



REVIEW ARTICLE

# Characteristics associated with social anxiety in adults with developmental stuttering: A review

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OPEN ACCESS

**PUBLISHED**

30 October 2024

**CITATION**

Bauerly, K.R., 2024. Characteristics associated with social anxiety in adults with developmental stuttering: A review. Medical Research Archives, [online] 12(10). <https://doi.org/10.18103/mra.v12i10.5876>

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**DOI**

<https://doi.org/10.18103/mra.v12i10.5876>

**ISSN**

2375-1924

## ABSTRACT

People who stutter are at a greater risk for developing symptoms of social anxiety, with up to 22-60% of adults who stutter meeting the criteria for a clinical diagnosis. Negative attitudes and feelings about speaking and stuttering are reported to emerge as early as the preschool years and are suspected to be due to exposure to negative listener reactions, stereotyping and social isolation. Repeated negative experiences lead to feelings of fear, embarrassment and loss of control during speaking which over time, leads to the development of more severe difficulties with speaking and an overall apprehension to speak as they perceive themselves as an incompetent communicator. The present review aims to summarize risk factors, particularly temperament and environmental factors, that are reported to play a role in the emergence and maintenance of social anxiety in people who stutter. Another aim of this review is to summarize the features of social anxiety reported in adults who stutter, some of which, are similar to high socially anxious fluent speakers (e.g., avoidant strategies) while others are specific to stuttering (e.g., muscle tension). The clinical implications of these findings and recommendations for future research are also discussed.

## Introduction

Developmental stuttering is a neurodevelopmental, early age onset disorder (DSM-IV Axis I) affecting approximately 1% of the adult population<sup>1,2</sup>. Symptoms of stuttering typically emerge in preschool children between the ages of 2 and 3 years old. There is a strong tendency for children, particularly females, to recover from stuttering spontaneously, as the sex ratio of boys to girls is approximately 1.2 at onset while in adulthood the ratio increases to approximately 3:1<sup>3</sup>. Early signs of stuttering include overt breakages in the fluent flow of speech including part-word, syllable or word repetitions as well as prolongations, breakages in sounds, or hard glottal attacks<sup>1</sup>. As the disorder persists, the stutters often become more frequent and can be accompanied with tension and struggle<sup>1,2,4</sup>. At the same time, negative attitudes towards communication are found to emerge<sup>5,6</sup> and are suspected to be due to exposure to negative listener reactions, stereotyping and social isolation<sup>7,8</sup>. For instance, research shows that preschool children show a preference to interact with their fluent peers<sup>9</sup> and have been observed to tease, ignore or interrupt a peer who stutters<sup>10</sup>. Children who stutter respond to these negative social interactions by reporting feelings of fear, embarrassment, shame and loss of control during speaking. Over time, the child who stutters begins to show more severe difficulties with communication and report apprehension to talk as they perceive oneself as an incompetent communicator<sup>7,11,12</sup>. In response to these struggles, escape behaviors begin to emerge in early childhood as an attempt to minimize a stuttering moment and may include visible tension or body movements such as head or hand jerking, eye blinking or sudden exhalation of the breath<sup>1</sup>. Avoidance behaviors are also observed to emerge as attempts to avoid a stuttering moment from occurring and may include word substitutions or circumlocutions, strategies to delay or prevent a stutter (e.g., "well", "you know"), starting tricks (e.g., "uh", "um") and anti-expectancy behaviors (e.g., speaking with a rapid monotone)<sup>1,4</sup>.

People who stutter are at a higher risk for developing symptoms of social anxiety, with up to 22-60% of

adults who stutter (AWS) meeting criteria for a clinical diagnosis<sup>13-18</sup>. The prevalence of social anxiety in AWS has been extensively studied using self-report measures such as the Fear of Negative Evaluation<sup>19</sup>, Inventory of Interpersonal Situations<sup>20</sup>, Social Avoidance and Distress Scale<sup>19</sup> and Social Phobia Anxiety Inventory<sup>21</sup>. A meta-analysis by Craig & Tran<sup>1</sup> reported substantially elevated social anxiety levels (effect size = .82) in AWS compared to controls. Kraaimaat et al.<sup>22</sup> reported that AWS were significantly more likely to self-report higher on scores of emotional tension and discomfort with speaking and to report a significantly lower frequency of social responses compared to controls. In a later study, Iverach et al.<sup>23</sup> found in a group of 275 AWS, that the high socially anxious AWS (n=82) were more likely to report using avoidance behaviors and experience dissatisfaction with speaking and stuttering. Similar results were reported in Tomisato et al.<sup>24</sup>. Other studies have found high socially anxious AWS are more likely to interpret social situations negatively, report greater difficulties with daily communication and self-report greater stuttering severity<sup>12,25</sup>. Blood et al.<sup>7</sup> found that self-reports of social anxiety, fear of negative evaluation and dissatisfaction with life are more likely to be experienced by AWS who experience childhood victimization, including physical, verbal, relational or cyber bullying.

## Risk factors for the development of social anxiety in people who stutter

Despite the strong evidence for social anxiety in adolescents and adults who stutter, we know very little about the risk factors leading to social anxiety during the childhood years. Several characteristics associated with social anxiety in children who do *not* stutter have been identified including temperament and environmental factors, both of which are reported in children who stutter.

## Temperamental factors

Temperament refers to biological based traits that include emotional, motor and attentional reactions as well as the self-regulatory responses to a situation<sup>26,27</sup>.

Research shows that socially anxious children who do not stutter are reported as shy, quiet, reticent and show negative affectivity and low adaptability to uncertain or changing situations<sup>28-31</sup>. Also, socially anxious children are less likely to initiate or maintain an interaction and are often reported to show cautiousness, fear, and withdrawal from social situations and activities<sup>29,32</sup>. It is not surprising, therefore, to find that an inhibited temperament serves as a prominent risk factor to the development of social anxiety in childhood<sup>33-38</sup>.

Several of these temperamental risk factors to social anxiety reported in children who do not stutter have been reported in children who stutter<sup>39-44</sup>. Through parental reports and behavioral observations, studies have reported children who stutter to exhibit a more negative affect, lower self-regulatory abilities, are less adaptable to change, show increased emotional responses and are more behaviorally inhibited<sup>39-49</sup>. For instance, Ntourou et al.<sup>47</sup> and Choi et al.<sup>48</sup> reported higher scores on the Short Behavioral Inhibition Scale in children who stutter compared to low anxious controls. Using a more direct measure of behavioral inhibition, the Go/NoGo task, Eggers et al.<sup>41</sup> reported school age children who stutter to have lower inhibitory control compared to controls. Several studies have found associations between these temperamental characteristics and stuttering severity. For instance, Ntourou et al.<sup>47</sup> showed a positive association between behavioral inhibition scores and stuttering severity, as well as self-reported speech attitudes. Tumanova et al.<sup>43</sup> reported temperament scores were positively associated with the use of physical behaviors that accompany moments of stuttering. Frost<sup>50</sup> also reported inhibited children who stutter are more likely to exhibit more secondary behaviors. While temperamental characteristics has been shown to be related to stuttering severity<sup>49</sup> and the use of secondary behaviors,<sup>50</sup> the direct relationship between temperament and social anxiety in children who stutter has received very little attention<sup>51</sup>.

## Environmental factors

Cognitive models of social anxiety propose that the relationship between temperament and social

anxiety is further influenced by environmental factors<sup>26,31,33</sup>. While temperamental traits have been considered to be relatively stable and consistent across situations, more recent evidence suggests that temperament is responsive to environmental influences and therefore, may evolve over time<sup>30,32,52</sup>. It is suggested that children with a behaviorally inhibited temperament are at greater risk for developing social anxiety if they also experience repeated, adverse environmental experiences. A number of environmental factors have been identified as possible risk factors to social anxiety including parenting style<sup>32,53</sup>, parental mental health<sup>54-56</sup>, and adverse life events<sup>57,58</sup>. There is evidence that an overcontrolling parenting style, lack of warmth/rejection, and overprotection during the elementary years strengthens the relationship between temperament and social anxiety in adolescents<sup>26,33,59</sup>. Other studies report that parents with social anxiety are significantly more likely to have a child with a social anxiety disorder<sup>60</sup>. Furthermore, a number of studies have linked stressful life events with the development of social anxiety such as changing schools, new sibling, divorce or family death<sup>60</sup>. Spence and Rapee<sup>31,52</sup> propose that these environmental factors interact with temperamental characteristics and interfere with the child's acquisition of social skills, interpersonal problems and emotional regulation abilities<sup>53,61</sup>.

The impact environmental factors can have on the interaction between temperament and social anxiety is particularly important for our understanding of childhood stuttering<sup>1</sup>. Several of the environmental risk factors for social anxiety identified in children who do not stutter have also been reported in children who stutter including parenting style<sup>62</sup> and adverse life events<sup>63-65</sup>. For instance, parents of children who stutter are observed to be more demanding or anxious compared to parents of peers<sup>66,64</sup>. A retrospective study reported that children perceived their parents to be lower in attachment and reported frustration with their attempts to remediate their stuttering<sup>62</sup>. Also, a few studies have reported the onset of stuttering following a traumatic life event<sup>63</sup>, while others found no relationship<sup>67</sup>. However, these

studies have only assessed the effects of environmental factors on the onset of stuttering, leaving the impact of social anxiety unexplored. Children who stutter with a more inhibited temperament are particularly vulnerable to negative social experiences as their increased emotional reactivity<sup>42</sup> coupled with a decrease in adaptability and emotional regulatory abilities<sup>68</sup>, puts them at a greater risk for developing symptoms of social anxiety<sup>52,58</sup>. As social behavior is learned through experiences, these children who stutter will have lower social confidence and poorer communication skills<sup>40,43</sup>. Over time, high socially anxious children who stutter are reported to fear negative listener reactions<sup>10</sup> and begin to anticipate a stuttering movement and in response, begin to develop secondary behaviors as an attempt escape or avoid a stuttering moment.

## Characteristics of social anxiety disorder in people who stutter

### FEAR OF NEGATIVE EVALUATION

One important characteristic of social anxiety is the fear of being negatively evaluated. Fear of negative evaluation is defined as an apprehension about others' evaluation<sup>19</sup>. High socially anxious speakers are more likely to interpret a listener's emotional expression as negative and as such, lead to anticipating others will evaluate themselves negatively as well<sup>69</sup>. Fear of negative evaluation is most commonly measured using the self-report, Fear of Negative Evaluation<sup>19</sup> or the abbreviated Brief Fear of Negative Evaluation<sup>66</sup>. Studies report that high socially anxious speakers experience anxiety when evaluating previous social interactions and anticipating future ones<sup>70</sup>. These negative feelings are found to lead to feelings of worry, dread and anxiousness as well as sweating and rapid heart rate<sup>71-73</sup>. Fear of negative evaluation is found to predict social anxiety levels<sup>72</sup>.

Adults who stutter (AWS) have self-reported significantly greater levels of fear of evaluation compared to adults who do not stutter (ANS) using the Brief Fear of Negative Evaluation (BFE)<sup>7,15,18,66</sup>.

Increases in negative social experiences can contribute to the onset and maintenance of fear of negative evaluation as well as the emergence of safety behaviors<sup>74,75</sup>. For instance, in a group of 133 AWS, Lowe et al.<sup>74</sup> reported a significant association between the use of safety behaviors (e.g., avoiding difficult words or socially threatening situations) and self-report measures of fear of negative evaluation<sup>19</sup> and Unhelpful Thoughts and Beliefs about Stuttering (UBSTAS)<sup>76</sup>. However, others have reported no significant differences in avoidance behaviors between AWS and individuals with a diagnosis of social phobia<sup>16</sup>. These discrepancies may be due to individual differences among AWS<sup>16,77,78</sup>. For instance, Brundage et al.<sup>79</sup> found no group differences between AWS and a group of controls on the Fear of Negative Evaluation questionnaire<sup>66</sup>; however, after forming subgroups based on high versus low scores, they found the AWS who scored the highest on the Fear of Negative Evaluation also scored significantly higher on an Interpretation and Judgement Questionnaire<sup>80</sup>, which is a questionnaire that quantifies negative interpretation and judgment biases for 24 social situations ranging from negative (e.g., *"A friend tells you that a colleague dislikes you"*) to ambiguous (e.g., *"The newly introduced person doesn't say anything to you"*).

### ANTICIPATORY PROCESSING

Over time, the AWS begins to anticipate negative social experiences prior to speaking<sup>81-83</sup>, which promotes the use of safety behaviors as an attempt to avoid or escape from a potential stuttering moment<sup>4,74</sup>. Prior to a social situation, high socially anxious speakers are reported to imagine in detail what might happen during a social event which elicits further anxiety and dread about the up-and-coming situation<sup>84-86</sup>. These cognitive processes often lead to completely avoiding the situation<sup>1</sup>, which perpetuates and maintains anxiety over the long-term. Similar effects have been reported in AWS. Anticipating a stuttering moment is a common phenomenon reported in AWS and is defined as a covert experience of anticipating an embarrassing moment will take place<sup>83,87,88</sup>. Jackson et al.<sup>88,89</sup>

describes this as long term anticipation where the AWS ruminates over an up- and- coming speaking situation (e.g., work meeting, social gathering) which subsequently elicits the engagement of self-management strategies such as previewing speech, changing speech rate, employing fluent enhancing techniques (e.g., easy onset) or avoiding the situation all together<sup>88</sup>. Jackson et al.<sup>88</sup> reported that up to 77% of AWS experience anticipation “often” and that these anticipatory events are not related to the AWS’ stuttering severity or treatment history. As described in Jackson<sup>81</sup>, AWS are also reported to undergo immediate or short-term anticipation where a stutter is anticipated to occur in the moment of speaking and is suspected to be associated in time with negative thoughts and autonomic arousal<sup>81,90</sup>. Using open-ended questions, Jackson et al.<sup>88</sup> found anticipating a stutter occurs at a cognitive level (e.g., negative thoughts) and is associated with learned negative fears to sounds and/or words. As such, anticipating a stuttering moment can lead to transient moments of anxiety, muscle tension, and/or avoidant strategies<sup>5,81,88</sup> as well as sympathetic nervous system increases<sup>90</sup>. Avoidant strategies include replacing or circumlocution around a word they suspect will be stuttered or avoiding a speaking situation all together. Jackson et al.<sup>88</sup> reported that some AWS felt that anticipation was helpful as it allotted them time to prepare for a self-management strategy such as relaxing their muscles or employing a fluency skill, while others reported to respond to the anticipation of stuttering with fear or dread.

#### AUTONOMIC REACTIVITY AND REGULATORY RESPONSES

A number of studies have used objective measures of sympathetic and parasympathetic indices to measure anxiety-related changes during speaking. The sympathetic and parasympathetic branches of the autonomic nervous system work complementary to one another to help regulate the day-to-day changes in emotional responses to internal and external demands<sup>91-93</sup>. The sympathetic nervous system or “fight or flight” function, prepares the body for stress by eliciting increases in heart rate and

breathing as well as sweating of the eccrine glands<sup>93,94</sup>. Skin conductance levels (SCL) is one of the most extensively used for measuring sympathetic activity<sup>91,93</sup>. It is a tonic measure of electrodermal activity which reflects eccrine sweat gland activity controlled by the sympathetic nervous system<sup>94,95</sup>. Increases in sympathetic nervous system activity occur when the autonomic fibers from the vagus nerve, sending regulatory signals to the heart, lungs and digestive organs, are inhibited<sup>96</sup>. When the vagus nerve is disinhibited, parasympathetic influences dominate, resulting in decreases in heart rate, slower breathing and decreases in sweat production. Parasympathetic nervous system activity can be indexed by measuring respiratory sinus arrhythmia (RSA), which is a metric of high frequency HR variability. (i.e., beat-to-beat variability). An increase in RSA (i.e., increase in inhibitory control on the sympathetic branch) is associated with decreases in heart rate and increases in HR variability<sup>93</sup>.

The reciprocal relationship between the sympathetic and parasympathetic nervous system in response to social stress has been widely studied<sup>97,98</sup>. Studies report high socially anxious speakers exhibit elevated levels of sympathetic activity and subsequent lower parasympathetic influences at rest and during socially stressful speaking tasks<sup>94,99</sup>. Research has shown that increases in RSA reflect positive affect<sup>100</sup> as well as improved behavioral regulation<sup>101</sup>, social engagement<sup>98,102,103</sup> and effortful control (i.e., regulation of appetitive or aversive stimuli)<sup>104,105</sup>. For instance, by tracking facial expressions and RSA levels when viewing negative stimuli, Pu et al.<sup>106</sup> reported that individuals with high RSA levels were better able to suppress negative emotion in a nonclinical population. Others report high RSA in individuals who are more effective at regulating stress through the use of attentional processes<sup>107</sup> and self-control strategies<sup>106,108</sup> such as cognitive reappraisal or suppression<sup>109,110</sup>. From this perspective, increased RSA (i.e. vagal input) may help prevent or reduce daily responses to stress<sup>109</sup> and improve the ability to socially engage in a flexible, adaptive manner<sup>96</sup>. Conversely, lower RSA levels or decreased

heart rate variability, has been found in high anxious individuals and has been suggested to contribute to poor inhibitory control and reduced attentional regulation<sup>111-113</sup>. Importantly, not all studies report increased sympathetic and decreased parasympathetic responses in high anxious speakers. Some studies report decreases in cortisol levels and sweat production subsequent to reduced heart rate and increased RSA levels in high anxious speakers and suggest this is a defensive response, due the need for increased attention and hypervigilance of their surroundings<sup>98,114</sup>. An increase in RSA, however, renders the autonomic nervous system less able to respond effectively to environmental stimuli<sup>98</sup>.

Heightened sympathetic nervous system activity has been reported in both children and adults who stutter<sup>115-117</sup>. Zimmerman<sup>118</sup> suggested that increases in sympathetic activity in response to emotional arousal is involved in the motoric breakdown leading to disfluencies. Since then, research has found increased sympathetic activity in AWS when anticipating or in response to a stressful speaking task<sup>115,119,120</sup>. Bowers et al.<sup>115</sup> reported significant increases in SCL in AWS when anticipating a feared versus neutral word and decreases in SCL when speaking in a fluency promoting condition (i.e., choral reading). Dietrich & Roamen<sup>119</sup> reported significant increases in SCL in AWS before and during a self-identified fearful speaking task. Other studies have reported similar increases in SCL in AWS during socially stressful tasks such as giving a job interview<sup>120</sup> and speaking in front of an audience<sup>121</sup>. On the contrary, several studies have reported no significant differences in sympathetic arousal between AWS and ANS during speaking tasks<sup>122-126</sup>. Studies assessing children who stutter during emotionally driven conditions have more consistently reported higher SCL during a range of speaking tasks. For instance, Zengin-Bolatkale et al.<sup>117</sup> reported significantly higher SCL in children who stutter compared to children who do not stutter while performing a cognitively stressful task. However, these group differences diminished with age. Jones et al.<sup>116</sup> reported higher SCL in children who

stutter versus children who do not stutter while viewing positively and negatively valenced video clips while the group of controls exhibited higher SCL when viewing only the negatively valenced video clip. However, Tumanova et al.<sup>127</sup> reported no differences in emotional reactivity between children who stutter versus children who do not stutter. It is possible that over time the AWS learns to develop coping strategies that reduce the emotional reactivity to emotionally arousing situations.

Few studies have assessed the emotional regulatory abilities in AWS<sup>124,128</sup>. Bauerly et al.<sup>124</sup> reported significantly higher RSA levels in AWS compared to ANS during rest and when preparing to give a speech. AWS' increased in RSA levels were suspected to be due to a need to continuously engage in an emotional regulatory strategy. A later study revealed that AWS' self-reports of trait and social anxiety were predictive of RSA levels during resting conditions<sup>128</sup>. That is, those who scored the lowest on self-reports of trait (i.e., STAI-T<sup>129</sup>) and social anxiety (i.e., SIAS<sup>21</sup>) were the ones who showed the highest RSA levels. The authors interpreted these findings to suggest that low self-reported anxiety scores simultaneous with high RSA levels in some AWS may reflect a self-regulatory strategy adopted in response to the chronic stress associated with stuttering.

While it is clear that feelings of social evaluative stress can lead to a set of psychological and physiological responses, studies have shown that these two stress responses do not always co-occur<sup>130,131</sup>. In support, Brundage et al.<sup>126</sup> reported no significant differences in skin conductance levels or heart rate in AWS across low- and high socially stressful speaking situations; however, subjective ratings of stress were significantly higher when speaking under high social stress. Similarly, Bauerly & Bilardello<sup>132</sup> reported no significant relationship between SCL and self-reports of anxiety in AWS. While research in this area is limited, results suggest that psychological and physiological stress responses may be governed by additional processes and one area receiving

considerable amount of attention in psychology is the relationship between social stress responses and attentional processing<sup>125,133,134</sup>.

#### ATTENTIONAL PROCESSING IN RESPONSE TO SOCIAL STRESS

Anxiety theories have suggested that an internal attentional focus to physiological reactions (e.g., increase in sweating) and/or negative thoughts (e.g., embarrassment) may exacerbate anxiety levels<sup>130,135</sup>. This line of research suggests that an increase in perceived levels of anxiety (i.e., psychological response) may be due to a tendency to focus their attention inward, on the self, when speaking in a socially stressful situation which is suspected to be an attempt to regulate heightened emotions<sup>84,94,95</sup>. However, these attentional shifts are not without consequences. Research shows that maladaptive attentional processing may lead to increases in negative, self-conscious thoughts (e.g., dread, embarrassment, shame), causing an increase in perceived levels of anxiety. Also, this self-focused attention can impair the speaker's ability to attend to the listener and receive social feedback, leading to disruptions in social interactions<sup>135,136</sup>.

While some studies have shown AWS to exhibit a hyperawareness to negative listener faces when anticipating a socially stressful speaking condition<sup>74,125,137</sup>, others have reported a shift away from listener reactions during the moment of speaking. For instance, when giving a speech to an audience, Lowe et al.<sup>78</sup> found AWS attended less to audience members, regardless of facial expressions, and more time on the background. When comparing the attentional focus across different emotional faces in the audience, the AWS looked for less time at audience members depicting positive faces and more time on audience members showing negative and neutral faces. Further analysis revealed that the avoidance of positive faces was associated with negative subjective ratings of performance and increased perceived levels of anxiety. Several other studies report that adolescents and adults who stutter focus their attention inward during socially

stressful situations. That is, they focus on anxiety-related symptoms such as physiological (e.g., heart rate, sweating) and psychological changes (e.g., negative thoughts)<sup>5,138-141</sup>. These attentional shifts are suggested to be a strategy used to regulate emotions; however, it comes with a cost as this results in an interference in communication as the speaker is not benefiting from positive listener reactions and may be perceived by the listener as uninterested in the conversation.

#### INTERPRETATION BIASES IN RESPONSE TO SOCIAL STRESS

Social interactions involve interpreting listener reactions which can range from positive (e.g., smiling), negative (e.g., furrowed eyebrows), or ambiguous (e.g., looking at watch). Research shows that socially anxious speakers are more likely to interpret social information as negative and lack positive interpretations of social cues (e.g.,<sup>133,142-146</sup>). For instance, a yawn may be interpreted by a high socially anxious speaker as boredom (i.e., negative) compared to tired (i.e., neutral). Cognitive models of social anxiety<sup>84</sup> propose that frequently interpreting ambiguous information as negative heightens and maintains anxiety. While Chen et al.<sup>133</sup> reported large effects sizes for both the clinical and subclinical populations, not all studies report negative biases in socially anxious speakers which they suspect may be due to methodological differences. In Chen et al.'s review, strongest effect sizes were reported in studies that employed subjective, self-report measures or interpretation questions immediately following a social scenario<sup>147,148</sup>. However, objective measures (e.g., reaction time studies), where participants respond to verbal (e.g., written scenarios) or visual (e.g., photographs, video scenarios) stimuli have also yielded strong relationships<sup>149-152</sup>.

Negative interpretation biases were first reported in AWS by Brundage et al.<sup>153</sup> using a negative judgement bias questionnaire and later Rodgers et al.<sup>154</sup> found high socially anxious adolescents who stutter to exhibit ambiguous social vignettes as negative. Research assessing AWS' preferential

tendency to interpret negative meanings from ambiguous social cues is in need of further research. Interpreting ambiguous information as negative may be especially harmful to AWS as social cues are often ambiguous (e.g., smiling) but can easily be interpreted as threatening (e.g., “*I look stupid*”) as opposed to benign (e.g., “*They enjoy my company*”) and as such, exasperate anxiety and lead to an increase in safety behaviors and stuttering severity<sup>154</sup>.

In summary, social anxiety is frequently reported in both children and adults who stutter. Responses to socially threatening situations begin as early as preschool and may result in the elicitation of negative thoughts and feelings about speaking, facial tension and physical struggle as well as the use of escape (e.g., physical movements) and avoidance (e.g., circumlocutions) behaviors. These behaviors cause the disorder to worsen and become more complicated to treat. Evidence for social anxiety using self-reports is strong, while objective measures are less consistent, suggesting that the emergence and maintenance of social anxiety in AWS is more cognitive driven. Studies of adolescents and adults who stutter have reported both attentional and interpretation processing biases, which are suspected to lead to the long-term maintenance of anxiety symptoms and further disruptions in communication, thus perpetuating the cycle of anxiety.

## Recommendation for future research

Research is needed into the identification of risk factors for social anxiety in people who stutter and determining whether these symptoms lead to the subsequent use of maladaptive, safety behaviors. Developing tools to enable clinicians to identify those children who are at risk for social anxiety will facilitate more individualized treatment approaches. Traditional stuttering treatment programs focus on replacing stuttered speech with a novel speech pattern that promotes fluency (e.g. easy onset). While immediate fluency gains are reported with this type of approach, there is a high rate of relapse<sup>1</sup>. The lack of long-term maintenance is likely due to the failure of these programs to go beyond the AWS’ motoric

disability and address symptoms of social anxiety. There are several different therapeutic approaches and techniques to addressing the cognitive and social aspects related to social anxiety and stuttering. Many of them incorporate basic strategies for addressing negative cognitions related to speaking and stuttering including cognitive restructuring, exposure or desensitization and attentional training<sup>75,155-157</sup>. For instance, the negative cognitions associated with stuttering are addressed using Cognitive Behavioral Therapy (CBT) for stuttering where problem-solving methods are used to identify distressful feelings and thoughts about speaking and modify them to promote increased participation and positive self-perceptions<sup>156,158</sup>. Several programs aim to reduce the frustration that emerges from stuttering through acceptance and mindfulness techniques<sup>157,159</sup>; while other programs aim to reduce escape and avoidance behaviors as well as emotional reactivity to moments of disfluency with the goal of achieving struggle-free, forward-moving disfluencies<sup>155</sup>. For instance, both CBT for stuttering<sup>158</sup> and Avoidance Reduction Therapy for Stuttering (ARTS®);<sup>155</sup> encourage the speaker to expose themselves as a person who stutters by reducing avoidance behaviors and openly stuttering in an attempt to reduce their fearful thoughts about speaking. While these therapy programs differ in their therapeutic approaches and techniques, they all incorporate basic strategies for addressing the social, emotional, and cognitive issues often associated with stuttering<sup>158</sup>. Considering that AWS are at a significant risk for developing symptoms of social anxiety<sup>77</sup>, it is not until treatment begins to address symptoms related to social anxiety will we see long-lasting changes from therapy<sup>158</sup>. Future research looking more closely at the maladaptive behaviors that accompany social anxiety in AWS, particularly interpretation and attentional biases, is needed in order to facilitate further improvements in treatment.

## Conclusion

Adults who stutter are at greater risk for developing social anxiety. Symptoms of social anxiety begin to emerge early, as young as 3 years old. While



research is needed in determining risk factors for social anxiety in this population, current evidence suggests that temperament and environmental factors play a role in the emergence and maintenance of symptoms associated with social anxiety. Several features of social anxiety found in fluent speakers are also found in adults who stutter, including fear of negative evaluation, maladaptive anticipatory and autonomic processing as well as information processing biases. Other symptoms such as the adoption of secondary, safety behaviors (e.g., escape behaviors) are more specific to the disorder of stuttering. Developing tools to enable clinicians to identify the behaviors associated with social anxiety in people who stutter will facilitate more individualized treatment programs targeting the reduction of social anxiety and the facilitation of long term treatment outcome.

## Conflicts of interest

The author has no conflicts of interest to declare.

## Funding statement

This research was supported by the National Institute on Deafness and Other Communication Disorders Grants R21 DC020013.

## Acknowledgements:

None

## References:

1. Bloodstein O, Ratner NB, Brundage SB. *A handbook on stuttering*. vol 1. Plural Publishing; 2021.
2. Yairi E, Ambrose N. Epidemiology of stuttering: 21st century advances. *Journal of fluency disorders*. 2013;38(2):66-87.
3. Craig A, Tran Y. The epidemiology of stuttering: The need for reliable estimates of prevalence and anxiety levels over the lifespan. *Advances in Speech Language Pathology*. 2005; 7(1):41-46.
4. Guitar B. *Stuttering: An integrated approach to its nature and treatment*. Lippincott Williams & Wilkins; 2013.
5. Vanryckeghem M, Brutten GJ, Uddin N, Van Borsel J. A comparative investigation of the speech-associated coping responses reported by adults who do and do not stutter. *Journal of Fluency Disorders*. 2004;29(3):237-250.
6. De Nil LF, Brutten G. Voice onset times of stuttering and nonstuttering children: The influence of externally and linguistically imposed time pressure. *Journal of Fluency Disorders*. 1991;16(2-3):143-158.
7. Blood GW, Blood IM. Long-term consequences of childhood bullying in adults who stutter: Social anxiety, fear of negative evaluation, self-esteem, and satisfaction with life. *Journal of fluency disorders*. 2016;50:72-84.
8. Beilby J. *Psychosocial impact of living with a stuttering disorder: Knowing is not enough*. Thieme Medical Publishers; 2014:132-143.
9. Ezrati-Vinacour R, Levin I. The relationship between anxiety and stuttering: A multidimensional approach. *Journal of fluency disorders*. 2004;29 (2):135-148.
10. Langevin M, Packman A, Onslow M. Peer responses to stuttering in the preschool setting. 2009;
11. Bricker-Katz G, Lincoln M, McCabe P. A life-time of stuttering: How emotional reactions to stuttering impact activities and participation in older people. *Disability and rehabilitation*. 2009;31(21): 1742-1752.
12. Mulcahy K, Hennessey N, Beilby J, Byrnes M. Social anxiety and the severity and typography of stuttering in adolescents. *Journal of fluency disorders*. 2008;33(4):306-319.
13. Blumgart E, Tran Y, Craig A. Social support and its association with negative affect in adults who stutter. *Journal of fluency disorders*. 2014;40: 83-92.
14. Craig A, Tran Y. Trait and social anxiety in adults with chronic stuttering: Conclusions following meta-analysis. *Journal of fluency disorders*. 2014; 40:35-43.
15. Iverach L, Jones M, O'Brian S, et al. Screening for personality disorders among adults seeking speech treatment for stuttering. *Journal of fluency disorders*. 2009;34(3):173-186.
16. Mahr GC, Torosian T. Anxiety and social phobia in stuttering. *Journal of Fluency Disorders*. 1999;24(2):119-126.
17. Gabel RM, Colcord RD, Petrosino L. Self-reported anxiety of adults who do and do not stutter. *Perceptual and Motor Skills*. 2002;94(3):775-784.
18. Messenger M, Onslow M, Packman A, Menzies R. Social anxiety in stuttering: measuring negative social expectancies. *Journal of fluency disorders*. 2004;29(3):201-212.
19. Watson D, Friend R. Measurement of social-evaluative anxiety. *Journal of consulting and clinical psychology*. 1969;33(4):448.
20. van Dam-Baggen R, Kraaimaat F. Assessing social anxiety: The Inventory of Interpersonal Situations (IIS). *European Journal of Psychological Assessment*. 1999;15(1):25.
21. Turner SM, Beidel DC, Dancu CV, Stanley MA. An empirically derived inventory to measure social fears and anxiety: the Social Phobia and Anxiety Inventory. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*. 1989;1(1):35.
22. Kraaimaat FW, Vanryckeghem M, Van Dam-Baggen R. Stuttering and social anxiety. *Journal of fluency disorders*. 2002;27(4):319-331.

23. Iverach L, Jones M, Lowe R, et al. Comparison of adults who stutter with and without social anxiety disorder. *Journal of fluency disorders*. 2018;56:55-68.
24. Tomisato S, Yada Y, Wasano K. Relationship between social anxiety and coping profile in adults who stutter. *Journal of Communication Disorders*. 2022;95:106167.
25. Lei X, Sasisekaran J, Nguyen-Feng VN. The experience of stuttering in everyday life among adults who stutter: The impact of trait social anxiety and the social situations. *Journal of Fluency Disorders*. 2024;80:106061.
26. Kagan J. Temperamental contributions to social behavior. *American psychologist*. 1989;44(4):668.
27. Nigg JT. Temperament and developmental psychopathology. *Journal of Child Psychology and Psychiatry*. 2006;47(3-4):395-422.
28. Lonigan CJ, Vasey MW, Phillips BM, Hazen RA. Temperament, anxiety, and the processing of threat-relevant stimuli. *Journal of Clinical Child and Adolescent Psychology*. 2004;33(1):8-20.
29. Rubin KH, Burgess KB, Hastings PD. Stability and social-behavioral consequences of toddlers' inhibited temperament and parenting behaviors. *Child development*. 2002;73(2):483-495.
30. Rothbart MK, Sheese BE, Rueda MR, Posner MI. Developing mechanisms of self-regulation in early life. *Emotion review*. 2011;3(2):207-213.
31. Spence SH, Rapee RM. The etiology of social anxiety disorder: An evidence-based model. *Behaviour research and therapy*. 2016;86:50-67.
32. Brook CA, Willoughby T. The social ties that bind: Social anxiety and academic achievement across the university years. *Journal of youth and adolescence*. 2015;44:1139-1152.
33. Fox NA, Henderson HA, Marshall PJ, Nichols KE, Ghera MM. Behavioral inhibition: Linking biology and behavior within a developmental framework. *Annu Rev Psychol*. 2005;56:235-262.
34. Rapee RM, Coplan RJ. Conceptual relations between anxiety disorder and fearful temperament. *New directions for child and adolescent development*. 2010;2010(127):17-31.
35. Pérez-Edgar K, Fox NA. Temperament and anxiety disorders. *Child and Adolescent Psychiatric Clinics*. 2005;14(4):681-706.
36. Clauss JA, Blackford JU. Behavioral inhibition and risk for developing social anxiety disorder: a meta-analytic study. *Journal of the American Academy of Child & Adolescent Psychiatry*. 2012;51(10):1066-1075. e1.
37. Fox NA, Nichols KE, Henderson HA, et al. Evidence for a gene-environment interaction in predicting behavioral inhibition in middle childhood. *Psychological Science*. 2005;16(12):921-926.
38. Biederman J, Rosenbaum JF, Bolduc-Murphy EA, et al. A 3-year follow-up of children with and without behavioral inhibition. *Journal of the American Academy of Child & Adolescent Psychiatry*. 1993;32(4):814-821.
39. Anderson SE, Bandini L, Dietz W, Must A. Relationship between temperament, nonresting energy expenditure, body composition, and physical activity in girls. *International journal of obesity*. 2004;28(2):300-306.
40. Choi D, Conture EG, Walden TA, Jones RM, Kim H. Emotional diathesis, emotional stress, and childhood stuttering. *Journal of Speech, Language, and Hearing Research*. 2016;59(4):616-630.
41. Eggers K, Luc F, Van den Bergh BR. Inhibitory control in childhood stuttering. *Journal of fluency disorders*. 2013;38(1):1-13.
42. Karrass J, Walden TA, Conture EG, et al. Relation of emotional reactivity and regulation to childhood stuttering. *Journal of communication disorders*. 2006;39(6):402-423.
43. Tumanova V, Backes N. Autonomic nervous system response to speech production in stuttering and normally fluent preschool-age children. *Journal of Speech, Language, and Hearing Research*. 2019;62(11):4030-4044.
44. Conture EG, Kelly EM, Walden TA. Temperament, speech and language: An overview.

- Journal of communication disorders*. 2013;46(2):125-142.
45. Johnson KN, Walden TA, Conture EG, Karrass J. Spontaneous regulation of emotions in preschool children who stutter: Preliminary findings. 2010;
  46. Zengin-Bolatkale H, Conture EG, Walden TA, Jones RM. Sympathetic arousal as a marker of chronicity in childhood stuttering. *Developmental neuropsychology*. 2018;43(2):135-151.
  47. Ntourou K, DeFranco EO, Conture EG, Walden TA, Mushtaq N. A parent-report scale of behavioral inhibition: Validation and application to preschool-age children who do and do not stutter. *Journal of Fluency Disorders*. 2020;63:105748.
  48. Choi D, Conture EG, Walden TA, Lambert WE, Tumanova V. Behavioral inhibition and childhood stuttering. *Journal of fluency disorders*. 2013;38(2):171-183.
  49. Tumanova V, Wilder B, Gregoire J, Baratta M, Razza R. Emotional reactivity and regulation in preschool-age children who do and do not stutter: Evidence from autonomic nervous system measures. *Frontiers in human neuroscience*. 2020;14:600790.
  50. Frost A. *The Relationship Between Behavioral Inhibition and Secondary Behaviors in Children Who Stutter*. University of South Alabama; 2022.
  51. Smith KA, Iverach L, O'Brian S, Kefalianos E, Reilly S. Anxiety of children and adolescents who stutter: A review. *Journal of fluency disorders*. 2014;40:22-34.
  52. Rapee RM, Spence SH. The etiology of social phobia: Empirical evidence and an initial model. *Clinical psychology review*. 2004;24(7):737-767.
  53. Rana SA, Akhtar S, Tahir MA. Parenting styles and social anxiety among adolescents. *New Horizons*. 2013;7(2):21.
  54. Beidel DC, Turner SM. At risk for anxiety: I. Psychopathology in the offspring of anxious parents. *Journal of the American Academy of Child & Adolescent Psychiatry*. 1997;36(7):918-924.
  55. Fyer AJ, Mannuzza S, Chapman TF, Martin LY, Klein DF. Specificity in familial aggregation of phobic disorders. *Archives of general psychiatry*. 1995;52(7):564-573.
  56. Rapee RM. The development and modification of temperamental risk for anxiety disorders: prevention of a lifetime of anxiety? *Biological psychiatry*. 2002;52(10):947-957.
  57. Acarturk C, Smit F, De Graaf R, Van Straten A, Ten Have M, Cuijpers P. Incidence of social phobia and identification of its risk indicators: a model for prevention. *Acta Psychiatrica Scandinavica*. 2009;119(1):62-70.
  58. Simon NM, Herlands NN, Marks EH, et al. Childhood maltreatment linked to greater symptom severity and poorer quality of life and function in social anxiety disorder. *Depression and anxiety*. 2009;26(11):1027-1032.
  59. Broeren S, Muris P, Diamantopoulou S, Baker JR. The course of childhood anxiety symptoms: Developmental trajectories and child-related factors in normal children. *Journal of abnormal child psychology*. 2013;41:81-95.
  60. Bögels SM, Brechman-Toussaint ML. Family issues in child anxiety: Attachment, family functioning, parental rearing and beliefs. *Clinical psychology review*. 2006;26(7):834-856.
  61. Geyer EC, Fua KC, Daniel KE, et al. I did OK, but did I like it? Using ecological momentary assessment to examine perceptions of social interactions associated with severity of social anxiety and depression. *Behavior therapy*. 2018;49(6):866-880.
  62. Lau SR, Beilby JM, Byrnes ML, Hennessey NW. Parenting styles and attachment in school-aged children who stutter. *Journal of communication disorders*. 2012;45(2):98-110.
  63. Poulos MG, Webster WG. Family history as a basis for subgrouping people who stutter. *Journal of Speech, Language, and Hearing Research*. 1991;34(1):5-10.
  64. Yairi E. The onset of stuttering in two-and three-year-old children: A preliminary report. *Journal of Speech and hearing Disorders*. 1983;48(2):171-177.

65. Starkweather CW. The epigenesis of stuttering. *Journal of fluency Disorders*. 2002;27(4):269-288.
66. Carleton RN, McCreary DR, Norton PJ, Asmundson GJ. Brief fear of negative evaluation scale—revised. *Depression and anxiety*. 2006;23(5):297-303.
67. Kraft SJ, Ambrose N, Chon H. Temperament and environmental contributions to stuttering severity in children: The role of effortful control. Thieme Medical Publishers; 2014:080-094.
68. Anderson JD, Pellowski MW, Conture EG, Kelly EM. Temperamental characteristics of young children who stutter. 2003;
69. Winton EC, Clark DM, Edelmann RJ. Social anxiety, fear of negative evaluation and the detection of negative emotion in others. *Behaviour research and therapy*. 1995;33(2):193-196.
70. Ganesh Kumar J, Athilakshmi R, Maharishi R, Maya R. Relationship between fear of negative evaluation and anxiety. *The International Journal of Indian Psychology*. 2015;3(1):74-80.
71. Rodebaugh TL, Weeks JW, Gordon EA, Langer JK, Heimberg RG. The longitudinal relationship between fear of positive evaluation and fear of negative evaluation. *Anxiety, Stress & Coping*. 2012;25(2):167-182.
72. Kocovski NL, Endler NS. Social anxiety, self-regulation, and fear of negative evaluation. *European Journal of Personality*. 2000;14(4):347-358.
73. Bernard R, Hofslundsengen H, Frazier Norbury C. Anxiety and depression symptoms in children and adolescents who stutter: A systematic review and meta-analysis. *Journal of Speech, Language, and Hearing Research*. 2022;65(2):624-644.
74. Lowe R, Helgadottir F, Menzies R, et al. Safety behaviors and stuttering. *Journal of Speech, Language, and Hearing Research*. 2017;60(5):1246-1253.
75. Menzies RG, Onslow M, Packman A, O'Brian S. Cognitive behavior therapy for adults who stutter: A tutorial for speech-language pathologists. *Journal of fluency disorders*. 2009;34(3):187-200.
76. St Clare T, Menzies RG, Onslow M, Packman A, Thompson R, Block S. Unhelpful thoughts and beliefs linked to social anxiety in stuttering: Development of a measure. *International Journal of Language & Communication Disorders*. 2009;44(3):338-351.
77. Iverach L, O'Brian S, Jones M, et al. Prevalence of anxiety disorders among adults seeking speech therapy for stuttering. *Journal of anxiety disorders*. 2009;23(7):928-934.
78. Lowe R, Guastella AJ, Chen NT, et al. Avoidance of eye gaze by adults who stutter. *Journal of fluency disorders*. 2012;37(4):263-274.
79. Brundage SB, Winters KL, Beilby JM. Fear of negative evaluation, trait anxiety, and judgment bias in adults who stutter. *American journal of speech-language pathology*. 2017;26(2):498-510.
80. Voncken MJ, Bögels SM, de Vries K. Interpretation and judgmental biases in social phobia. *Behaviour research and therapy*. 2003;41(12):1481-1488.
81. Jackson ES, Gerlach H, Rodgers NH, Zebrowski PM. My client knows that he's about to stutter: How can we address stuttering anticipation during therapy with young people who stutter? Thieme Medical Publishers; 2018:356-370.
82. Jackson ES, Tiede M, Beal D, Whalen DH. The impact of social-cognitive stress on speech variability, determinism, and stability in adults who do and do not stutter. *Journal of Speech, Language, and Hearing Research*. 2016;59(6):1295-1314.
83. Arenas RM, Zebrowski PM. The relationship between stuttering anticipation and verbal response time in adults who stutter. *Speech, Language and Hearing*. 2017;20(1):1-14.
84. Wells A, Clark DM, Salkovskis P, Ludgate J, Hackmann A, Gelder M. Social phobia: The role of in-situation safety behaviors in maintaining anxiety and negative beliefs. *Behavior Therapy*. 1995;26(1):153-161.
85. Hinrichsen H, Clark DM. Anticipatory processing in social anxiety: Two pilot studies. *Journal of behavior therapy and experimental*

- psychiatry. 2003;34(3-4):205-218.
86. Vassilopoulos SP. Anticipatory processing plays a role in maintaining social anxiety. *Anxiety, Stress, and Coping*. 2005;18(4):321-332.
87. Alm PA. Stuttering and the basal ganglia circuits: a critical review of possible relations. *Journal of communication disorders*. 2004;37(4):325-369.
88. Jackson ES, Yaruss JS, Quesal RW, Terranova V, Whalen DH. Responses of adults who stutter to the anticipation of stuttering. *Journal of fluency disorders*. 2015;45:38-51.
89. Jackson ES, Rodgers NH, Rodgers DB. An exploratory factor analysis of action responses to stuttering anticipation. *Journal of Fluency Disorders*. 2019;60:1-10.
90. Walsh B, Usler E. Physiological correlates of fluent and stuttered speech production in preschool children who stutter. *Journal of Speech, Language, and Hearing Research*. 2019;62(12):4309-4323.
91. Berntson GG, Cacioppo JT, Grossman P. Whither vagal tone. *Biological psychology*. 2007;74(2):295-300.
92. Berntson GG, Cacioppo JT, Quigley KS. Autonomic determinism: the modes of autonomic control, the doctrine of autonomic space, and the laws of autonomic constraint. *Psychological review*. 1991;98(4):459.
93. Porges SW. The polyvagal perspective. *Biological psychology*. 2007;74(2):116-143.
94. Bradley MM, Codispoti M, Cuthbert BN, Lang PJ. Emotion and motivation I: defensive and appetitive reactions in picture processing. *Emotion*. 2001;1(3):276.
95. Coan JA, Allen JJ. *Handbook of emotion elicitation and assessment*. Oxford university press; 2007.
96. Porges SW. Vagal tone: a physiologic marker of stress vulnerability. *Pediatrics*. 1992;90(3):498-504.
97. Friedman BH. An autonomic flexibility–neurovisceral integration model of anxiety and cardiac vagal tone. *Biological psychology*. 2007;74(2):185-199.
98. Thayer JF, Lane RD. A model of neurovisceral integration in emotion regulation and dysregulation. *Journal of affective disorders*. 2000;61(3):201-216.
99. Hagenars MA, van Minnen A. The effect of fear on paralinguistic aspects of speech in patients with panic disorder with agoraphobia. *Journal of Anxiety Disorders*. 2005;19(5):521-537.
100. Calkins SD. Cardiac vagal tone indices of temperamental reactivity and behavioral regulation in young children. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*. 1997;31(2):125-135.
101. Stifter CA, Fox NA. Infant reactivity: Physiological correlates of newborn and 5-month temperament. *Developmental psychology*. 1990;26(4):582.
102. Balzarotti S, Biassoni F, Colombo B, Ciceri MR. Cardiac vagal control as a marker of emotion regulation in healthy adults: A review. *Biological psychology*. 2017;130:54-66.
103. Mauss I, Wilhelm F, Gross J. Is there less to social anxiety than meets the eye? Emotion experience, expression, and bodily responding. *Cognition and emotion*. 2004;18(5):631-642.
104. Sulik MJ, Eisenberg N, Silva KM, Spinrad TL, Kupfer A. Respiratory sinus arrhythmia, shyness, and effortful control in preschool-age children. *Biological psychology*. 2013;92(2):241-248.
105. Sulik MJ, Eisenberg N, Spinrad TL, Silva KM. Associations between respiratory sinus arrhythmia (RSA) reactivity and effortful control in preschool-age children. *Developmental psychobiology*. 2015;57(5):596-606.
106. Pu J, Schmeichel BJ, Demaree HA. Cardiac vagal control predicts spontaneous regulation of negative emotional expression and subsequent cognitive performance. *Biological psychology*. 2010;84(3):531-540.
107. Balle M, Tortella-Feliu M, Bornas X. Distinguishing youths at risk for anxiety disorders from self-reported BIS sensitivity and its psychophysiological concomitants. *International Journal of Psychology*. 2013;48(5):964-977.

108. Geisler FC, Kubiak T. Heart rate variability predicts self-control in goal pursuit. *European Journal of Personality: Published for the European Association of Personality Psychology*. 2009;23(8):623-633.
109. Eisenberg N, Fabes RA, Shepard SA, et al. Contemporaneous and longitudinal prediction of children's social functioning from regulation and emotionality. *Child development*. 1997;68(4):642-664.
110. Volokhov RN, Demaree HA. Spontaneous emotion regulation to positive and negative stimuli. *Brain and cognition*. 2010;73(1):1-6.
111. Park G, Van Bavel JJ, Vasey MW, Thayer JF. Cardiac vagal tone predicts inhibited attention to fearful faces. *Emotion*. 2012;12(6):1292.
112. Park G, Vasey MW, Van Bavel JJ, Thayer JF. Cardiac vagal tone is correlated with selective attention to neutral distractors under load. *Psychophysiology*. 2013;50(4):398-406.
113. Park G, Vasey MW, Van Bavel JJ, Thayer JF. When tonic cardiac vagal tone predicts changes in phasic vagal tone: The role of fear and perceptual load. *Psychophysiology*. 2014;51(5):419-426.
114. Jönsson P. Respiratory sinus arrhythmia as a function of state anxiety in healthy individuals. *International journal of psychophysiology*. 2007;63(1):48-54.
115. Bowers A, Saltuklaroglu T, Kalinowski J. Autonomic arousal in adults who stutter prior to various reading tasks intended to elicit changes in stuttering frequency. *International Journal of Psychophysiology*. 2012;83(1):45-55.
116. Jones R, Choi D, Conture E, Walden T. Temperament, emotion, and childhood stuttering. Thieme Medical Publishers; 2014:114-131.
117. Zengin-Bolatkale H, Conture EG, Walden TA. Sympathetic arousal of young children who stutter during a stressful picture naming task. *Journal of fluency disorders*. 2015;46:24-40.
118. Zimmermann G. Stuttering: A disorder of movement. *Journal of Speech, Language, and Hearing Research*. 1980;23(1):122-136.
119. Dietrich S, Roaman MH. Physiologic arousal and predictions of anxiety by people who stutter. *Journal of Fluency Disorders*. 2001;26(3):207-225.
120. Brundage SB. Virtual reality augmentation for functional assessment and treatment of stuttering. *Topics in Language Disorders*. 2007;27(3):254-271.
121. Bauerly KR, Mefferd A. The effects of attentional focus on speech motor control in adults who stutter with and without social evaluative threat. *Journal of Fluency Disorders*. 2023;77:105995.
122. Weber CM, Smith A. Autonomic correlates of stuttering and speech assessed in a range of experimental tasks. *Journal of Speech, Language, and Hearing Research*. 1990;33(4):690-706.
123. Peters HF, Hulstijn W. Stuttering and anxiety: The difference between stutterers and nonstutterers in verbal apprehension and physiologic arousal during the anticipation of speech and non-speech tasks. *Journal of Fluency Disorders*. 1984;9(1):67-84.
124. Bauerly KR, Jones RM, Miller C. Effects of social stress on autonomic, behavioral, and acoustic parameters in adults who stutter. *Journal of Speech, Language, and Hearing Research*. 2019;62(7):2185-2202.
125. Bauerly KR. Attentional biases in adults who stutter before and following social threat induction. *Folia Phoniatrica et Logopaedica*. 2022;74(4):239-253.
126. Brundage SB, Brinton JM, Hancock AB. Utility of virtual reality environments to examine physiological reactivity and subjective distress in adults who stutter. *Journal of fluency disorders*. 2016;50:85-95.
127. Tumanova V, Woods C, Wang Q. Effects of physiological arousal on speech motor control and speech motor practice in preschool-age children who do and do not stutter. *Journal of Speech, Language, and Hearing Research*. 2020;63(10):3364-3379.
128. Bauerly KR, Jones RM. The impact of self-reported levels of anxiety on respiratory sinus

arrhythmia levels in adults who stutter. *Journal of Communication Disorders*. 2021;90:106084.

129. Spielberger CD, Gonzalez-Reigosa, F., Martinez-Urrutia, A.. The state-trait anxiety inventory. *Revista Interamericana de Psicología/Interamerican Journal of Psychology*. 1971;5

130. Dickerson SS. Emotional and physiological responses to social-evaluative threat. *Social and Personality Psychology Compass*. 2008;2(3):1362-1378.

131. Kemeny ME, Gruenewald TL, Dickerson SS. Shame as the emotional response to threat to the social self: Implications for behavior, physiology, and health. *Psychological inquiry*. 2004;15(2):153-160.

132. Bauerly KR, Bilardello C. Resting autonomic activity in adults who stutter and its association with self-reports of social anxiety. *Journal of fluency disorders*. 2021;70:105881.

133. Chen J, Short M, Kemps E. Interpretation bias in social anxiety: A systematic review and meta-analysis. *Journal of Affective Disorders*. 2020; 276:1119-1130.

134. Coombes SA, Higgins T, Gamble KM, Cauraugh JH, Janelle CM. Attentional control theory: Anxiety, emotion, and motor planning. *Journal of anxiety disorders*. 2009;23(8):1072-1079.

135. Gray J, McNaughton N. The neuropsychology of anxiety. *Crossref Google Scholar Article Locations: Article Location Article Location More AR articles citing this reference The Neurocognitive Bases of Human Volition Patrick Haggard*. 2003;1(2):3.

136. Dickerson SS, Gruenewald TL, Kemeny ME. When the social self is threatened: Shame, physiology, and health. *Journal of personality*. 2004;72(6):119 1-1216.

137. Lowe R, Menzies R, Packman A, O'Brian S, Jones M, Onslow M. Assessing attentional biases with stuttering. *International Journal of Language & Communication Disorders*. 2016;51(1):84-94.

138. Plexico L, Manning WH, DiLollo A. A phenomenological understanding of successful stuttering management. *Journal of fluency disorders*. 2005;30(1):1-22.

139. Lowe R, Menzies R, Onslow M, Packman A, O'Brian S. Speech and anxiety management with persistent stuttering: Current status and essential research. *Journal of Speech, Language, and Hearing Research*. 2021;64(1):59-74.

140. Rodgers NH, Lau JY, Zebrowski PM. Attentional bias among adolescents who stutter: Evidence for a vigilance–avoidance effect. *Journal of Speech, Language, and Hearing Research*. 2020;63(10):3349-3363.

141. Tran Y, Blumgart E, Craig A. Subjective distress associated with chronic stuttering. *Journal of fluency disorders*. 2011;36(1):17-26.

142. Beard C, Amir N. Interpretation in social anxiety: When meaning precedes ambiguity. *Cognitive therapy and research*. 2009;33:406-415.

143. Gutiérrez-García A, Calvo MG. Social anxiety and threat-related interpretation of dynamic facial expressions: sensitivity and response bias. *Personality and Individual Differences*. 2017;107: 10-16.

144. Campbell D, Sareen J, Stein M, et al. Happy but not so approachable: the social judgments of individuals with generalized social phobia. *Depression and Anxiety*. 2009;26(5):419-424.

145. Stopa L, Clark DM. Social phobia and interpretation of social events. *Behaviour research and therapy*. 2000;38(3):273-283.

146. Amir N, Beard C, Bower E. Interpretation bias and social anxiety. *Cognitive Therapy and Research*. 2005;29:433-443.

147. Scoth DE, Lioffi C. A systematic review of experimental paradigms for exploring biased interpretation of ambiguous information with emotional and neutral associations. *Frontiers in psychology*. 2017;8:244801.

148. Hirsch CR, Meeten F, Krahe C, Reeder C. Resolving ambiguity in emotional disorders: The nature and role of interpretation biases. *Annual review of clinical psychology*. 2016;12(1):281-305.

149. Buhlmann U, Wacker R, Dziobek I. Inferring other people's states of mind: Comparison across social anxiety, body dysmorphic, and obsessive–



- compulsive disorders. *Journal of Anxiety Disorders*. 2015;34:107-113.
150. Wenzel A, Lystad C. Interpretation biases in angry and anxious individuals. *Behaviour Research and Therapy*. 2005;43(8):1045-1054.
151. Kreifelts B, Brück C, Ethofer T, et al. Prefrontal mediation of emotion regulation in social anxiety disorder during laughter perception. *Neuropsychologia*. 2017;96:175-183.
152. Ritter J, Brück C, Jacob H, Wildgruber D, Kreifelts B. Laughter perception in social anxiety. *Journal of Psychiatric Research*. 2015;60:178-184.
153. Brundage SB, Hancock AB. Real enough: Using virtual public speaking environments to evoke feelings and behaviors targeted in stuttering assessment and treatment. *American Journal of Speech-Language Pathology*. 2015;24(2):139-149.
154. Rodgers NH, Lau JY, Zebrowski PM. Examining the effects of stuttering and social anxiety on interpretations of ambiguous social scenarios among adolescents. *Journal of communication disorders*. 2022;95:106179.
155. Sisskin V. Avoidance reduction therapy for stuttering (ARTs). *More than fluency: The social, emotional, and cognitive dimensions of stuttering*. 2018;157:186.
156. Menzies RG, O'Brian S, Onslow M, Packman A, St Clare T, Block S. An experimental clinical trial of a cognitive-behavior therapy package for chronic stuttering. 2008;
157. Beilby JM, Yaruss JS. Acceptance and commitment therapy for stuttering disorders. *More than fluency: The social, emotional, and cognitive dimensions of stuttering*. 2018;111:129.
158. Amster BJ, Klein ER. *More than fluency: The social, emotional, and cognitive dimensions of stuttering*. vol 1. Plural Publishing; 2018.
159. Cheasman C, Everard R, Simpson S. *Stammering therapy from the Inside*. J & R Press Limited; 2013.