**Examining the Effects of Stuttering and Social Anxiety on Interpretations of
Ambiguous Social Scenarios Among Adolescents**

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Abstract

Purpose: The proclivity to construe ambiguous information in a negative way is known as interpretation bias, which has been implicated in the onset and/or maintenance of social anxiety. The purpose of this study was to examine group and individual differences in interpretation bias among young people who stutter and their typically fluent peers during the adolescent years when social fears and worries tend to escalate.

Methods: A total of 99 adolescents (13 to 19 years old) participated, including 48 adolescents who stutter (67% male) and 51 typically fluent controls (68% male). They completed a computerized vignette-based interpretation bias task in which they first read 14 short ambiguous social scenarios (half including a verbal interaction, half including a non-verbal interaction). They were then presented with four possible interpretations of each scenario including two negative interpretations (one target, one foil) and two positive interpretations (one target, one foil). Participants used a 4-point Likert scale to rate how similar in meaning each interpretation was to the original scenario. Participants also completed self-report measures of social and general anxiety, and provided a speech sample for stuttering analysis.

Results: There was no effect of stuttering on interpretations; the adolescents who stutter rated interpretations across both verbal and non-verbal scenarios comparably to the controls, and stuttering severity did not affect interpretation ratings. However, across groups, there was a significant effect of social anxiety such that higher social anxiety was associated with more negative interpretations, and lower social anxiety was associated with more positive interpretations.

INTERPRETATION BIAS AND STUTTERING

55 **Discussion:** This study provides preliminary evidence that social anxiety may affect
56 how adolescents interpret ambiguous social cues in verbal and non-verbal scenarios
57 more than stuttering, although more research into how people who stutter process
58 social information is warranted.

59 *Keywords:* interpretation bias, social anxiety, stuttering, adolescence,
60 psychosocial

Examining the Effects of Stuttering and Social Anxiety on Interpretations of Ambiguous Social Scenarios Among Adolescents

Many social situations that we encounter in our daily lives are ambiguous—a colleague not responding to our email, a stranger watching us as we walk past, a friend yawning while we tell a story. Our unique reasoning patterns influence how we perceive and interpret such ambiguous cues and ultimately how we respond to them (Muris, 2010). For individuals with social anxiety, these interpretations tend to be negative: your colleague is upset with you, the stranger does not like your outfit, your friend finds your story boring. The proclivity to construe ambiguous information in a negative way is a cognitive process known as *interpretation bias*, which has been implicated as one of the factors involved in the onset and maintenance of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997). A population that is at unique risk for developing social anxiety is individuals who stutter (see review by Craig & Tran, 2014). Their history of communication challenges and adverse listener reactions in those moments can perpetuate fear of stuttering and ensuing negative listener evaluation in future interactions. Both listener reactions and their meaning are subjective and contingent upon one's own unique interpretation and experience (Mancinelli, 2018). Do people who stutter tend to draw negative conclusions about social cues from their conversational partners, possibly due to repeated exposure to challenging interactions where they feel negatively evaluated by their listeners? This is an empirical question in need of examination. In the present study, we investigated group and individual differences in interpretation bias among young people who stutter and their typically fluent peers

during the period of development when they are highly sensitive to their social environment: adolescence (Guyer et al., 2016; Kilford et al., 2016; Steinberg, 2005)

1.1 Social Anxiety Characteristics

Social anxiety is characterized by exceedingly high levels of fear or anxiety about social situations in which the person is exposed to possible scrutiny by others, such as during social interactions, being observed, or performing in front of others (American Psychiatric Association, 2013). Young people who experience social anxiety commonly fear speaking in front of a class, performing in front of others, asking a teacher a question, meeting new people, joining in conversations, asking for help in shops or at school, and going to social events where peers are present (Beidel & Turner, 2007; Rao et al., 2007). Critically, these are also situations that adolescents who stutter have endorsed as being difficult when attempting to manage their stuttering (Hertsberg et al., 2016)

Social anxiety affects an estimated 12.1% of the population, and tends to emerge around 13 years of age (Kessler et al., 2005). Although younger children can experience high levels of social anxiety too, the psychophysiological changes that accompany the onset of puberty make adolescents particularly primed for the emergence of social anxiety (Haller et al., 2015; Miers et al., 2013). In particular, vast structural and functional neurodevelopment in social-affective networks in the brain renders adolescents highly sensitive to their social world and vulnerable to environmental stress (Steinberg, 2005; Sturman & Moghaddam, 2011; Tottenham & Galván, 2016).

Social anxiety is experienced along a continuum of intensity and severity (Spence & Rapee, 2016). While clinical cut-offs for diagnosing social anxiety disorder exist, many young people report a high degree of social anxiety symptoms without necessarily meeting the requirements for a clinical diagnosis of social anxiety disorder (Knappe et al., 2015). Subclinical levels of social anxiety can be just as troublesome as clinically diagnosed social anxiety disorder with regard to associated impairment, handicap in various domains of daily life, and development of concomitant mental health problems (Knappe et al., 2009; Tillfors & Van Zalk, 2015). Adolescent social anxiety is associated with lower peer acceptance, increased peer victimization, impaired romantic relationships, high levels of loneliness, and poor relationships with parents. Affected youth are also at increased risk for experiencing other psychological problems such as generalized anxiety, depression, and substance abuse (Knappe et al., 2015; Tillfors & Van Zalk, 2015). Once they enter the workforce, individuals with both subclinical and clinical levels of social anxiety disorder experience greater economic burden than individuals who do not experience social anxiety symptoms (Acarturk et al., 2009), a pattern that reflects the disadvantages that people who stutter commonly experience in the United States labor market (Gerlach et al., 2018).

1.2 Social Anxiety and Stuttering

The act of stuttering is often associated with an emotional response (Craig, 2014), which has promoted a long held interest in linking stuttering and anxiety. While various forms of anxiety have been studied among people who stutter (specifically trait, state, and social), examining social anxiety rather than other forms of anxiety in this population is of particular importance because stuttering is bound to social or

performance-based situations and only perceived in the presence of others (Menzies et al., 1999).

Negative social consequences of stuttering can begin as early as the preschool years (Ezrati-Vinacour et al., 2001; Langevin et al., 2010). Preschoolers and kindergarteners who stutter, as a group, demonstrate more negative attitudes toward communication than their typically fluent peers, and this trend continues into the school-age years (Vanryckeghem et al., 2005). Many school-age children who stutter experience teasing and bullying (Davis et al., 2002; De Nil & Brutton, 1991; Langevin et al., 1998), both of which have been linked to heightened risk for social anxiety (Bouman et al., 2012; Ranta et al., 2013). Studies of anxiety prevalence among school-age children who stutter are very limited and the findings have been equivocal. A recent study by Iverach and colleagues (2016) reported that school-age children who stutter have a six-fold increased odds for social anxiety disorder and seven-fold increased odds for generalized anxiety. Results from one investigation showed higher rates of generalized anxiety among school-age boys who stutter when compared to typically fluent controls (Blood & Blood, 2007), while most other studies of childhood anxiety in the stuttering population have found no such group differences (Craig & Hancock, 1996; Ortega & Ambrose, 2011; Smith et al., 2017). These inconsistent findings impede our ability to draw firm conclusions about the relationship between social anxiety and stuttering in the school-age years.

During adolescence, the influence of negative environmental and cognitive factors related to stuttering continues. In addition to experiencing negative listener reactions, stuttering during the adolescent years can also elicit other social penalties

such as teasing and bullying (Blood et al., 2007, 2011; Blood & Blood, 2016), peer rejection (Adriaenssens et al., 2017), and romantic rejection (Van Borsel et al., 2011). The high social cost of stuttering in adolescence is associated with more negative attitudes towards communication among young people who stutter, while typically fluent adolescents tend to develop more positive attitudes towards communication with age (Guttormsen et al., 2015). Negative communication attitudes are important to consider among adolescents because they have been linked to increased state and trait anxiety (Mulcahy et al., 2008). The published prevalence rates of anxiety among adolescents who stutter are more consistent than among younger children, although the evidence is limited. Gunn and colleagues (2014) reported that 38% of treatment-seeking adolescents who stutter in their sample attained at least one diagnosis of an Axis I mental health disorder, with 71% of these classified as anxiety disorders; this is nearly double the current estimates for adolescents in the general population. Further, compared to typically fluent controls, adolescents who stutter have been shown to exhibit higher levels of social anxiety (Blood et al., 2001; Erickson & Block, 2013; Hollister, 2015; Mulcahy et al., 2008), trait anxiety (Blood et al., 2007; Davis et al., 2007; Mulcahy et al., 2008), and state anxiety (Mulcahy et al., 2008), although severity of anxiety tended to be within the normal range across these studies.

The higher incidence of social anxiety among adolescents who stutter when compared to their typically fluent peers is likely related to the atypical social stressors they experience due to stuttering including, but not limited to, adverse listener reactions, negative attitudes about communication, teasing, and bullying. These interpersonal obstacles are likely exacerbated by the unique neurocognitive changes that occur

during the teenage years. Since social anxiety typically emerges in early adolescence (Kessler et al., 2005), it is of present interest to study the nature of social anxiety among people who stutter near its expected age of onset. Not only would this illuminate the individual differences that drive development of social anxiety for those who stutter, it also has important implications for therapy. For instance, individuals who stutter with concomitant mental health issues tend to have more difficulty maintaining speech-related changes following therapy (Iverach et al., 2009). This suggests that addressing anxiety-related concerns could maximize treatment efficacy and outcomes for young people who stutter. As such, it is of critical importance to understand the cognitive processes that influence the emergence and development of these anxiety-related concerns. In the general population, a cognitive process known as *interpretation bias* has been implicated as one such factor, although it has yet to be investigated among the stuttering population.

1.3 Interpretation Bias: A Cognitive Process Linked to Social Anxiety

The onset of social anxiety is thought to be predicated on a variety of biological and environmental factors that interact throughout early and middle childhood (Spence & Rapee, 2016). The convergence of a number of distal and proximal risk factors promote the manifestation of anxiety (Lau & Waters, 2017). Distal risk factors are characteristics such as genetics, environmental experiences, temperament, and neurobiology that put an individual at risk for later anxiety. We propose that stuttering can be conceptualized as one such distal risk factor. Proximal risk factors promote immediate vulnerability to anxiety. In particular, Lau and Waters (2017) theorized that certain ways of processing affective stimuli, such as the tendency to process social

information in negative ways, may be one such proximal risk factor that mediates the contribution of distal risk factors to anxiety symptoms. Although most of the research on information-processing bias and social anxiety has focused on adults, there are both theoretical and practical reasons to investigate the development of threat-related biases in anxious youth—primarily, that social anxiety typically emerges in early adolescence and continues to develop across time (Bar-Haim et al., 2007).

One form of information-processing bias that has been implicated in the maintenance of social anxiety is interpretation bias, which is the tendency to construe negative or threatening meaning from ambiguous social cues (Clark & Wells, 1995; Rapee & Heimberg, 1997). This type of maladaptive processing of social information can occur before an event takes place (e.g., expecting to perform in an embarrassing way and that others will judge one's performance negatively), during an event (e.g., misinterpreting ambiguous social cues as negative), and/or after the event is over (e.g., appraising one's own performance and others' reactions as being worse than they actually were) (Spence & Rapee, 2016). Thus, one's default tendency to explain the causes and outcomes of ambiguous information in a negative manner can perpetuate feelings of social anxiety.

Biased interpretations have been found to characterize socially anxious adolescents (e.g., Giannini & Loscalzo, 2016; Gonzalez et al., 2017; Haller et al., 2016; Miers et al., 2008) and adults (e.g., Amir et al., 2005, 2012; Badra et al., 2016; Chen et al., 2018; Huppert et al., 2003). Methods of measuring interpretations vary, but in general, participants are presented with ambiguous scenarios, words, or pictures and then asked to interpret the meaning of those stimuli. One of the most common

approaches utilizes an ambiguous vignette paradigm, which is based off the seminal work of Eysenck and colleagues (1991). In this type of task, participants read short scenarios that can be construed in a negative or benign way (e.g., Barrett, Rapee, Dadds, & Ryan, 1996; Eysenck et al., 1991; Gonzalez et al., 2017; Huppert et al., 2003; Kingsbury & Coplan, 2016; Lisk, Pile, Haller, Kumari, & Lau, 2018; Lothmann, Holmes, Chan, & Lau, 2011; Mathews & Mackintosh, 2000; Miers et al., 2008). Participants are then presented with possible negative or benign interpretations and are prompted to endorse the statement(s) that aligns with their own understanding of the scenario. The advantage of this approach is high face validity in that the scenarios depict realistic social interactions that youth may actually encounter in their lives. An important aspect of Eysenck et al.'s (1991) original task was the inclusion of scenarios that reflected physical and social events to assess the context specificity of interpretation bias among individuals whose anxiety was primarily related to physical or social threat. In the present study, we modified this parameter specifically to include interpretations of verbal and non-verbal scenarios as it was hypothesized that verbal events would be particularly relevant to the emotional concerns of adolescents who stutter as they might anticipate stuttering in those situations.

1.4 Purpose of the Present Study

The purpose of this study was to investigate group and individual differences in how adolescents who stutter and typically fluent controls interpret ambiguous social scenarios. To address this purpose, we posed three research questions:

- 1) How do adolescents who stutter and typically fluent controls compare in their interpretations of ambiguous social cues in verbal and non-verbal scenarios? We

predicted that adolescents who stutter would endorse negative interpretations of ambiguous *verbal* scenarios to a greater degree than their typically fluent peers, but that the two groups would endorse negative interpretations of ambiguous *non-verbal* scenarios similarly.

2) Among adolescents who stutter and typically fluent controls, how does social anxiety affect interpretations of ambiguous social cues in verbal and non-verbal scenarios? We predicted that high social anxiety would be associated with greater endorsement of negative interpretations across both types of scenarios, and low social anxiety would be associated with greater endorsement of positive interpretations across both types of scenarios.

3) Among adolescents who stutter, how does stuttering severity affect interpretations of ambiguous social cues in verbal and non-verbal scenarios? We predicted that there would be no meaningful effect of stuttering severity on interpretations across scenarios.

2. Methods

2.1 Participants

The participants included in this study were recruited as part of a larger study of cognitive bias and stuttering in adolescence (Rodgers, 2019). A total of 102 participants were recruited for the overall study (69 males, 33 females) ranging in age from 13.08 to 19.92 years ($M = 15.65$, $SD = 1.78$). There were 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). For the current dataset, three participants were excluded from the analysis (2.9% of the

sample), including two control participants who did not meet the 10/14 accuracy criteria on the interpretation bias task, and one stuttering participant who demonstrated response times of less than 200ms during the task which was insufficient time needed to read each of the statements. Hence, all forthcoming data are from the 48 adolescents who stutter (32 males, 16 females) and 51 controls (34 males, 17 females) who were included in the analyses. These adolescents who stutter ranged in age from 13.08 to 19.92 ($M = 15.56$, $Mdn = 15.63$, $SD = 1.82$). The typically fluent controls ranged in age from 13.17 to 19.33 ($M = 15.67$, $Mdn = 15.33$, $SD = 1.66$). Age did not differ significantly between the two groups, $t(97) = .30$, $p = .76$. 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). All adolescents who stutter had history of stuttering therapy, and 27 (56.25%) were currently in therapy at the time of data collection. As a group, the cumulative duration of stuttering therapy ranged from 1 month to 14.5 years ($M = 6.62$, $SD = 3.85$). 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 traditional criterion of at least 3% stuttered syllables 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 conceal stuttering and thus their < 3% frequency 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 occupation and education were used to calculate a weighted SES score ranging from 8 to 66, which did not differ between the stuttering group ($M = 53.35$, $SD = 9.68$) and control group ($M = 54.30$, $SD = 9.09$), $t(97) = .50$, $p = .62$.

Participants represented a variety of geographic locations in the United States including the Midwest ($n = 60$), East Coast ($n = 19$), South ($n = 14$), and Rocky Mountain ($n = 6$) regions. 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 emails distributed locally.

2.2 Procedures

The study protocol was approved by the Institutional Review Board at the University of Iowa. Data collection occurred during one in-person visit with the participant at a private location at the research lab or the participant's home. After obtaining consent from the participant and their parent, the participant and the first author worked one-on-one for the remainder of the session. The participant first completed an attentional bias task (previously reported in Rodgers et al., 2020) followed by the computerized interpretation bias task and several paper-pencil self-report questionnaires. The results from the interpretation bias task and self-report anxiety questionnaires are described in this paper. 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.

2.3 Interpretation Bias Task

2.3.1 Task Structure

The interpretation bias task was programmed and administered on a Dell Latitude E6420 laptop 14-inch color screen using *Paradigm Stimulus Presentation* software (Perception Research Systems, 2007). Participants were seated approximately 60 cm from the computer screen, and they provided their responses on the laptop keyboard. The task was self-paced and took approximately 10 minutes to complete.

The structure and flow of the task was adapted from the work of Eysenck, Mogg, May, Richards, and Mathews (1991) and Mathews and Mackintosh (2000). Participants silently read the task instructions on the computer screen which prompted them to pay attention to the title of each vignette and to imagine as if the scenario was truly happening to them. They completed one training trial with a non-social scenario to become familiarized with the task before beginning. Participants then read 14 vignettes which were presented one-by-one in randomized order (details of the scenarios are offered in the following section, 2.3.2). Each screen displayed a brief title at the top of the screen (bolded, center-aligned), followed by a two-sentence vignette (unbolded, left-aligned). For example:

Class Presentation

You are standing at the front of the class giving a presentation. At the end of the presentation, you ask if anyone has any questions, and no one raises their hand.

Participants were instructed to pay particular attention to the title of the scenario as remembering the title would help them at the end of the activity. After reading each vignette, participants pressed the spacebar to continue to the next screen which presented a yes/no comprehension question to confirm they were attending to details of the preceding vignette. For example, "After your presentation, did you ask if anyone had any questions?" The comprehension question did not require participants to make an emotional interpretation of the story; its purpose was simply to ensure they were paying attention to and comprehended the vignette. Once they responded to the comprehension question by pressing the "y" key for yes or "n" key for no, there was a 1000ms inter-trial interval followed by presentation of the next title and vignette.

After participants finished reading the 14 vignettes and answering the respective comprehension questions, they began the recognition portion of the task where they were prompted to recall each of the scenarios and rate four possible interpretations of the ambiguous cue embedded in those scenarios. To do so, one of the 14 titles appeared at the top of the screen along with one of four interpretive statements that disambiguated the respective scenario in a negative or positive manner. Participants were asked to rate each statement by how similar its meaning was to the corresponding scenario on a four-point Likert scale (1 = very different, 2 = a little different, 3 = a little similar, 4 = very similar) by pressing the associated number key on the keyboard. Once the participant indicated their response, that statement offset, and the next statement immediately appeared. The four statements were presented one-by-one in random order so participants would not be tempted to rate the interpretations in comparison to the others. The four statements included two targets (negative, positive) and two foils

(negative, positive), each one sentence in length. For example, in relation to the “Class Presentation” vignette provided above, the four statements included:

Negative target: “No one raises their hand because your presentation was boring.”

Positive target: “No one raises their hand because your presentation was clear.”

Negative foil: “You got a bad grade for your presentation.”

Positive foil: “You got a good grade for your presentation.”

The targets were directly related to the specific ambiguous cue that participants were resolving in either a negative or positive manner, while the foils were an overall negative or positive impression of the broader situation described in the scenario. Foils were included to assess participants’ response sensitivity as they allow for examination of general response biases toward a particular emotional valence (i.e., negative, positive), not specifically explanations of the causes or outcomes of the scenario (Eysenck et al., 1991). Further, response biases may reflect variations in how the original ambiguity was encoded in memory (Mathews & Mackintosh, 2000).

Once the participant provided a rating for each of the four statements for a given scenario, the screen cleared and a different title was randomly presented along with the four interpretive statements for that scenario, and so forth.

To encourage the participants to truly imagine themselves in the scenarios, the researcher guided each participant through a brief imagery exercise prior to the start of the task (Holmes et al., 2006; Holmes & Mathews, 2005). In this exercise, participants were asked to close their eyes and imagine they were biting into a lemon (Lothmann et al., 2011). They were prompted to describe what they see, hear, smell, taste, and feel

with scaffolding as needed. Once their ability to describe their imagined experience was confirmed by the researcher, the participant was asked to apply these imagery principles to the upcoming task.

2.3.2 Vignettes

A total of 14 vignettes were created for this study, including seven verbal and seven non-verbal social scenarios.¹ Each vignette contained two sentences that were displayed as three lines of text on the screen, with the end of the vignette alluding to an ambiguous social cue. Of note, each ambiguous cue was related to an unclear external cue about others' behavior (e.g., why someone was looking at you) rather than uncertainty about one's own behavior (e.g., why you hesitated when answering a question). The second person singular pronoun "you" was utilized in the vignettes and interpretive statements to promote self-reference (Eysenck et al., 1991).

The vignettes represented hypothetical social scenarios that are common to adolescent social and academic environments. The seven verbal scenarios reflected speaking situations that adolescents who stutter have endorsed as being difficult situations in which to manage their stuttering, such as giving a class presentation, talking to a teacher, and ordering at a restaurant (Hertsberg et al., 2016). The seven non-verbal social scenarios reflected situations in which the adolescent was not speaking, such as standing on their own at a school dance, overhearing their friends talking about them, and texting with someone they are romantically interested in. One verbal scenario was adapted from the *Adolescent Interpretation Bias Questionnaire* (AIBQ; Miers et al., 2008) and five non-verbal scenarios were adapted from the AIBQ

¹ Scenarios can be provided by the first author upon request.

and previous studies by Lau and colleagues (Lau, Belli, & Chopra, 2012; Lothmann et al., 2011). These were modified to ensure relevance and grammatical appropriateness for Standard American English-speaking adolescents. The remaining vignettes were created by this research team for purposes of this study. The task was piloted with three adolescent participants who confirmed the relevance of the scenarios to their lives.

Including verbal and non-verbal social scenarios allowed for evaluation of the content specificity of adolescents' interpretation biases. Because the behavior of stuttering is bound to verbal situations and therefore more relevant to their emotional concerns (Mathews & Macleod, 2005), it was hypothesized that the adolescents who stutter would be more likely than the controls to negatively interpret verbal scenarios in which they would be talking and thus anticipating stuttering (Jackson et al., 2018). On the other hand, it was hypothesized that the adolescents who stutter and typically fluent controls would demonstrate comparable interpretations of non-verbal scenarios since the participants were not asked to envision themselves speaking in those scenarios. Therefore, assessing the content specificity of interpretations across the two groups allowed for a targeted understanding of the specific parameters under which negative social interpretations may arise for adolescents who stutter, and whether this distinguishes adolescents who stutter from their typically fluent peers.

2.3.3 Outcome Measure

During the recognition portion of the interpretation bias task, the ratings for each of the four interpretive statements were provided on the laptop keyboard by pressing 1, 2, 3, or 4 to coincide with the participant's rating. These ratings were the primary outcome measure. Response times to key press were also recorded by the

experimental software and used to check that the participant took ample time to read through all stimuli. Ratings for scenarios in which the comprehension question was answered incorrectly were excluded from the analysis, and participants who answered more than four comprehension questions incorrectly were omitted from the analysis.

2.4 Other Measures

2.4.1 Social Anxiety

The *Social Anxiety Scale for Adolescents* (SAS-A; La Greca & Lopez, 1998) was used to measure self-reported social anxiety. The SAS-A was normed on adolescents ranging from 13 to 18 years of age. It is comprised of three subscales: Fear of Negative Evaluation from Peers (eight items), Social Avoidance and Distress specific to new situations or unfamiliar peers (six items), and Generalized Social Avoidance and Distress (four items). Respondents rate how often they experience each statement on a five-point Likert scale, where 1= never and 5 = always. Relevant items are summed to obtain the three subscale scores, and all items are summed to obtain a total score which can range from 18 to 90, where higher scores reflect greater social anxiety vulnerability. Total SAS-A scores were inputted in the statistical models. Adequate internal consistency, test-retest reliability, and factorial invariance have been previously reported for the SAS-A (La Greca et al., 2015; La Greca & Harrison, 2005; Storch et al., 2004).

2.4.2 General Anxiety

The *Revised Children's Manifest Anxiety Scale – Second Edition* (RCMAS-2; Reynolds & Richmond, 2008) assesses general anxiety across three domains: Social Anxiety (12 items), Physiological Anxiety (12 items), and Worry (16 items). There are

also two validity subscales: Defensiveness (nine items) and Inconsistent Responding (scorer looks for incompatible responses across nine pairs of similar items). No participants in the current sample demonstrated six or more instances of inconsistent responding, which would preclude analysis of their responses per the RCMAS-2 scoring guidelines. Adequate internal consistency has been reported for all subscales (Reynolds & Richmond, 2008).

The RCMAS-2 was collected in the present study for two reasons. First, social anxiety commonly co-occurs with general anxiety, and thus the information is provided descriptively for a more holistic depiction of anxiety across the two groups. Table 2 provides correlations between the subscale scores of the SAS-A and RCMAS-2. Secondly, it includes a subscale of Defensiveness which assesses the degree to which the respondent provides socially desirable responses that present themselves in a positive light (e.g., "I like everyone I know," "I am always kind,"). High scores on the Defensiveness subscale are taken to indicate the respondent is not willing to admit to common imperfections as they have a high need for social acceptance. Previous studies have reported non-negligible rates of defensiveness among young people who stutter on the RCMAS and RCMAS-2 (Gunn et al., 2014; Iverach, Lowe, et al., 2017; Messenger et al., 2015). In the present sample, eight adolescents who stutter (16% of the stuttering group) and six typically fluent controls (11% of the control group) scored above the clinical cut-off (>60) for Defensiveness. As such, it was deemed relevant to the interpretation bias task in which participants could consciously manipulate their responses to portray themselves a certain way, and could thus be statistically controlled for.

2.4.3 Stuttering Severity

A 300-syllable conversational speech sample and 300-syllable oral reading sample were collected from each participant and later analyzed offline to assess stuttering severity via the *Stuttering Severity Instrument–Fourth Edition* protocol (SSI-4; G. Riley, 2009). The conversational topics included hobbies, school, favorite movies or books, or a recent vacation. The oral reading passage used was the first 300 syllables of the *Rainbow Passage* (Fairbanks, 1960), a standardized reading passage that surveys all English speech sounds. A Canon Vixia HF R800 HD Camcorder mounted on a tripod three feet from the speaker was used to audio/video record the speech samples, which were later analyzed by six trained research assistants that were blind to participants' group membership. The raters analyzed each speech sample for frequency of stuttering-like disfluencies (i.e., sound/syllable repetitions, audible and inaudible sound prolongations), 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 and oral reading samples 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 1. All speech samples were scored by two raters; interrater reliability was judged to be very good with a weighted kappa agreement of $w=.86$.

[INSERT FIGURE 1]

2.5 Data Analysis

To account for subject- and item-specific variability, linear mixed-effects models were fit to participants' ratings using the *lmer* function (Kuznetsova et al., 2017) in the

lme4 package (Bates et al., 2015) in R version 3.5.3 (R Core Team, 2019). To address the first research question of how adolescents who stutter and typically fluent controls compare in their interpretations of ambiguous scenarios, a full factorial combination of group (stuttering, control), valence (negative, positive), and target type (target, foil) was used to predict within-subject variation in ratings, which served as the dependent variable. As there were no meaningful reference groups among the levels of the predictors and to reduce collinearity among the main effects and interactions, the predictor variables were effect-coded (Group: control = 1, stuttering = -1; Valence: negative = -1, positive = 1; Target type: foil = -1, target = 1). To increase statistical power, ratings for the verbal and non-verbal scenarios were analyzed separately.

For the second research question exploring the effect of social anxiety on how adolescents interpreted ambiguous scenarios, total SAS-A scores were entered into the model as a four-way interaction with group x valence x target type x SAS-A. Again, separate models were run for the verbal and non-verbal scenarios.

For the third research question exploring the effect of stuttering severity on how adolescents who stutter interpreted ambiguous scenarios, a subgroup of adolescents who stutter was created, group and SAS-A scores were removed from the model, and SSI scores were entered as a three-way interaction with valence x target type x SSI.

3. Results

Before we answer the research questions by presenting results of the mixed-effects models, we first present group differences in the anxiety measures, and then offer descriptive statistics for the interpretation ratings.

3.1 Group Differences in Anxiety

3.1.1 Social Anxiety

Among the adolescents who stutter, total SAS-A scores averaged 49.88 (*range* = 19 – 87, *Mdn* = 49.5, *SD* = 16.49). Among the controls, total SAS-A scores averaged 48.55 (*range* = 26 – 76, *Mdn* = 47, *SD* = 13.00). These total means, as well as the subscale means, were not significantly different between groups (see Table 1). However, total SAS-A scores for both groups approached the suggested clinical cut-off score of >50 for high social anxiety (La Greca & Lopez, 1998) and were significantly higher than the normative sample ($t(297) = 5.44, p < .0001$ for the stuttering group; $t(301) = 5.37, p < .0001$ for the control group).

[INSERT TABLE 1]

Results also indicated a significant two-way interaction between group x sex on total SAS-A scores. Girls who stutter had higher total scores than boys who stutter ($t(46) = -3.44, p = .001$), as seen in Figure 2. There were no main or interacting effects of age or stuttering severity (for the stuttering group) on total SAS-A scores.

[INSERT FIGURE 2]

3.1.2 Generalized Anxiety

The RCMAS-2 is comprised of three subscales that can be summed to calculate a total score, along with two validity subscales to ensure accurate responding. Among the adolescents who stutter, total RCMAS-2 scores averaged 54.31 (*range* = 37 – 70, *Mdn* = 54, *SD* = 8.89). Among the controls, total RCMAS-2 scores averaged 51.43 (*range* = 37 – 80, *Mdn* = 49, *SD* = 9.45). These total scores did not significantly differ between groups. The only subscale that significantly differed between groups was

Defensiveness ($t(95) = -2.88, p = .005$), where the stuttering group averaged 52.94 ($range = 21 - 69, Mdn = 52, SD = 9.54$) and the control group averaged 47.06 ($range = 35 - 69, Mdn = 43, SD = 10.52$).

Correlations between the subscale and total scores for the SAS-A and RCMAS-2 are provided in Table 2.

[INSERT TABLE 2]

3.2 Interpretation Ratings

On the interpretation bias task, the overall accuracy of all participants averaged 93.22% ($SD = 6.95$), with the stuttering group averaging 92.71% accuracy ($SD = 6.67$) and the control group averaging 93.70% accuracy ($SD = 7.23$). As a result of incorrect responses to the comprehension questions following display of each vignette, 5.8% of ratings for the verbal scenarios and 7.5% of ratings for the non-verbal scenarios were excluded from the analyses.

Figure 3 displays the average ratings across both groups and all conditions (verbal and non-verbal scenarios, negative and positive valence, target and foil statements). Both groups rated the target interpretations higher than the foils. Positive targets and negative targets were rated similarly, but positive foils tended to be rated higher than negative foils. Although both groups generally rated the interpretations similarly for the verbal and non-verbal conditions, the controls tended to rate the interpretations negligibly higher than the adolescents who stutter. Figure 4 presents a subset of the data from Figure 3 to aid visual comparison of the stutterers' ratings between the verbal and non-verbal scenarios, since this distinction was of primary interest in the study. The adolescents who stutter rated the negative targets for the

verbal scenarios negligibly higher than those of the non-verbal scenarios, but rated the positive targets and foils for the verbal and non-verbal scenarios equivalently. They rated the negative foils of the non-verbal scenarios higher than the negative foils of the verbal scenarios.

[INSERT FIGURE 3]

[INSERT FIGURE 4]

3.2.1 Research Question 1: Group Differences on Interpretations

To address the first research question of how adolescents who stutter and typically fluent controls compare in their interpretations of ambiguous social cues in verbal and non-verbal scenarios, two separate models were run: one predicting ratings for the verbal scenarios, and another predicting ratings for the non-verbal scenarios.

3.2.1.1 Verbal Scenarios. A full factorial combination of group (stuttering, control), valence (negative, positive), and target type (target, foil) was used to predict within-subject variation in interpretation ratings of the *verbal* scenarios. The maximal random effects structure supported by the data for this model included random intercepts for subject and item, random subject slopes for valence and target type and their interaction, and a full factorial combination of random item slopes for group, valence, and target type. Only a significant main effect of target type emerged ($\beta = 0.39$, $t(7.11) = 5.65$, $p < .001$), such that target interpretations were rated on average 0.78 units higher than foils. There were no main or interacting effects of group or valence on ratings. That is, adolescents who stutter rated the interpretations for verbal scenarios similarly to the controls, and negative interpretations were rated similarly to positive interpretations for the verbal scenarios. As adolescents who stutter scored significantly

higher on the Defensiveness subscale of the RCMAS-2, and thus their tendency to respond in a socially desirable manner could have influenced the deliberate process of rating the interpretations, it was then added into the model as a covariate to control for its potential confounding effect. The results were unchanged.

3.2.1.2 Non-Verbal Scenarios. A full factorial combination of group (stuttering, control), valence (negative, positive), and target type (target, foil) was used to predict within-subject variation in interpretation ratings of the *non-verbal* scenarios. The maximal random effects structure supported by the data for this model included random intercepts for subject and item, random subject slopes for valence and target type, and random item slopes for group and valence. The results matched that of the verbal scenarios in that there was a significant main effect of target type; target interpretations were rated on average .60 units higher than foils ($\beta = 0.30$, $t(96.74) = 13.28$, $p < .001$), meaning targets were rated as more similar to the scenario than foils. There were no main or interacting effects of group or valence on ratings. Defensiveness was then added into the model as a covariate to control for any potential confounding effect, and the results were unchanged.

3.2.2 Research Question 2: Effect of Social Anxiety on Interpretations

To address the second research question of how social anxiety affected interpretation ratings in verbal and non-verbal scenarios, two separate models were run: one examining the effects of social anxiety on ratings for the verbal scenarios, and the other examining the effects of social anxiety on ratings for the non-verbal scenarios.

3.2.2.1 Verbal Scenarios. Social anxiety (centered) was entered into the model as a four-way interaction with group, valence, and target type to predict within-subject

variation in interpretation ratings of the *verbal* scenarios. The maximal random effects structure for this model included random intercepts for subject and item, random subject slopes for valence and target type and their interaction, and random item slopes for group and target type. Including social anxiety in this interaction revealed several significant effects that were not present in the first model reported in section 3.2.1.1. Significant main effects of valence ($\beta = 0.14$, $t(93.19) = 5.10$, $p < .001$) and target type ($\beta = 0.04$, $t(7.05) = 5.66$, $p < .001$) were identified such that positive interpretations were rated significantly higher than negative interpretations and targets were rated significantly higher than foils. These main effects were subsumed under significant two-way interactions between valence and target type ($\beta = -0.10$, $t(139.30) = -4.87$, $p < .001$) and valence and social anxiety ($\beta = -.007$, $t(93.96) = -3.92$, $p < .001$). This means that across all participants engaging with the verbal scenarios, negative foils were rated lower than positive foils, and adolescents with lower social anxiety had greater differences in their ratings of positive versus negative statements than those with higher social anxiety. Further, as seen in Figure 5, a significant three-way interaction between valence, target type, and social anxiety also emerged ($\beta = -.003$, $t(141.40) = -2.21$, $p = .03$) such that the interaction between valence and target type differed across levels of social anxiety. That is, as social anxiety increased, negative targets were rated higher and positive targets were rated lower.

[INSERT FIGURE 5]

3.2.2.2 Non-Verbal Scenarios. Social anxiety (centered) was entered into the model as a four-way interaction with group, valence, and target type to predict within-subject variation in interpretation ratings of the *non-verbal* scenarios. The maximal

random effects structure for this model included random intercepts for subject and item, random subject slopes for valence and target and their interaction, and a full factorial combination of group, valence, and target for random item slopes. In addition to the significant main effect of target type that was maintained from the model reported in section 3.2.1.2 ($\beta = .30$, $t(6.97) = 5.63$, $p < .001$), a significant two-way interaction between valence and social anxiety emerged ($\beta = -.01$, $t(93.43) = -4.48$, $p < .001$). As seen in Figure 6, this indicated that the effect of valence on ratings differed by degree of social anxiety, such that adolescents with lower social anxiety (1 SD below the mean) rated the positive interpretations higher than the negative interpretations.

[INSERT FIGURE 6]

3.2.3 Research Question 3: Effect of Stuttering Severity on Interpretations

To address the third research question of how stuttering severity affected stutterers' interpretation ratings in verbal and non-verbal scenarios, we first created a subset of data that only included the adolescents who stutter. We then ran two separate models: one examining the effects of stuttering severity on ratings for the verbal scenarios, and the other examining the effects of stuttering severity on ratings for the non-verbal scenarios.

3.2.3.1 Verbal Scenarios. A three-way full factorial combination of valence, target type, and stuttering severity was used to predict ratings for the *verbal* scenarios among the adolescents who stutter. The maximal random effects structure supported by the data for this model included random intercepts for subject and item, random subject slopes for valence and target type, and a random item slope for target type. A significant main effect of target type emerged ($\beta = 0.37$, $t(22.87) = 4.02$, $p < .001$), such that

targets were rated higher than foils which mirrored the result of the primary model analysis. There were no main or interacting effects of stuttering severity on ratings for the verbal scenarios.

3.2.3.2 Non-Verbal Scenarios. A three-way full factorial combination of valence, target type, and stuttering severity was used to predict ratings for the *non-verbal* scenarios among the adolescents who stutter. The maximal random effects structure supported by the data for this model included random intercepts for subject and item, random subject slopes for valence and target and their interaction, and random item slopes for valence and target and their interaction. A significant main effect of target type emerged, $\beta = .32$, $t(19.74) = 3.91$, $p < .001$, which mirrored the finding of the primary model documented in section 3.2.1.2. There were no main or interacting effects of stuttering severity on ratings for the non-verbal scenarios meaning that adolescents who stutter less severely endorsed interpretations similarly to those who stutter more severely.

4. Discussion

The purpose of this study was to investigate how adolescents who stutter and their typically fluent peers interpret ambiguous social cues in verbal and non-verbal scenarios. There were two main findings. First, there was no effect of stuttering on interpretation across verbal and non-verbal scenarios. This was apparent when looking at the effect of stuttering group membership on interpretations, which revealed no group differences in interpretations (did *not* support our first hypothesis), as well as the null effect of stuttering severity on interpretations (did support our third hypothesis). Second, regardless of group membership, adolescents with lower social anxiety demonstrated a

positive interpretation bias across verbal and non-verbal scenarios, while adolescents with higher social anxiety demonstrated a negative interpretation bias for the verbal scenarios only; this supported our second hypothesis.

4.1 Experience with Stuttering Did Not Influence Interpretations

In the present context, experience with stuttering was examined in two ways: diagnosis of stuttering and stuttering severity. Taken together, the findings suggest that neither having a diagnosis of stuttering nor the degree of stuttering severity (for stutterers only) influenced how adolescents interpreted ambiguous social scenarios. Several researchers have speculated that there is a link between stuttering and interpretation bias (Iverach, Rapee, et al., 2017; Mancinelli, 2018; McAllister et al., 2015; Smith et al., 2014), but the present findings did not support this hypothesis. Recall that we predicted that adolescents who stutter would endorse negative interpretations of ambiguous verbal scenarios to a greater degree than their typically fluent peers, but that the groups would not differ in their interpretations of ambiguous non-verbal scenarios. As participants were asked to try to fully immerse themselves in the scenarios and imagine that the situations were really happening to them, we hypothesized that adolescents who stutter were likely to envision themselves stuttering in the verbal scenarios. As such, they would imagine themselves to be receiving negative listener judgments and reactions, subsequently contributing to negative interpretations of those verbal scenarios as a result. In this way, we expected the verbal scenarios to be more relevant to the emotional concerns of the stutterers than to the controls (Mathews & Mackintosh, 2000). However, this hypothesis was not supported as there were no significant group differences in verbal or non-verbal scenario ratings.

The lack of context specificity of interpretation bias across groups in the present study (i.e., the fact that both groups rated interpretations of verbal and non-verbal scenarios comparably) mirrors one of the main findings of Eysenck et al. (1991), whose paper inspired the present study. In their sample of anxious adults, there was also no evidence of context specific interpretation bias. They reported that anxious adults with *social* concerns and those with *physical* concerns interpreted ambiguous scenarios regarding social and physical threats comparably, thus leading them to speculate that the interpretation bias of anxious individuals is general rather than specific. The results of the present study extend this conclusion to adolescents and further support the argument that there may be other domains of concern that should be examined. For example, the verbal and non-verbal scenarios in this study both reflected social situations, and thus it is unclear how the groups would have differed in their interpretations of non-social situations. Future work in this area should consider including non-social scenarios in addition to social scenarios to further elucidate the conditions under which interpretations of a certain valence arise for adolescents who stutter.

Of note is that the null influence of group was maintained even when the models controlled for defensiveness (measured via a subscale of the RCMAS-2). This was true despite the fact that the stuttering group demonstrated significantly higher scores for defensiveness than the controls, suggesting that they had a greater tendency to provide socially desirable responses (Van De Mortel & Van De Mortel Rn, 2008). Research has shown that a defensive coping style can be triggered by high rejection sensitivity, which is the tendency to anxiously expect, easily perceive, and strongly react to rejection

(Downey et al., 2004). The ambiguous social cues in the present stimuli could have been construed in a negative way that implicated social rejection (e.g., your crush has not replied to your last text, your teacher sighs when you ask for help). Young people who stutter have been shown to be significantly more rejected than their peers during the school-age years (Davis et al., 2002) and adolescence (Blood et al., 2011; Blood & Blood, 2004; Erickson & Block, 2013). However, with only 14 of the 99 participants demonstrating clinical levels of defensiveness (eight stuttering, six controls) it is possible that there were not enough participants with high levels of defensiveness to meaningfully account for variation in this construct.

When exploring the influence of stuttering severity on interpretation ratings for the stuttering group only, stuttering severity did not moderate the effect of valence and target on ratings. This indicates that adolescents who stutter more severely were not more likely to endorse negative interpretations than adolescents who stutter less severely. This finding contributes to the existing literature indicating that the degree of psychosocial impact of stuttering on individuals who stutter is not necessarily contingent upon the severity of their overt stuttering behaviors. For instance, research has shown that anxiety and communication attitudes are not associated with the frequency or severity of the surface level features of stuttering (Blood et al., 2007; Blumgart et al., 2010; Mulcahy et al., 2008), but it is associated with the degree of impact of stuttering on one's quality of life (Manning & Gayle Beck, 2013). Further, stuttering severity has not been shown to relate to how much a speaker anticipates stuttering (Jackson et al., 2015) or their locus of control (De Nil & Kroll, 1995). While adolescents who exhibit mild stuttering behaviors may struggle to cope with stuttering

and social interactions as much or *more* than those who stutter more frequently (Beilby, 2014), our findings challenge the results of other studies that have reported that higher stuttering severity is associated with lower self-perceived communication competence (Blood et al., 2001), lower social acceptance (Adriaenssens et al., 2015), lower self-esteem (Adriaenssens et al., 2015), greater social anxiety (Ezrati-Vinacour & Levin, 2004; Hollister, 2015), and more negative communication attitudes (Guttormsen et al., 2015). While our preliminary findings suggest that experience with stuttering did not influence how adolescents interpreted ambiguous social scenarios, there are likely individual differences in other cognitive and emotional processes that modulate the impact of stuttering on interpretation bias, above and beyond a diagnosis of stuttering or stuttering severity. For example, Hollister (2015) reported that “hot” effortful control (i.e., emotion regulation abilities) moderated the effect of stuttering severity on adaptive coping. Future investigations should include such constructs as effortful control, self-focused attention, safety behaviors, and post-event processing which have been shown to play a role in maintaining social anxiety (review in Morrison & Heimberg, 2013).

4.2 Social Anxiety Influenced Interpretations for Both Groups

Another primary finding of this study was that social anxiety moderated the effect of valence on ratings for both verbal and non-verbal scenarios, regardless of participant group. For the verbal scenarios, adolescents with high social anxiety, regardless of group affiliation, endorsed negative *targets* to a greater degree than positive *targets*, while those with low social anxiety endorsed positive *targets* to a greater degree than negative *targets*. For the non-verbal scenarios, adolescents with low social anxiety endorsed positive interpretations to a greater degree than negative interpretations, with

no significant effect of target type (i.e., target versus foil statements). Further, adolescents with high social anxiety endorsed positive and negative interpretations similarly for the non-verbal scenarios. Since the targets received distinctly higher ratings than the foils for the verbal scenarios and *not* the non-verbal scenarios, this suggests that the target statements related to the verbal scenarios were more salient or relatable to the participants than those of the non-verbal scenarios. This could have resulted from the participants generally identifying more with the verbal scenarios than the non-verbal scenarios, perhaps due to enhanced susceptibility to social-evaluative threat associated with the act of speaking. It should be noted that across all analyses, target interpretations were rated higher than foils, indicating the participants across both groups did not demonstrate response biases. In other words, they processed the specific ambiguous cue that was embedded in the scenarios rather than preferentially processing general negative or positive emotionality in the vignettes.

Across both the verbal and non-verbal scenarios, participants with low social anxiety demonstrated a positive interpretation bias as they endorsed the positive interpretations to a significantly greater degree than those with high social anxiety. This tendency to favor positive interpretations is a typical pattern of non-anxious individuals (Tadic et al., 2015), and may reflect greater trait resilience (Kleim et al., 2014) or serve as a protective buffer against social anxiety. Either way, it likely has positive implications for future psychosocial well-being.

On the other hand, participants with high social anxiety showed a negative interpretation bias for the verbal scenarios only, with no bias for the non-verbal scenarios. This negative interpretation bias for verbal scenarios mirrors the findings of

negative interpretation bias in other studies of socially anxious youth (Haller et al., 2016; Miers et al., 2008; Orchard et al., 2017) and adults (Amir et al., 2005; Dryman & Heimberg, 2015; Giannini & Loscalzo, 2016; Huppert et al., 2003; Kanai et al., 2010), as well as other health issues in youth and adult populations such as depression (Eley et al., 2008; Holmes et al., 2009; Normansell & Wisco, 2017) and chronic pain (see review by Lau et al., 2018). Speaking is regarded as a performance-based situation whereby the manner and content of one's verbal delivery can be judged by listeners, whereas non-speaking social situations may not necessarily subsume such listener evaluation. Indeed, research has shown that highly socially anxious individuals fear situations that involve speaking more than situations that do not (Peyre et al., 2016). Thus, individuals who stutter who are highly socially anxious, such as the girls who stutter in this study, might be at particular risk for negative interpretation bias in verbal scenarios.

This study is the first empirical investigation of interpretation bias and stuttering. One related previous study investigated the relationship between fear of negative evaluation (a core component of social phobia) and judgment bias (another form of cognitive bias) among adults who do and do not stutter (Brundage et al., 2017). Although the adults who stutter in that study reported higher degrees of fear of negative evaluation than the non-stuttering adults, both groups perceived threat in ambiguous scenarios comparably. We can speculate that this null result reflects a similar pattern as found in the present study: that both groups interpreted ambiguous social scenarios comparably. However, judgment and interpretation biases reflect distinct cognitive processes, and thus this speculation is made with caution.

Notably, the adolescents who stutter and typically fluent controls in the present sample scored similarly on the self-report measure of social anxiety, although both groups demonstrated greater degrees of social anxiety than the normative sample (La Greca & Lopez, 1998). Although this was an unexpected finding (cf. Blood et al., 2001; Erickson & Block, 2013; Hollister, 2015; Mulcahy et al., 2008), it allowed us to examine any unique contribution of stuttering to interpretations above and beyond the influence of social anxiety which, as discussed in the previous section (4.1), there did not appear to be. An interesting finding related to social anxiety was the significant interacting effect of group and sex on social anxiety scores such that girls who stutter reported higher levels of social anxiety than boys who stutter. This is similar to findings from another study, which showed that girls who stutter reported lower levels of self-esteem and poorer communication attitudes than their male counterparts (Adriaenssens et al., 2015). One possibility is that the sex differences are not stuttering-specific but rather mirror those found in the general population (Ranta et al., 2007; Weinstock, 1999). Another explanation is that men and women experience stuttering differently, and the intersection of stuttering and gender makes women who stutter vulnerable to poorer psychological health outcomes (Nang et al., 2018). The literature on experiences and outcomes of females who stutter is limited. Because of the lower prevalence of stuttering among females than males (Yairi & Ambrose, 1999), girls who stutter are often underrepresented in stuttering research and sometimes excluded from studies altogether (Blood & Blood, 2007; Woods & Williams, 1971; Yairi & Williams, 1970). More research is needed to understand if the sex differences in psychological health

outcomes that exist between males and females who stutter are similar to or distinct from those observed in the general population.

4.3 Limitations

The null influence of group could be a result of methodological limitations related to the stimuli and/or paradigm that failed to capture a latent phenomenon. Of the 14 vignettes used in this study, six were adapted from previously used sources and eight were created for the purposes of this study. All vignettes were piloted with three typically fluent adolescents who affirmed the relevance of the scenarios and their associated interpretations to their lives which addressed issues of face validity, albeit with a very restricted sample. However, this was not the case for all study participants, some of whom reported informally to the researcher that they could not relate to many of the scenarios. For those participants, it is possible that they would have rated many interpretations (particularly those related to the scenarios they could not relate to) with low values thus dampening the relationships under investigation. In future variants of this task, after reading each vignette, participants could rate how relevant the vignette was to them and then those ratings could be controlled for in the analyses. Alternatively, a bank of vignettes could be provided to the participants, from which they select the vignettes that are most personally salient to them. In this way, participants would have a personalized experience with the task by rating interpretations of vignettes that they could most relate to. Putting the salience of the vignettes aside, it is also possible that the four interpretations offered to the participants were not similar to the participants' actual interpretations of the ambiguous cues. Rather than using this closed response format, an open response format could be implemented in which after reading the

scenario, participants are asked, “What do you think is happening?” Participants can generate several possible interpretations and then select the one that is the most likely explanation (Normansell & Wisco, 2017).

The null group effect could have also been a function of the sample population. The adolescents who stutter were recruited from speech-language pathologists (many of whom are stuttering specialists) and as such, these participants had received speech therapy at some point in time. Speech-language pathologists have different approaches to therapy, but those who are skilled in the treatment of stuttering often incorporate a counseling approach to help young people address the adverse social, emotional, and cognitive aspects of living with stuttering. Therefore, it is possible that this sample of adolescents who stutter had previous support in developing an adaptive orientation towards communication, thus minimizing any negative interpretation bias they may have had. Further, their performance in this study may not generalize to the behavior of adolescents who stutter in the broader population given that most stutterers in the general population do not seek therapy (Manning, 2010). The issue of sampling bias is a common problem in research with clinical populations, and a very difficult one to address.

4.4 Future Directions

The present study aimed to compare interpretation bias between adolescents who stutter and typically fluent peers, and as such, the scenarios and interpretations in the present study had to be applicable to both adolescents who do and do not stutter. However, utilizing scenarios and interpretations that are more directly related to stuttering may illuminate individual differences within the population of individuals who

stutter. It would be important to disentangle the contribution of interpretations and attributions that individuals who stutter conjure when faced with ambiguous social situations. While interpretations explain the outcome of ambiguous situations, attributions explain the *cause* of that outcome. For example, if you are talking on the phone and you suddenly hear the phone cut out, you might interpret that as the person on the other end hung up on you, rather than a mechanical issue with the phone line (interpretation). Then, you may attribute the hang-up to the fact that you could not communicate clearly, or that the person was in a rush and had to get off the phone (attribution). The former attribution is linked to an internal locus of control, whereas the latter attribution is linked to an external locus of control. Importantly, the construct of locus of control has long been of interest in the field of stuttering, primarily as it relates to treatment outcomes (Block et al., 2006; Boyle, 2018; Craig & Andrews, 1985; De Nil & Kroll, 1995; Lee et al., 2011; J. Riley et al., 2004). Thus, linking individual differences in interpretations of ambiguous social cues to attributions of those interpretations has potentially direct relevance to treatment outcomes for individuals who stutter.

It would also be worthwhile to study interpretation bias among a broader age range of individuals who stutter. The present study only included adolescents and it is possible that during this developmental period, adolescents are sensitive to all aspects of their social experience, regardless of whether they reflect verbal or non-verbal situations. Investigating interpretation biases in children and adults who stutter (ideally within a longitudinal framework) may elucidate the developmental course of interpretation bias and its functional outcomes for individuals who stutter such as social anxiety and quality of life.

Performance on the vignette-based task used in the present study and the possible variants of the task as described here reflect explicit cognitive processes in which participants are able to exert cognitive control on their behavior. There are paradigms that may measure more implicit forms of interpretation bias such as a text comprehension task (MacLeod & Cohen, 1993) or a morphed faces task (Heuer et al., 2010; Niedenthal et al., 2001; Richards et al., 2007) which both rely on response times.

5. Conclusion

The present study examined interpretations of ambiguous cues in verbal and non-verbal social scenarios among adolescents who stutter and their typically fluent peers, as well as the influence of individual differences in social anxiety and stuttering severity on interpretations. Utilizing a vignette-based recognition task, the main findings indicated that there was no meaningful effect of stuttering on interpretation bias in the present sample; the adolescents who stutter rated interpretations of verbal and non-verbal scenarios comparably to their typically fluent peers, and stuttering severity did not affect interpretation ratings in either type of scenario. However, across both groups, there was a meaningful influence of social anxiety such that higher social anxiety was associated with greater endorsement of negative interpretations of the verbal scenarios, and lower social anxiety was associated with greater endorsement of positive interpretations of ambiguous verbal and non-verbal scenarios. Taken together, this study provides preliminary evidence that social anxiety may affect how adolescents interpret ambiguous social cues in verbal and non-verbal scenarios more than stuttering.

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FIGURES

Figure 1. *Range of Stuttering Severity (SSI-4) Among the Adolescents Who Stutter*

Figure 2. *Group by Sex Interaction on SAS-A Scores*

Note. Bars depict standard error estimates. *** $p < .005$

Figure 3. Mean Interpretation Ratings by the Adolescents Who Stutter and Controls Across Social Scenarios that Included a Verbal Versus Nonverbal Interaction

Note. Bars depict standard error estimates. Higher ratings indicate that the interpretation was more similar to how participants originally encoded the scenario in memory.

Figure 4. *Mean Interpretation Ratings by the Adolescents Who Stutter Across Social Scenarios that Included a Verbal Versus Nonverbal Interaction*

Note. Bars depict standard error estimates. Higher ratings indicate that interpretation was more similar to how participants originally encoded the scenario in memory.

Figure 5. *Three-Way Interaction of Valence by Target Type by Social Anxiety on Ratings for the Verbal Scenarios*

Note. Bars depict standard errors of parameter estimates.

Figure 6. *Two-Way Interaction of Valence by Social Anxiety on Ratings for the Non-Verbal Scenarios*

Note. Bars depict standard errors of parameter estimates.

TABLES

Table 1. Mean (SD) Self-Report Anxiety Assessment Scores

Measure	Subscale	Stuttering	Control	Group Difference
SAS-A	Fear of Neg. Evaluation	22.04 (8.29)	22.43 (7.27)	$t(97) = 0.25, p = .80$
	Distress in New Situations	18.75 (5.98)	17.67 (4.83)	$t(97) = -0.99, p = .32$
	Distress in General	9.08 (3.95)	8.43 (3.02)	$t(97) = -0.93, p = .36$
	Total	49.88 (16.49)	48.44 (13.00)	$t(97) = -0.45, p = .66$
RCMAS-2	Social Anxiety	51.90 (10.61)	49.41 (9.37)	$t(95) = -1.33, p = .19$
	Physiological Anxiety	47.70 (10.31)	46.04 (8.96)	$t(95) = -0.84, p = .40$
	Worry	53.21 (10.44)	52.22 (10.56)	$t(95) = -0.46, p = .65$
	Defensiveness	52.94 (9.54)	47.06 (10.52)	$t(95) = -2.88, p = .005^*$
	Inconsistent Responding	2.46 (1.44)	2.04 (0.87)	$t(95) = -1.73, p = .09$
	Total	54.31 (8.89)	51.43 (9.45)	$t(95) = -1.55, p = .13$

Note: SAS-A = Social Anxiety Scale for Adolescents; RCMAS-2 = Revised Children's

Manifest Anxiety Scale-Second Edition. The last column provides results of the between-group t -tests.

* $p < .005$ (Bonferroni correction applied)

Table 2. *Correlations Between SAS-A and RCMAS-2 Subscales and Total Scores*

	1	2	3	4	5	6	7	8	9	10
SAS-A										
1. Fear Neg. Eval.	—									
2. New Situations	.67**	—								
3. Generalized	.61**	.71**	—							
4. SAS-A Total	.92**	.89**	.82**	—						
RCMAS-2										
5. Social	.75**	.71**	.72**	.82**	—					
6. Physiological	.44**	.42**	.32**	.46**	.42**	—				
7. Worry	.79**	.72**	.60**	.81**	.71**	.54**	—			
8. Defensiveness	-.19	-.08	-.09	-.15	-.14	-.13	-.21*	—		
9. Incons. Resp.	.17	.02	-.04	.09	.11	.20	.11	-.001	—	
10. RCMAS-2 Total	.75**	.71**	.67**	.81**	.80**	.69**	.88**	-.01	.15	—

Note. Fear Neg. Eval. = Fear of Negative Evaluation subscale of the SAS-A; New

Situations = Social Avoidance and Distress in New Situations subscale of the SAS-A;

Generalized = Generalized social avoidance and distress subscale of the SAS-A; SAS-

A Total = total score for the SAS-A; Social = Social Anxiety subscale of the RCMAS-2;

Physiological = Physiological Anxiety subscale of the RCMAS-2; Worry = Worry

subscale of the RCMAS-2; Defensiveness = Defensiveness subscale of the RCMAS-2;

Incons. Resp. = Inconsistent Responding subscale of the RCMAS-2; RCMAS-Total =

total score for the RCMAS-2. * $p < .05$. ** $p < .01$.