to social avoidance and distress specific to new situations or unfamiliar peers, and four items related to generalized social avoidance and distress. Items are rated on a 5-point Likert scale (*1* = never, *5* = always) and summed across relevant items to obtain the three subscale scores and a total score. The total score could range from 18 to 90, with higher scores reflecting greater social anxiety vulnerability. Total SAS-A scores were utilized in our exploratory analyses. Adequate internal consistency, test–retest reliability, and factorial invariance have been reported for the SAS-A (Ingles et al., 2010; La Greca & Harrison, 2005; Storch et al., 2004).

Stuttering Severity

Stuttering severity was assessed using the Stuttering Severity Instrument–Fourth Edition (Riley, 2009). A 300-syllable conversational speech sample and a 300-syllable oral reading sample were collected from each participant at the end of each visit. The oral reading passage used was the first 300 syllables of the "Rainbow Passage" (Fairbanks, 1969). The speech samples were audio-/video-recorded using a Canon Vixia HF R800 HD Camcorder mounted on a tripod 3 ft from the speaker. The recordings were later analyzed off-line by six trained research assistants who were blind to participants' group membership. The raters analyzed each speech sample for frequency of stuttering-like disfluencies (i.e., sound/syllable repetitions, audible sound prolongations, blocks), average duration of the three longest stuttering-like disfluencies, and how distracting any associated behaviors were (e.g., head movements, limb movements). These values were calculated for the conversational speech sample and oral reading sample and then averaged for each participant, such that a weighted stuttering severity score was calculated. Distribution of stuttering severity for the adolescents who stutter is provided in Figure 3. All videos were scored by two raters; interrater reliability was judged to be very good with a weighted kappa agreement of $w_i = .86$.

Data Analysis

For the engagement condition, 10.2% of trials were excluded from the analysis. Of this 10.2%, 6.2% of trials were incorrect and 4.0% of trials had RTs that were greater than ± 1.96 *SD*s from each participant's mean RT for that condition or < 250 ms. For the disengagement condition, 10.3% of trials were excluded from the analysis. Of this 10.3%, 5.9% of trials were incorrect and 4.4% of trials had RTs that were greater than ± 1.96 *SD*s from each participant's mean RT for that condition or < 250 ms. All told, a total of 9,873 trials from 86 participants were analyzed.

The data were analyzed using R Version 3.5.3 (R Core Team, 2019). To account for subject- and item-specific variability, linear mixed-effects models were fit to participants' RT using the *lmer* function (Kuznetsova et al., 2017) in the *lme4* package (Bates et al., 2015). In the two omnibus models, group, emotion type, and their interaction were entered as predictors. Group and emotion type were dummy coded, with the control group and neutral emotion serving as the reference groups, respectively. RT for the engagement and disengagement trials served as the dependent variables; RTs for the two conditions were log-transformed in all analyses to normalize their skewed distribution. In addition to our omnibus models, mixed models allowed us to explore any moderating effects of individual differences related to social anxiety and stuttering severity on RT. Therefore, in one pair of our follow-up models, social anxiety was entered into a three-way interaction with group and emotion type to predict RT on the engagement and disengagement trials. In a second pair of follow-up models, stuttering severity was entered into a two-way interaction with emotion type to predict RT on the engagement and disengagement trials for the adolescents who stutter only. In all models, the maximal random effects structures supported by the data were included as covariates.

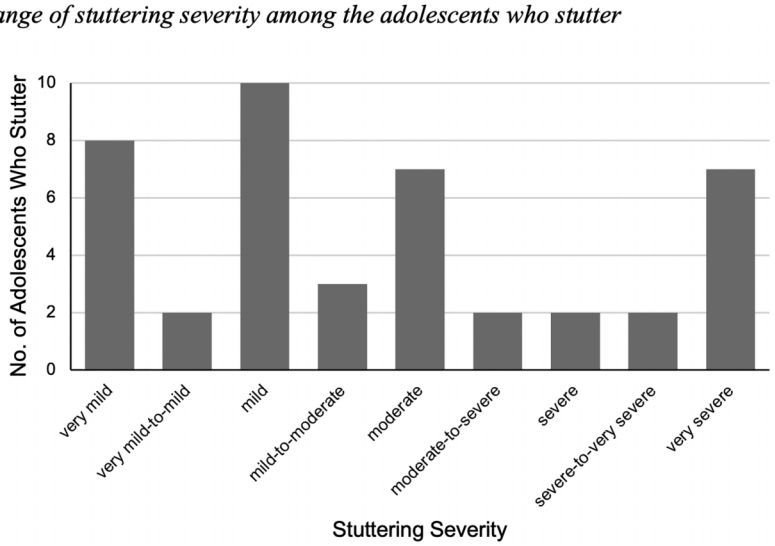
Results

Social Anxiety

On the SAS-A, possible scores ranged from 18 to 90, with higher scores reflecting greater social anxiety vulnerability. Among the adolescents who stutter, SAS-A scores averaged 49.70 (range: 19–87, $Mdn = 48$, $SD = 17.16$). Among the controls, SAS-A averaged 48.77 (range: 26–75, $Mdn = 47$, $SD = 13.28$). These means were not significantly different, $t(84) = 0.28$, $p = .78$, $d = 0.06$. However, the average SAS-A scores for both groups were higher than those for the normative sample, $t(297) = 5.44$, $p < .0001$, $d = 0.76$, for the stuttering group, and $t(301) = 5.37$, $p < .0001$, $d = 0.78$, for the control group, and both approached the suggested clinical cutoff score of > 50 for high social anxiety (La Greca & Lopez, 1998).

Results also revealed a significant two-way interaction between Group × Sex on social anxiety, $t(82) = 2.15$, $p = .03$, $d = 1.05$. The female adolescents who stutter had higher

Figure 3. Range of stuttering severity among the adolescents who stutter.



SAS-A scores than male adolescents who stutter (M = 44.07 for males, M = 60.20 for females; $t(42) = 3.26$, $p = .002$), whereas the female and male control participants had comparable SAS-A scores (M = 48.14 for males, M = 50.07 for females; $t(42) = 0.44$, $p = .66$). There were no effects of age or stuttering severity (for the stuttering group) on SAS-A scores.

Attentional Bias

The participants' overall accuracy on the task averaged 93.94% (SD = 3.56), with the stuttering group averaging 93.84% accuracy (SD = 3.90) and the control group averaging 94.02% accuracy (SD = 3.19), which was not a significant between-group difference, $t(84) = 0.26$, $p = .80$. Group accuracy across engagement and disengagement conditions is provided in Table 2, which also contains the raw, untransformed RTs across conditions. Note that the RTs to respond to the threatening faces (Columns 3 and 7) are not meaningful on their own; they are only meaningful when compared to responding to the neutral faces (Columns 4 and 6, respectively).

Attentional Engagement Trials

In the primary model, the main effects of group (stuttering, control) and emotion type (neutral, anger, fear), as well as their interaction, were used to predict within-subject variation in RT (log) for the engagement trials. The maximal random effects structure supported by the data included random intercepts for subject and item, and a random subject slope for emotion type. There was a significant main effect of group on RT, $\beta = .10$, $t(83.82) = 2.28$, $p = .03$, but no main effect of emotion type on RT. There was also a significant two-way interaction between Group × Emotion Type, $\beta = -.02$, $t(80.71) = -2.30$, $p = .02$, such that the adolescents who stutter were faster to engage with fearful faces than to maintain attention on neutral faces, $\beta = -.04$, $t(81.34) = -2.19$, $p = .03$, but they were not significantly

Table 2. Average accuracy and response time (RT; *SD*) across groups for the engagement and disengagement conditions.

	Engagement trials[a]			Disengagement trials[b]		
Group	% accuracy	RT when attention shifted to threat faces	RT when attention stayed on neutral faces	% accuracy	RT when attention shifted to neutral faces	RT when attention stayed on threat faces
Stuttering	94.05 (3.96)	809.86 (198.19)	836.43 (198.87)	93.60 (4.64)	790.44 (181.48)	838.75 (197.53)
Control	93.60 (3.85)	762.49 (163.35)	757.76 (159.48)	94.51 (3.73)	767.84 (165.46)	770.75 (171.83)

[a]The raw RTs are only meaningful when certain trials are compared against others. Each engagement trial began by orienting participants' attention on the neutral face. Therefore, rapid attentional engagement with threatening faces was indicated if their RT was lower (i.e., faster) when they shifted their attention toward the threatening faces (third column) when compared to maintaining their attention on the neutral faces (fourth column), which is where their attention initially began. [b]Each disengagement trial began by orienting participants' attention on the threatening face. Therefore, rapid attentional disengagement from threatening faces was indicated if their RT was lower (i.e., faster) when they shifted their attention toward the neutral faces (sixth column) when compared to maintaining their attention on the threatening faces (last column), which is where their attention initially began.

faster to engage with angry faces than to maintain attention on neutral faces, β = −.02, $t(143.80) = -1.59$, $p = .11$ (see Figure 4).

Two exploratory follow-up analyses were conducted to evaluate any moderating effects of social anxiety and stuttering severity. Social anxiety (centered) was entered into the model as a three-way interaction with group and emotion type. The maximal random effects structure supported by the data for this model included random intercepts for subject and item. There were no main or interacting effects of social anxiety, but the significant main effect of group and the significant two-way interaction between Group × Emotion Type held, β = .10, $t(96.20) = 2.13$, $p = .04$ and β = −.02, $t(4909) = -2.94$, $p = .003$, respectively.

For stuttering severity, a subset of the data containing only adolescents who stutter was created. Then, the main effects for stuttering severity and emotion type, as well as their interaction, were used to predict their RT for the engagement trials. The maximal random effects structure supported by the data for this model included only a random intercept for subject. None of the main or interacting effects was significant, although the two-way interaction between Stuttering Severity × Emotion Type approached significance, β = −.004, $t(2448) = -1.91$, $p = .06$.

Attentional Disengagement Trials

The models to assess performance on the disengagement trials were evaluated in the same order as described above for the engagement trials. The maximal random effects structure supported by the data for all models included random intercepts for subject and item, as well as a random subject slope for emotion type.

In the primary model, the main effects for group and emotion type, as well as their interaction, were used to predict within-subject variation in RT for the disengagement trials. While there were no main effects of group or emotion type on RT, there was a significant two-way interaction between Group × Emotion Type, β = .03, $t(80.00) = 2.73$, $p = .008$, such that the adolescents who stutter were faster to disengage from angry faces, β = .04, $t(99.78) = 2.17$, $p = .03$, and fearful faces, β = .05, $t(84.91) = 2.58$, $p = .01$, than to maintain attention on those threatening faces. Figure 5 demonstrates the Group × Emotion Type interaction.

Two exploratory follow-up analyses were conducted to observe any potential moderating effects of social anxiety and stuttering severity. Social anxiety (centered) was entered into the model as a three-way interaction with group and emotion type. There were no main or interacting effects of social anxiety, yet the two-way interaction between Group × Emotion Type held, β = −.03, $t(77.56) = 2.71$, $p = .008$.

For stuttering severity, a subset of the data containing only the adolescents who stutter was created. Then, the main effects of stuttering severity and emotion type, as well as their interaction, were used to predict RT for the disengagement trials. There were no main or interacting effects of stuttering severity.

Discussion

The purpose of this study was to investigate how adolescents who stutter visually process socially threatening information compared to their typically fluent peers. Our first hypothesis was not supported in that the adolescents who stutter did *not* report higher levels of social anxiety than their typically fluent peers. However, despite comparable levels of social anxiety across groups, our second hypothesis was supported in that the adolescents who stutter demonstrated rapid engagement with and rapid disengagement from threatening faces to a greater degree than the typically fluent controls. This suggests a VA pattern of attentional allocation to socially threatening information among the adolescents who stutter, which was importantly *not* modulated by higher levels of social anxiety. Among the

Figure 4. Group differences in RT to the three emotions in the attentional engagement condition. Bars depict standard errors of parameter estimates. Facial images from Model WM-025 reproduced with permission from the Chicago Face Database (Ma et al., 2015). RT = response time.

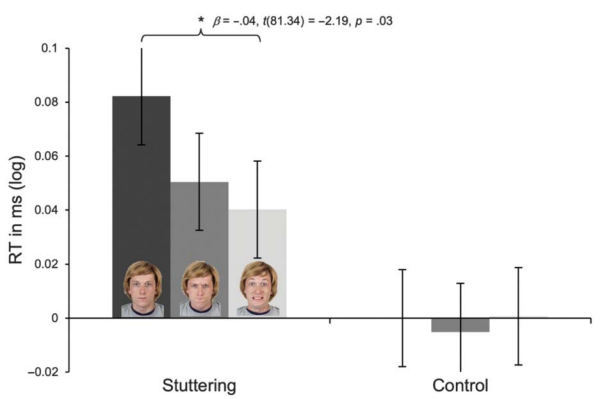
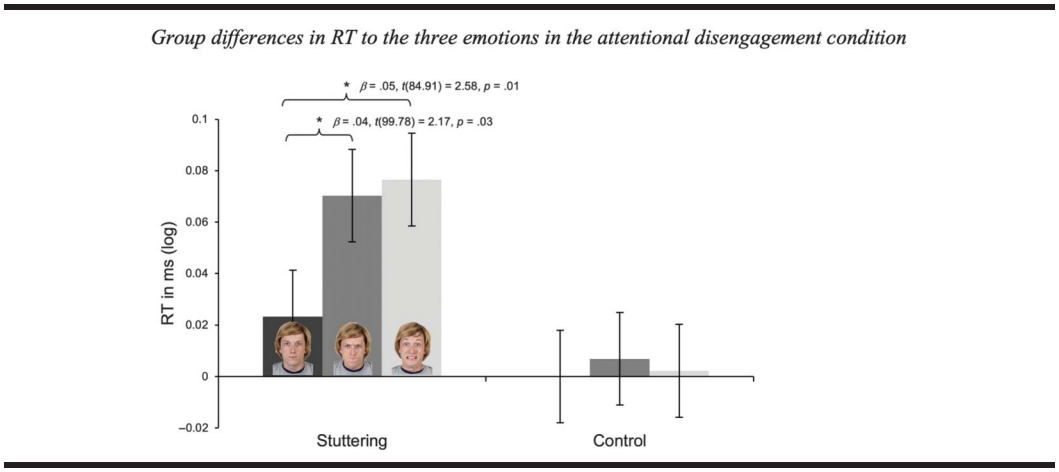


Figure 5. Group differences in RT to the three emotions in the attentional disengagement condition. Bars depict standard errors of parameter estimates. Facial images from Model WM-025 reproduced with permission from the Chicago Face Database (Ma et al., 2015). RT = response time.



stuttering group specifically, stuttering severity did not impact performance.

These results contribute to the growing literature base on attentional processes among people who stutter, broadly considered. A recent meta-analysis of attention in developmental stuttering revealed lower parent-reported attentional focus/persistence abilities among children who stutter than children who do not stutter, although no reliable differences in behavioral measures of attention were identified (Ofoe et al., 2018). Among adults who stutter, there have been noted differences in visual selective and divided attentional resources (Doneva et al., 2017), as well as atypical attentional control and resource allocation in language production (Maxfield et al., 2016). The current findings contribute to our understanding of unique attentional patterns among individuals who stutter when compared to typically fluent controls; specifically, attentional differences do not exist only in "cold" attentional tasks relegated to cognition and perception but also in "hot" attentional tasks that tap into social–emotional processing as well.

The current findings extend previous, albeit limited, work in the area of social–emotional attentional bias among people who stutter. Across emotional Stroop and dot-probe tasks, people who stutter have demonstrated attentional biases to threatening stimuli, which has been shown to even impact speech motor control (Hennessey et al., 2014; van Lieshout et al., 2014). The current findings are in line with several previous studies that have generally shown a group effect, meaning that people who stutter have a greater tendency to demonstrate threat-based attentional biases than controls (Hennessey et al., 2014; Lowe et al., 2012). However, the current findings challenge other studies that have reported an anxiety effect where only people who stutter with elevated anxiety show an attentional bias (Lowe et al., 2016; McAllister et al., 2015). Interestingly, the two prior studies that showed an anxiety effect are the only studies that have previously implemented the dot-probe task. Of these two prior studies, only Lowe et al. (2016) included a control group, which makes it the most comparable study to the current one. However, notable methodological differences between our two studies hinder direct comparison of the results. First, the participants in the Lowe et al. (2016) study were adults, whereas the participants in this study were adolescents. We should not assume that adults and adolescents would demonstrate similar attentional patterns to social–emotional stimuli. Second, the task structure of the Lowe et al. (2016) study was a traditional dot-probe task without anchor probes, whereas this study modified the task to include anchor probes. Including anchor probes allowed us to compare how quickly participants looked toward versus away from threatening faces, rather than calculating a blunt attentional bias index, thus granting a more nuanced examination of underlying attentional processes that would not have been feasible with a traditional dot-probe task. Another important difference in task structure is that Lowe et al. (2016) included household objects as the referent images in each trial, whereas the current study included neutral facial expressions as the referent images. Including two competing images that were both socially relevant granted a more pointed investigation of attentional allocation in the social context—which is critical in the study of stuttering because stuttering takes on meaning in social interactions. All told, these methodological adjustments to the traditional dot-probe task could have yielded the novel finding that adolescents who stutter demonstrated an attentional bias *regardless* of their social anxiety status.

Social anxiety severity likely did not impact attentional allocation because the two groups, on average, reported comparable levels of social anxiety. This extends the limited evidence base on rates of social anxiety among adolescents who do and do not stutter. While Mulcahy et al. (2008) reported significantly higher levels of social anxiety among 19 adolescents who stutter when compared to 18 controls, several other research groups have reported social anxiety among teens who stutter that is within normal limits (Blood et al., 2007; Gunn et al., 2014; Iverach, Lowe, et al.,

2017). Although there were no group differences in the current sample, both groups reported social anxiety levels that were, on average, significantly higher than the normative sample; in fact, they were so high that they approached the suggested clinical cutoff of 50 for this measure (La Greca & Lopez, 1998). This indicates that either this sample included a group of adolescents who were abnormally high in their feelings of social anxiety compared to the general population or that adolescents are generally more anxious nowadays than they were at the time the normative data were collected, perhaps suggesting that the normative data are outdated. Either way, the fact that the two groups in the current study reported similarly high levels of social anxiety allowed us to investigate the unique contribution of stuttering, above and beyond that of social anxiety, to how adolescents process social information.

Our results revealed that adolescents who stutter quickly engaged with threatening faces and also quickly disengaged from those threatening faces. The threatening faces included expressions of anger and fear. Although the adolescents who stutter only showed a statistically significant engagement effect for the fearful faces, the mean RT for attentional engagement with the angry faces was numerically closer to, in the same direction as, and had overlapping standard error estimates with the fearful faces. As such, we suspect that the "null" effect for engaging with angry faces among the stuttering group was a matter of chance or lower power. Regardless, the overall pattern of rapid attentional engagement and rapid attentional disengagement reflects a VA effect (Mogg & Bradley, 1998)—a pattern of attentional allocation that is typically associated with social anxiety. This is what makes the present findings interesting and challenges previously consistent reports in the social anxiety literature that VA is unique to social anxiety; if that were the case, then social anxiety would have been a meaningful predictor of attentional engagement and disengagement in this study. Subsumed under the VA hypothesis, socially anxious individuals scan their environment and efficiently identify potential sources of social-evaluative threat (vigilance). However, once a threatening cue is found, they divert their attention away from that cue in an attempt to minimize their discomfort (avoidance). This pattern of selective attention to emotional stimuli is consistent with the predictions put forth by attentional control theory (Eysenck et al., 2007). Attentional control theory posits that anxiety weakens the efficiency of top-down, goal-driven attentional processes, thus increasing the extent to which processing is influenced by the bottom-up, stimulus-driven attentional system. Thus, while anxiety dampens attentional control, it increases attention to threat-relevant cues.

Although the VA effect typically reflects attentional allocation patterns of anxious individuals, our results suggest that this behavioral pattern is associated with the experience of stuttering beyond the confines of social anxiety (given that there were no significant group differences in social anxiety and that social anxiety did not moderate group differences). Perhaps the adolescents who stutter evaluated threatening social cues differently than the controls. For instance, they may have a lower threshold for identifying threatening cues, they may be more sensitive to distinguishing between threatening and neutral cues, or there may exist a combination of the two processes (Weierich & Treat, 2014). Research on nonanxious individuals indicates that adaptive attention systems tend to demonstrate vigilance toward cues that are evaluated as highly threatening, while avoiding cues that are evaluated as mildly threatening (see review in Yiend, 2010). This differential processing promotes adaptive behavior that meets the demands of the situation. However, if a mildly threatening cue is evaluated as being highly threatening, the attentional system could be recruited to prioritize processing of that cue. Thus, it is possible that the adolescents who stutter evaluated the angry and fearful expressions in this task as more threatening than the controls did, and that is what quickly captured their attention. In addition, this pattern of behavior does not appear to be linked to higher levels of social anxiety, but rather a reflection of some other process related to the experience of stuttering. Whether this pattern of behavior reflects a real-world phenomenon in which adolescents who stutter are vigilant–avoidant of threatening social cues in real social interactions, such as adverse listener reactions, is an area for future investigation.

The VA effect among the adolescents who stutter in this study complements the fact that behavioral coping responses to stuttering are commonly placed along an approach–avoidance continuum. Approach behaviors, such as being open about stuttering and seeking support, are associated with better psychosocial adjustment. On the contrary, avoidance behaviors, such as refraining from speaking in stressful situations, are related to negative personal impact (Plexico et al., 2009b). On a more fundamental level, attentional avoidance is regarded as a defensive coping response that results from top-down redirection of attention away from threatening information (Barry et al., 2015). By avoiding social cues that are perceived to be threatening, individuals limit their opportunities to process cues that could disconfirm or reappraise their negative beliefs (Bögels & Mansell, 2004)—and may also drive avoidant behavioral coping responses. As such, many cognitive-behavioral approaches to stuttering therapy including stuttering modification therapy (Van Riper, 1973), Acceptance and Commitment Therapy (Beilby et al., 2012a), and Avoidance Reduction Therapy for Stuttering (Sisskin, 2018) strive to help clients increase their approach behaviors, such as entering feared speaking situations and saying words that they anticipate stuttering on, to name a few. It is of long-term interest to examine whether increasing attentional allocation toward benign stimuli, over threatening stimuli, can have cascading positive effects on communicative and psychological outcomes for people who stutter (McAllister et al., 2017).

Limitations and Future Directions

There are several meaningful avenues for follow-up on this study that could deepen and broaden our understanding of the psychosocial attentional processes associated

with stuttering, such as issues related to the cross-sectional design, sample population, methodology, and intervention efforts. Overall, the present findings suggest that the relationship between stuttering and attentional bias may very well bypass social anxiety, which has important implications for a psychosocial model of stuttering that does not include social anxiety as a factor. However, due to the cross-sectional nature of this study, these results do not allow us to make firm conclusions about the directionality of the relationship between stuttering and attentional bias. On the one hand, it is reasonable to speculate that, because people who stutter frequently encounter negative listener reactions to their stuttering, they develop an attentional attunement to those cues and eventually come to anticipate them. From this perspective, experience with stuttering would precede the development of attentional bias toward threatening social cues. On the other hand, it is possible that adolescents who stutter are naturally more inclined to attend to threatening social stimuli, perhaps as a function of a behaviorally inhibited temperament (Choi et al., 2013), which impacts how their psychosocial orientation toward stuttering develops.

Regarding the sample population, the adolescents who stutter were recruited by referrals from speech-language pathologists. Thus, the majority of these participants were currently in speech therapy or had been in therapy in the recent past. This introduced some sampling bias, and thus, generalizing these results to the broader population of adolescents who stutter should be made with caution. Furthermore, collecting more holistic psychological profiles on participants would be crucial for comprehensively examining individual differences, such as more diverse mental health outcomes (e.g., depression, trait anxiety), temperament, and quality of life indicators.

Methodologically, although the 500-ms stimulus presentation time in this study is standard protocol for a dot-probe task, it is not without shortcomings. Specifically, it somewhat obscures our ability to disentangle overt versus covert attentional processes. If a participant's attention plainly stayed on the cued stimulus for the entire 500-ms duration until the target probe appeared in that location, then RT to the target probe would be very quick because the participant was already looking there. However, from a vision science perspective, 500 ms is enough time for attention to overtly, and certainly covertly, shift to another stimulus and back again within that time frame (Weierich et al., 2008). Therefore, it is difficult to draw firm conclusions about the underlying attentional processes (i.e., overt vs. covert attention) taking place during a 500-ms stimulus duration and is thus an important limitation to consider. Follow-up studies may present stimuli for 100–250 ms to assess more covert attentional processes. Furthermore, omitting data from 16 of the participants due to low accuracy (< 85%), who as a group were younger than the participants who reached the accuracy criterion, could speak to the potential difficulty of this task for younger adolescents. Future experimental studies that assess attention with children and young adolescents should consider methodological parameters for maximizing motivation and performance. There are also alternative tasks and methodologies that could be employed, such as a visual search paradigm or utilizing eyetracking and neurophysiological methodologies, that could further clarify the specific attentional mechanisms underlying attentional bias among adolescents who stutter to inform theoretical and practical applications.

Conclusions

This study examined attentional allocation to socially threatening facial stimuli among adolescents who stutter and typically fluent controls, as well as the influence of individual differences in social anxiety and stuttering severity on performance. Utilizing a modified dot-probe paradigm, the results indicated that the adolescents who stutter were relatively faster to engage with threatening faces than to maintain attention on neutral faces and also relatively faster to disengage from threatening faces than to maintain attention on those faces. The controls did not show any attentional preference for the threatening faces over the neutral faces in either the engagement or disengagement conditions. Interestingly, the two groups demonstrated equivalent levels of social anxiety that were both, on average, very close to the clinical cutoff score for high social anxiety, although degree of social anxiety did not influence RT in either condition. Taken together, this study provides preliminary support for a VA pattern of attentional allocation to threatening stimuli among adolescents who stutter.

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