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# Relationships between public attitudes toward stuttering and autonomic and subjective indices of anxiety

## Relacje między postawami wobec jąkania a autonomicznymi i subiektywnymi wskaźnikami lęku

**Abstract**

**Introduction**: Research has shown that adults who stutter have reacted with increased skin conductance and lower heart rates when confronted with videos of severe stuttering compared to videos of fluent speech. It has not been clearly established how these physiological indices or autonomic arousals are related to stuttering attitudes. The current study sought to compare physiological and psychometric measures of anxiety with stuttering attitudes.

**Method**: In a multiple-baseline design, 18 normal hearing university students listened to short samples of stuttered, masked, and normally fluent speech while their skin conductance and heart rate variability were being monitored by an Empatica E4 wristband device. Pre-experimentally and after each speech condition, they rated their comfort level on a 1–9 scale. Participants filled out the *State-Trait Anxiety Inventory* (*STAI*) (Spielberger, 1977) prior to the physiological measures and the short state anxiety inventory afterwards. At the end, they filled out the *Public Opinion Survey of Human Attributes–Stuttering* (*POSHA–S*).

**Results**: No significant main effects were observed for either autonomic measure for the three speech conditions, but interactions were significant. Individual participant analysis revealed that every respondent reacted differently to the skin conductance or heart rate variability. By contrast, mean subjective comfort ratings were more often lower after hearing stuttered or masked speech and higher after hearing fluent speech. Correlations between all the measures and the *POSHA–S* summary scores revealed little relationship between the autonomic measures and stuttering attitudes, but higher levels of state or trait anxiety were associated with more positive beliefs about people who stutter. In contrast, lower levels of anxiety tended to be associated with more positive self-reactions to those who stutter.

**Conclusion**: This study did not replicate previous reports of heightened autonomic reactions to stuttering among nonstuttering adults, although psychometric measures suggest a relationship between anxiety and stuttering attitudes. Further research should explore these relationships, especially with young children.

**Key words**: stuttering attitudes; anxiety; autonomic measures; psychometric measures; *POSHA–S*

**Abstrakt**

**Wprowadzenie**: Badania wykazały, że dorosłe osoby jąkające się zareagowały podwyższeniem przewodnictwa skóry i obniżeniem tętna podczas nagrań filmów prezentujących silne jąkanie w porównaniu z filmami z płynną mową. Nie ustalono jednoznacznie, w jaki sposób te wskaźniki fizjologiczne lub pobudzenia autonomiczne są powiązane z postawami wobec jąkania. Obecne badanie miało na celu porównanie fizjologicznych i psychometrycznych miar lęku z postawami wobec jąkania.

**Metoda**: W badaniu eksperymentalnym, z wykorzystaniem pomiaru kilku poziomów wyjściowych, 18 normalnie słyszących studentów słuchało krótkich próbek mowy jąkającej się, zamaskowanej i mowy normatywnie płynnej, ich przewodnictwo w skórze i zmienność rytmu serca były wtedy monitorowane przez urządzenie zamocowane na nadgarstku (typ Empatica E4). Uczestnicy oceniali przed eksperymentem oraz po każdym nagraniu (mowy z jąkaniem i płynnej) swój poziom komfortu w skali od 1 do 9. Przed pomiarami fizjologicznymi uczestnicy wypełnili *Inwentarz Stanu i Cechy Lęku* (STAI) (Spielberger, 1977), a następnie krótki inwentarz lęku stanowego. Na koniec wypełnili *Ankietę Opinii Publicznej o Ludzkich Atrybutach – Jąkanie* (POSHA–S).

**Wyniki**: Nie zaobserwowano żadnych znaczących głównych efektów dla żadnej miary autonomicznej dla trzech stanów mowy, ale interakcje były znaczące. Indywidualna analiza uczestników wykazała, że każdy respondent inaczej reagował na przewodnictwo skóry czy zmienność rytmu serca. Natomiast średnie oceny komfortu subiektywnego były częściej niższe po usłyszeniu mowy z jąkaniem lub zamaskowanej, a wyższe po usłyszeniu mowy płynnej. Korelacje między wszystkimi pomiarami a wynikami sumarycznymi POSHA–S ujawniły niewielki związek między miarami autonomicznymi a postawami wobec jąkania, ale wyższy poziom lęku jako stanu lub cechy wiązał się z bardziej pozytywnymi przekonaniami na temat osób jąkających się. W przeciwieństwie do tego, niższy poziom lęku wiązał się z bardziej pozytywnymi reakcjami własnymi u osób jąkających się.

**Wnioski**: Badanie to nie potwierdziło wcześniejszych doniesień o nasilonych autonomicznych reakcjach na jąkanie wśród niejąkających się osób dorosłych, chociaż pomiary psychometryczne sugerują związek między lękiem a postawami wobec jąkania. Dalsze badania powinny eksplorować te relacje, zwłaszcza u małych dzieci.

**Słowa klucze**: postawy wobec jąkania, lęk, pomiary autonomiczne, pomiary psychometryczne, *POSHA–S*

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## 1. Introduction

### 1.1. Attitudes

Despite the lack of universal agreement, one of the more widely accepted conceptions of "attitudes" holds that there are affective (emotional), behavioral, and cognitive components, or ABCs (Alport, 1954). Attitudes have been measured in numerous ways, but two that are well known are implicit and explicit (Bohner & Dickel, 2011). Implicit attitudes focus on emotional and cognitive domains that often operate under the radar of one's awareness while explicit attitudes can comprise all three components (affective, behavioral, and cognitive) and are typically ascertained through thoughtful self-report.

A large body of research deals with public attitudes toward stuttering, primarily measured as explicit beliefs or reactions, with the overarching goal of ameliorating negative attitudes such that the "attitude environments" in which those who stutter grow up and live are maximally supportive and empathetic (St. Louis, 2015). This research has explored myriad factors that affect, or are related to, negative public attitudes, such as demographic, geographic, linguistic, and other variables (Hughes, 2015).

Unquestionably, the cognitive component of attitudes toward stuttering has received the most research attention. The most widely used instruments have been lists of bipolar adjectives, also known as semantic differential scales, regarding personality or other characteristics of stuttering persons (e.g., aggressive—submissive) (Woods & Williams, 1976) or questions about the nature of stuttering or what a person who stutters might think, feel, or do (e.g., "People who stutter are shy and reserved", "Stuttering is caused by psychological problems", or "People who stutter should not seek work that requires speaking to the public") (St. Louis, 2011).

Considerable—but less—emphasis has been placed on measuring the emotional aspects of the nonstuttering individuals whose attitudes were being measured. Examples of questions about how one feels when talking with a stuttering person would include "If I were talking to a person who stutters, I would feel comfortable" or "I would be worried or concerned if my neighbor stuttered" (St. Louis, 2011).

No doubt, the least emphasis has been on the behavioral component of stuttering attitudes. Ratings about what one would actually do when confronting stuttering would include such items as "If I were talking with a person who stutters, I would tell the person to »Slow down«" (St. Louis, 2011).

### 1.2. Measuring emotion in stuttering

Investigations of emotions in general have utilized subjective, physiological, and behavioral methods. Subjective data collection can obviously be from verbal self-report but typically involves paper-and-pencil assessment tools from which participants' feelings to various stimuli are inferred. One widely used instrument is the *State-Trait Anxiety Inventory* (*STAI*), which measures both "state" (currently felt) and "trait" (habitually felt) anxiety (Spielberger, 1977). In addition to subjective response evaluation, physiological, and neuroimaging methods measure participants' emotional processes via autonomic nervous system activation and brain states. Examples include electrodermal, cardiovascular, and pupillary response measures (Mauss & Robinson, 2009).

It is widely known that emotional responses such as anxiety, fear, anger, and disgust increase physiological arousal, which is modulated by the autonomic nervous system (Kreibig, 2010; Levenson, 1992; Sinha, Lovallo, & Parsons, 1992). The autonomic nervous system is divided into the sympathetic and parasympathetic components. These antagonistic subsystems mediate both electrodermal activity and heart rate variability. Autonomic markers such as skin conductance, heart rate, and blood pressure are considered objective indicators of emotional processes (Boucsein, 2012).

Aberrant patterns of speech fluency in stuttering have been reported to elicit negative emotional responses and negative attitudes in fluent listeners toward stuttering (Guntupalli, Everhart, Kalinowski, Nanjundeswaran, & Saltuklaroglu, 2007; Walden & Lesner, 2018). Such emotional reactions in the nonstuttering population could be the genesis of negative attitudes that, in turn, can affect peers who stutter in terms of their self-images, social relationships, academic and/or vocational careers, and their psychological states (Blumgart, Tran & Craig, 2010; Plexico, Hamilton, Hawkins, & Erath, 2019; Tran, Blumgart, & Craig, 2011).

A series of studies have shown that when fluent speakers were exposed to video clips of stuttering versus video clips of fluent speakers, their skin conductance levels were significantly elevated, and their heart rates were lowered (Guntupalli, Kalinowski, Nanjundeswaran, Saltuklaroglu, & Everhart, 2006; Guntupalli et al., 2007; Guntupalli, Nanjundeswaran, Dayalu, & Kalinowski, 2012; Zhang, Kalinowski, Saltuklaroglu, & Hudock, 2010). As well as collecting physiological data, these researchers obtained subjective behavioral responses via self-assessment scales. The results showed that participants exposed to video clips of stuttering generally rated their feelings as highly aroused and negatively valent.

Most of these studies on attitudes toward stuttering are based on watching videos of stuttered speech. Some studies, however, have presented listeners with audio recorded speech samples with stuttering and evaluated listeners' attitudes only with self-report scales (e.g., Allard & Williams, 2008; Amick, Chang, Wade & McAuley, 2017).

## 2. What are the origins of public attitudes toward stuttering?

In contrast to what stuttering attitudes consist of in terms of their ABCs, relatively little research emphasis has been directed to understanding where these attitudes come from in the first place. How, for example, does a mentally stable person with a healthy personality come to believe that stuttering is due to a psychological problem? Why do most people conclude that stuttering would likely be unacceptable, or at least an unnecessary burden, in such professions as teaching or arguing cases in front of a jury? Implicit attitudes might uncover a few of these reasons (Walden & Lesner, 2018), but most likely would not elucidate exactly where they came from.

### 2.1. Listener role when the speaker does not communicate as expected

To address the issue of the origin of negative attitudes toward stuttering, it is instructive to consider the acts of normal speaking and listening in what speech scientists (Denes & Pinson, 1963) many years ago termed the "speech chain". In any natural language, detailed rules govern the expected phonological, syntactic, semantic, and pragmatic nature of what is spoken both for the speaker and for the listener. When something goes awry in any of those processes, the speech chain is broken or compromised. And when that happens as a conversation partner is listening to another person speaking, the listener will proceed through a partly conscious and partly unconscious thought process about what went wrong. With a misarticulation of one phoneme, such as /r/, most listeners will quickly conclude that the speaker probably cannot produce that sound, and then proceed to make the appropriate adjustments in their own phonological encoding in order not to misunderstand the speaker.

With stuttering, the weak link in the speech chain can be minor, as in a speaker producing a few more than expected sound or syllable repetitions. And for some listeners, this might not be perceived as a problem at all. However, when the speaker produces long sound or syllable repetitions, tense prolongations or complete blocks (stoppages), accompanied by auditory evidence of tension and struggle, and even visual aspects of facial grimaces or atypical body movements, the listener is obliged to make dramatic adjustments in the decoding of the intended message. In the process, it is almost inevitable that listener hypotheses are generated to explain this highly atypical speaking pattern and that emotions emerge that are unrelated to the speaker's intended message. One of the thoughts that nearly always comes to the listener's mind is that of not knowing how to react to a speaker's atypical speech. Simultaneously, it is reasonable to assume that the listener would feel discomfort or a number of related emotions, such as anxiety, frustration, annoyance, helplessness, or even disgust (Panico, Healey, Brower, & Susca, 2005; Park, Schaller, & Crandall, 2007; van Leeuwen, Hunt, & Park, 2015). These emotions would result from an activation of the sympathetic branch of the autonomic nervous system that "kicks in" for "fight, flight, or freeze" reactions.

In fact, the overwhelming majority of nonstuttering people do not react overtly and strongly when confronted with most instances of stuttering. Presumably, they have learned to temper their reactions and typically use the hypotheses they may have generated or adopted from others to "explain" the stuttering in their minds. They may look surprised or make a non-humorous smile and then wait anxiously while the speaker works his way through a stuttered message, trying to appear as unconcerned as possible. But subtle, presumably unconscious, changes do occur in listeners' behavior when confronted with stuttered speech. Bowers, Crawcour, Saltuklaroglu, & Kalinowski (2010) documented that listeners' eyes were more likely to fixate on a fluent speaker's eyes when fluent, but more likely to avert to the same speaker's nose when he stuttered. White and Collins (1984) advanced the notion that nonstuttering people default to those few times when they, themselves, were "stuttering", usually when nervous, and thereby assume that people who stutter are always nervous. Extending this argument, MacKinnon, Hall, and Macintyre (2007) advanced the "anchoring-adjustment" hypothesis for formation of the stuttering stereotype, that is, the view that those who stutter are regarded as nervous, shy, introverted, and so on. People anchor their stereotypes first in their own experiences but then adjust them based on what they know or learn about the targets of their stereotypes later.

### 2.2. Development of stuttering attitudes in children

Until recently, it was assumed that young children would not have negative reactions to stuttering but would learn these negative reactions from parents or older children. That turned out *not* to be the case in explicit attitude measures. Weidner, St. Louis, Burgess, and LeMasters (2015) found that preschoolers had more negative attitudes toward stuttering than did kindergarten children. The preschoolers' only experience with stuttering prior to an orally administered instrument was a 1.5 min cartoon video featuring two children stuttering as they talked about neutral topics. After responding to the questionnaire, none of the preschoolers were able to give any semblance of a description or definition of stuttering (St. Louis et al., 2018). The results for American preschoolers were replicated in remarkably similar ratings by Turkish preschoolers in their language (Weidner, St. Louis, Nakıscı, & Özdemir, 2017). Further, kindergarten through fifth or sixth grade children from the US, and later from Bosnia and Herzegovina, showed a pattern of increasingly more positive attitudes as they got older (Glover, St. Louis & Weidner, 2019; Weidner, Junuzović-Žunić, & St. Louis, 2020). Their parents' attitudes were stable in both studies, and the parents' level of positivity was only approached by the oldest children in the fifth or sixth grades. These results were consistent with an earlier study in Turkey that showed sixth graders' stuttering attitudes to be nearly identical to the attitudes of their parents, grandparents, and neighbors (Özdemir, St. Louis, & Topbaş, 2011). If unconscious, sympathetic autonomic reactions to the stuttering video had occurred in the Weidner et al. (2015), Weidner et al. (2017), Glover et al. (2019, and Weidner et al. (2020) studies, we assume that they would have occurred most dramatically in the youngest children, given that their stuttering attitudes were the most negative.

## 3. Issues in measurement of public attitudes

The current study sought to further clarify the relationship between measured attitudes toward stuttering and emotions or autonomic responses elicited by actual stuttering. In the process, it would be an attempt to replicate the findings of Guntupalli et al. (2006, 2007, 2012) of autonomic arousal in response to stuttered speech in adults. Before proceeding to the purpose and methodology, the important issue of variability must be considered.

Clearly, stuttering can be highly variable, as can individuals who stutter (Tichenor & Yaruss, 2021; Van Riper, 1971). Similarly, it has been shown that attitudes toward stuttering can be highly variable (Hughes, 2015; St. Louis, 2015). Some of the sources of variability in the public's attitudes toward stuttering are relevant to this study. One's experience with stuttering would almost certainly be related to one or more unique individuals who stutter with whom one has interacted. Those could be siblings, parents, relatives, close friends, acquaintances, or strangers. Each stuttering individual would make a specific impression on the person that would affect their attitude (St. Louis, Kuhn, & Lytwak, 2015). If the public is to rate their ABCs of stuttering attitudes without—or even to some extent with—prior exposure to a stuttering individual, what they know and do not know about stuttering will no doubt come into play. If a definition or description of stuttering were given beforehand, respondents' attitudes could also be affected positively or negatively. If nonstuttering people are exposed to an actual model of stuttering (video, audio, or actual person), the speaker's stuttering symptoms and severity would likely affect group or individual attitudes. This would very likely be the case if the exemplar of stuttering was associated with accessory or secondary behaviors such as jaw tightening, head nodding, or facial grimaces. It is reasonable to further assume that viewing and listening to the speech of a person with such accessory behaviors might evoke greater emotional arousal than if listeners were exposed to the auditory stuttering symptoms only. Additionally, a stuttering speaker's accent, language content, vocal pitch and loudness, articulation, accent, prosody, and facial expressions could also affect a listener's stuttering attitudes, as could the speaker's gender, race, or cultural familiarity. And, finally, if attitudes were to be compared across different languages, all the differences inherent in different linguistic styles and perhaps even word order could be sources of variability.

Research methods have dealt with such variability in different ways. For a generation, nearly all investigators of stuttering attitudes have subjected group samples to inferential statistical analysis of quantitative results with the purpose of generalizing to various groups making up the general public. In all of these studies, measures such as standard deviations are taken as indices of variability and accounted for by conventional limits that determine statistical significance. An almost universally accepted assumption in these studies is that in the face of individual participant variability, even wide variability, the preponderance of participants will respond or react similarly enough to justify mean values as being regarded as valid indices of group trends (Babbie, 2021).

In contrast, a small but growing number of investigations have employed qualitative methods to understand a few individuals rather than a population. Using guided interviews, investigators have sought to bore down further into individual reactions to stuttering in order to root out some of the sources of variability that would not be apparent in group studies (e.g., Babbie, 2021; Hughes & Strugalla, 2015; Panico et al., 2005).

Another infrequently used approach currently is the so-called single-subject research method, derived from behavioral research that was often guided by operant procedures to change behaviors (Skinner, 1957). It typically employs only a few participants but uses a longitudinal strategy of multiple baselines and treatments (e.g., St. Louis & Martin, 1978). In pure single-subject research, like qualitative research, the intent is not to generalize to a population but to describe and document in detail how individuals may similarly or differently respond to the same experimental conditions. We submit, however, if a sufficient number of participants is included, and if the experimental conditions are presented systematically, multiple baseline data can be analyzed not only in terms of individual responses to a variety of experimental conditions, but also as group quantitative data. Such a strategy was utilized in the current study.

## 4. Purpose

The purpose of this investigation was to determine the relationship between public attitudes toward stuttering and anxiety, considering both one's subjective anxiety levels and one's autonomic arousal resulting from exposure to severe stuttering. Two research questions guided the design, data analysis, and organization of results: (a) As a group and as individuals, to what extent do young adults react autonomically and cognitively to stuttered speech as compared to difficult-to-understand and normal speech? (b) As a group and as individuals, how and to what degree are young adults' self-reported levels of anxiety and cognitive ratings of comfort related to their measured attitudes toward stuttering?

## 5. Method

### 5.1. Participants

University students served as participants. In addition to being available for testing in a lab at a mid-Atlantic American university, students would represent the population of young adults who would most likely influence young children who stutter in the future. Additionally, college students are free to select their own social media; thus, to the extent that they may have been influenced by recently posted or circulated accounts or stories of stuttering, it is likely that their attitudes would reflect the most recent—and potentially dynamic—public perceptions of stuttering.

### 5.2. Experimental design

#### 5.2.1. Attitudes toward stuttering

The *Public Opinion Survey of Human Attributes–Stuttering* (*POSHA–S*) (St. Louis, 2011, 2012, 2015), a standardized self-report instrument, was chosen to measure their beliefs and self reactions to stuttering. A database taken from more than 16,000 individuals from 47 countries and administered in 28 languages permits comparison to "average" attitudes around the world. It should be noted that, in its standard use, neither the disorder of "stuttering" nor the other "anchor attributes" (i.e., obesity, mental illness, left handedness, and intelligence) are defined for *POSHA–S* participants.

Thus, in most previous research, the *POSHA–S* has been administered to naïve respondents in the sense that they are given no a priori information about, or perspectives related to, stuttering (St. Louis, 2015). In this study, however, it was necessary to administer this instrument at the end of the experiment because its introduction at the beginning could affect subjective and autonomic measures of anxiety. Therefore, if, as Guntupalli et al. (2006, 2007, 2012), Zhang et al. (2010), and others have concluded, exposure to stuttering is related to heightened autonomic arousal, it would be plausible to expect that stuttering attitudes could be less positive than would be the case with naïve respondents.

### 5.2.2. Psychometric self-report measures of anxiety

The widely used *State-Trait Anxiety Invent*ory (*STAI*) (Spielberger, 1977) was chosen as a standardized measure because it permits estimates of one's general level of anxiety (trait anxiety) as well as one's momentary level (state anxiety). Participants filled out the long forms (20 items each) for both state and trait anxiety at the beginning of the experiment. About midway through the experiment, we decided to modify the protocol slightly to add the *STAI* short form to look at state anxiety (10 items) as the last measure taken for participants in order to estimate whether the entire experiment changed participants' state anxiety.

Additionally, we needed a measure that could be obtained easily and repeatedly in just a few seconds several times during the experiment. We asked participants to report their "level of comfort" on a 1–9 scale, with 1 indicating "very uncomfortable" and 9 indicating "very comfortable". We assumed that the "comfort" would roughly parallel the inverse of their subjective anxiety level.

### 5.3. Experimental measures and stimuli

The autonomic reactivity aspect of the study involved listening to three speaking conditions: stuttered, masked, and normal, each preceded by an identical baseline. As further summarized below, the experimental design was informed by the following constraints or guidelines. First, we sought a technology that could be used with a wide age range, including children. Second, we sought stimuli to minimize the confounding inherent in using different speakers with different physical characteristics by using only one speaker for all three conditions. Third, since we wanted to imply that listeners were listening to three different speakers, we utilized a recorded audio signal only and showed a slightly different computerized image of a face with a neutral emotional expression for each. Fourth, we sought to minimize experiment-induced uncertainty and discomfort during baseline measures. Fifth, we wanted participants to hear stuttering so severe that none could reasonably be expected not to notice it.

### 5.3.1. Physiological instrumentation

As noted, procedures were fashioned to be robust enough to be utilized later with a wide age range, including young children. Accordingly, rather than use conventional psychophysiological experimental instrumentation that was bulky and fixed in place, as used in most previous autonomic physiological research studies, we determined that the recording device should be unobtrusive and permit a modest range of movement to participants. The Empatica E4 Wristband (E4) (Empatica, 2018) was used to record participants' electrodermal skin conductance in microsiemens (identified in the E4 and in this report as EDR) and heart rate variability or variation in inter-beat intervals in seconds (referred to in the E4 and herein as IBI). Resembling a large watch or wrist-worn step counter, the E4 operates with a rechargeable battery and Bluetooth transmission of data to a computer with no wires or electrodes on the hands, the ear, or the chest.

#### 5.3.2. Speech stimuli

Three approximately 30-sec speech samples were recorded in a sound-treated booth. The content of these samples—all produced by the same male speaker (first author)—were similar but not identical. The content was very simple, that is, a few simple sentences about the speaker and his family, which would be completely understandable to all ages (See Appendix A). The speaker was a mostly recovered stutterer, with years of experience producing voluntary stuttering. He spoke fluently for two conditions and faked very severe stuttering in a third condition. One of the two fluent samples was mixed with "20-talker babble" or speech noise at a –5 signal-to-noise ratio such that five communication sciences and disorders students rated it from 2%–80% intelligible or understandable (mean = 32%). As with the stuttered sample, the other fluent sample was free of noise and was uniformly rated as 100% intelligible. After being recorded digitally into Adobe Audition using a 44.1 kHz sampling frequency and 16-bit resolution recorder, all samples were RMS equalized for intensity in MATLAB.

The aforementioned research of Guntupalli et al. and Zhang et al. utilized videos from different stuttering speakers. They did control for visual aspects of stuttering or visual characteristics of various speakers, which, according to Richardson et al. (2020), can affect electrodermal reactivity in some people. Relatedly, implicit attitudes of race, for example, cannot be voluntarily inhibited (Project Implicit Social Attitudes, 2021). Our intention was to control as much as possible for these and other potentially confounding variables.

Many previous studies have asked respondents to look at a large plus sign during baselines while being recorded for electrophysiological responses, sometimes for up to five minutes (e.g., Braithewaite, Watson, Jones, & Rowe, 2015). We reasoned that some respondents would become anxious simply wondering how long they would need to sit and watch such a plus sign, especially those most uncomfortable with silence. Adopting the idea of moving bars showing time elapsed and time remaining in computer downloads, we provided a bar, which respondents could watch, that filled progressively from left to right in increments across the screen for each baseline.

Our three speech samples were recorded to represent three different speaking situations and/or different environments, with the implication that each would be a different speaker. Accordingly, we used the Avatar Maker program (https://avatarmaker.net) to select three unique—but similar—computer-generated male faces with neutral emotional expressions to represent the "three speakers". They were chosen to show medium brown to almost black hair and a complexion almost equidistant from a clearly Caucasian or a clearly African-American face in order that a distinctive race would be minimized as much as possible. We reasoned that slightly different faces would highlight the fact that, even though older participants might well recognize that the same voice produced the speech samples, they were to be rated as different speakers and/or different environments.

A Latin Square strategy was utilized to generate nine different PowerPoint presentations to be shown to participants with equally counterbalanced orders of presentations of the three audio samples (masked, stuttered, and fluent) and the three different faces. The nine were assigned in order of participant testing. The Latin Square design permitted data analysis for equivalent tokens, not only for the three conditions (stuttered, masked, and fluent) but also for the order of each of these in the sequence (first, second, or third order).

### 5.3.3. Experimental sequence

Each participant was run individually through the following protocol. Prior to participants' arrival, earphones of a portable audiometer and the E4 were cleaned and disinfected. PowerPoint slides were loaded on a Macintosh desktop computer and questionnaires and paperwork were readied. Upon arrival, the experimenter(s) first screened participants' hearing, left and right ears, at 500, 1000, 2000, 3000, and 4000 Hz at 25 dB HL. Anyone failing the screening would have been dismissed immediately, but this did not occur.

Each subject was read an overview of what would occur during the approximately half-hour experimental session. Any questions were answered before participants were asked to sign a consent form approved by the Institutional Review Board at West Virginia University (No. 1702445283R001). Next, they were asked to fill out the *STAI* and a questionnaire (see Appendix B). Following that, they were told to go to a nearby bathroom, to use the restroom if needed or to get a drink of water if desired. They were instructed to then wash their hands and wrists with water only, without soap, and dry them thoroughly. Upon returning to the lab, the experimenter then fitted the E4 wristband on the participant's non-dominant wrist (previously recorded on the questionnaire) and then helped them place the hand on a soft towel placed on the desk in front of the computer screen comfortably such that it would not likely be moved for about 10 minutes.

Participants were then asked to rate their level of comfort by saying a number from "one" to "nine". Headphones were then placed over the participants' ears and adjusted until they stated that they were satisfied that the headphones would not need to be touched or adjusted for the duration of the experiment. The experimenter(s) instructed participants not to move or talk except to report their level of comfort a few times when asked and shown a 1–9 scale on the screen. At that point, a pre-experimental self-rating for comfort occurred.

Next, the experimenter turned on the E4 and asked each participant to sit quietly during the first of three baseline periods and watch the computer screen for two minutes while a colored bar moved every 15 seconds from left to right across the screen to let them know the time elapsed and remaining. At the end of two minutes, the first face appeared on the computer screen and the first audio speech sample began. After it was finished in about 30 seconds, a comfort rating scale appeared, and the experimenter asked participants to verbally rate their comfort level on the 1–9 scale. This was followed by a second two-minute baseline, then the second face and second audio sample. After another comfort level rating, the sequence was repeated a third time with the third face and third audio sample, which was then followed by the final comfort level rating.

At this point, the E4 was turned off and the earphones were removed. Lastly, all participants filled out the *POSHA–S*, but eight of them were first asked to fill out the short form of the state portion of the *STAI.* Upon completion of the questionnaire(s), participants were dismissed.

### 5.3.4. Data analyses

The *POSHA–S* was analyzed in the standard way (St. Louis, 2015). In addition to demographic items, 45 items were averaged into 11 components, and those components further averaged into three subscores, and the two stuttering-related subscores (Beliefs and Self Reactions) were averaged into an Overall Stuttering Score (OSS). All of these 60 ratings were then compared to the *POSHA–S* database of more than 16,000 respondents from nearly 50 countries around the world in terms of percentiles of mean ratings of our respondents compared to the mean ratings of the nearly 200 samples from previous investigations.

The *STAI* ratings were analyzed in terms of means for both state and trait anxiety. These were compared to norms available for college students in the *STAI* manual.

For the first research question, we identified the beginning of each E4 Wristband recording from the Unix time stamp on the datafile and the actual time recorded by the experimenter on her smartphone. From those, we determined each successive baseline and speaking condition, again by identifying beginning times recorded by the experimenter. Using SPSS software, we ran ANOVAs for main effects and interactions for the three conditions (masked, stuttered, and normal) as well as for the three counterbalanced orders of the three conditions (first, second, and third). These were carried out for EDR and for IBI in order to compare (a) changes from baseline and (b) differences among the three speaking conditions. Additionally, means for each condition were calculated and graphed in terms of consecutive autonomic measures and then separated by condition. In the consecutive graphs, if a progressively decreasing pattern or increasing pattern of means occurred, or if all means were the same, rather than showing reversals in the profile presumably occasioned by alternating baselines and conditions as sought in single-subject research methodology, then the individual analyses for conditions were not carried out. In such cases, we would assume that it was some extraneous variable, such as progressive habituation throughout the experiment, that was responsible for the changes in autonomic reactivity rather than the masked, stuttered, and normal speech, or the resting baseline periods in between.

Comfort level ratings were simply averaged across conditions for four occasions: before the autonomic recording and then after each of the three speaking conditions. Pre-experimental *STAI* trait and state raw scores were determined for each respondent and averaged for all participants. Post short-form *STAI* state questionnaire results were compared with the pre-full form *STAI* trait results. Similarly, the standard summary measures of the *POSHA–S* were determined for each participant as well as for the group. Those included components and subscores as follows: Obesity/Mental Illness subscore, Beliefs subscore and its four components (Traits/Personality, Help From, Cause, and Potential), Self Reactions subscore and its four components (Accommodating/Helping, Social Distance/Sympathy, Knowledge/Experience, and Knowledge Source), and Overall Stuttering Score (mean of the Beliefs and Self Reactions subscores).

We generated multiple baseline graphs for each participant. We also ran Pearson correlation coefficients between all pairs of individual participant means among the autonomic, comfort, *STAI*, and *POSHA–S* ratings.

Overall, we predicted for both group data and for individual data that masked and stuttered speech would be associated with increased autonomic reactivity and also with less comfort (more discomfort) compared to baseline conditions. We were uncertain whether stuttering or masked speech would generate greater reactivity or discomfort, but we hypothesized that arousal and subjective discomfort would be greater than for baseline or normal speech.

## 6. Results

### 6.1. Participants

Eighteen university students served as participants. None of them majored in communication sciences and disorders or had taken clinical courses in the major. All had normal screened hearing levels. Thirteen were undergraduates; five were graduate students. Their ages ranged from 19.4 yr to 27.7 yr, with a mean age of 22.1 yr. Eight (44%) were male; 10 (56%) were female. None were or had been married or were parents. None reported stuttering, mental illness, or left handedness. One (6%) reported being obese, and four (22%) reported being intelligent. Additional information about participants is provided in Appendix B.

### 6.2. Group data

#### 6.2.1. Public attitudes toward stuttering

Table 1 shows the mean ratings for the components, subscores, and OSS for the 18 participants along with the percentiles relative to the median of the mean sample ratings for 208 previous *POSHA–S* samples. The mean *OSS* of +26 was well above the worldwide sample average of +20 (75$^{th}$ percentile) even after being exposed to severe stuttering. Beliefs were about average at +35 (47$^{th}$ percentile), but Self Reactions at +17 were much more positive than average (91$^{st}$ percentile). The Obesity/Mental Illness of –32 was also about average (51$^{st}$ percentile). Of all the 60 individual and combined ratings, 52% were in the interquartile range (25$^{th}$–75$^{th}$ percentile), 17% were in the first quartile (0–25$^{th}$ percentile), and 32% in the fourth quartile (75$^{th}$–100$^{th}$ percentile). Summary *POSHA–S* ratings are shown in Figure 1 relative to the highest, lowest, and median sample mean values in the database.

Table 1
*Mean POSHA–S summary scores of the 18 participants in comparison to the 208 samples in the POSHA–S database in terms of percentiles.*

| *POSHA–S* Rating | Mean Value (–100 to +100) | Percentile |
|---|---|---|
| ***Overall Stuttering Score*** | ***+26*** | ***75th percentile*** |
| **Beliefs about People Who Stutter** | **+35** | **47th percentile** |
| Traits/Personality | +9 | 30th percentile |
| Help From | +6 | 64th percentile |
| Cause | +34 | 46th percentile |
| Potential | +72 | 62nd percentile |
| **Self Reactions to People Who Stutter** | **+17** | **91st percentile** |
| Helping/Accommodating | +69 | 92nd percentile |
| Distance/Sympathy | +24 | 60th percentile |
| Knowledge/Experience | –29 | 59th percentile |
| Knowledge Source | +7 | 73rd percentile |
| **Obesity/Mental Illness** | **–32** | **51st percentile** |
| Impression | –4 | 71st percentile |
| Want/Have | –93 | 8th percentile |
| Amount Known | +1 | 68th percentile |

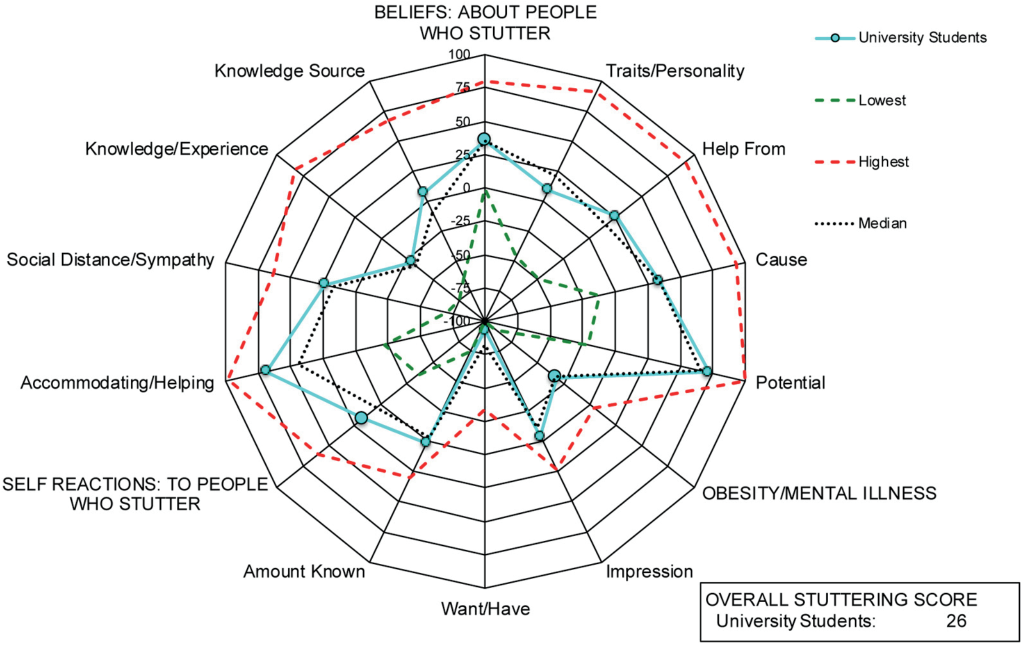



*Figure 1.* Radial graph showing *POSHA–S* summary scores (Overall Stuttering Scores, subscores, and components) in relation to the lowest, highest, and median of sample means in the *POSHA–S* database.

### 6.2.2. Self-report of anxiety

The mean of *STAI* state anxiety raw scores was 28.1, and the mean of *STAI* trait anxiety raw scores was 32.1. Our participants had lower anxiety scores than the means in the normative sample for college students as follows: state—12$^{th}$ to 30$^{th}$ percentile, trait—22$^{nd}$ to 32$^{nd}$ percentile. These results indicate clearly that the participants in this study subjectively did not experience even average levels of state or trait anxiety. For the last eight participants who filled out the STAI short form for state anxiety, the mean score was 15.3 or between the 32$^{nd}$ to 36$^{th}$ percentile.

### 6.2.3. Subjective comfort levels

The mean 1–9 self-rating for comfort level before the 1$^{st}$ condition was 7.8. After counterbalanced conditions, mean ratings were as follows: masked = 6.2, stuttered = 6.2, and normal = 7.6. Dependent *t* tests were run between each of the pairwise comfort ratings. There was no significant difference between the pre-experimental comfort rating and the post-normal speech rating ($p$ =. 528) or between the post-masked and post-stuttered speech ($p$ = .875). By contrast, the remainder of the contrasts were significant: pre versus masked ($p$ = .001), pre versus stuttered ($p$ < .001), normal versus masked ($p$ = .016), and normal versus stuttered ($p$ = .003).

#### 6.2.4. Autonomic reactions

Table 2 shows the means and standard deviations of the EDR and IBI results for the entire duration (~30 sec) of the three conditions: stuttering, masked, and fluent along with the full 2-min baselines that preceded each of them. Given that there were nine different orders of audio and facial stimuli, each of the nine pairs occurred twice.

Table 2
*Mean values and standard deviations for the EDR results (in microsiemens) and IBI results (in seconds) for three audio conditions and their preceding baselines.*

| | | Baseline Masked | Masked | Baseline Stuttering | Stuttering | Baseline Normal | Normal |
|---|---|---|---|---|---|---|---|
| EDR | Mean | 1.0541 | 1.0662 | 0.9049 | 0.9566 | 0.7931 | 1.0028 |
| | SD | 1.8594 | 1.7452 | 1.6586 | 1.6612 | 0.9418 | 1.7404 |
| IBI | Mean | 0.8591 | 0.7738 | 0.7727 | 0.7821 | 0.7636 | 0.7854 |
| | SD | 1.0418 | 0.1203 | 0.1299 | 0.1326 | 0.1117 | 0.1317 |

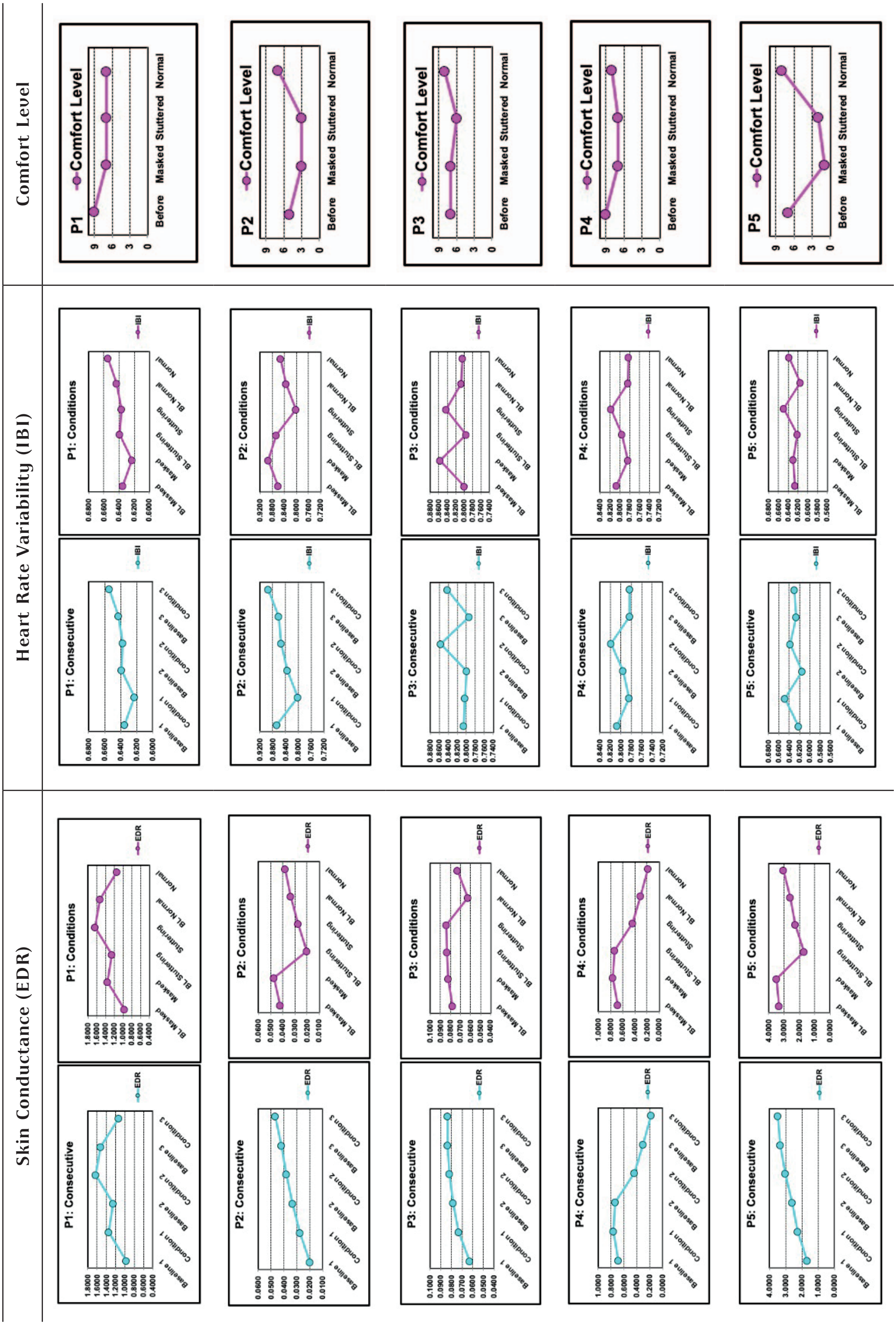
Univariate ANOVAs revealed that masked, stuttered, and normal conditions, as well as their presentation in first, second, or third positions, were not significantly different for either EDR or IBI ($p > .05$), but there were significant interactions between condition and order for both measures. Importantly, considering ANOVAs as well only on baseline data preceding each listening condition, conditions, orders, and interactions were statistically significant for both physiological measures. It appeared that individual participants reacted differently to the various conditions.

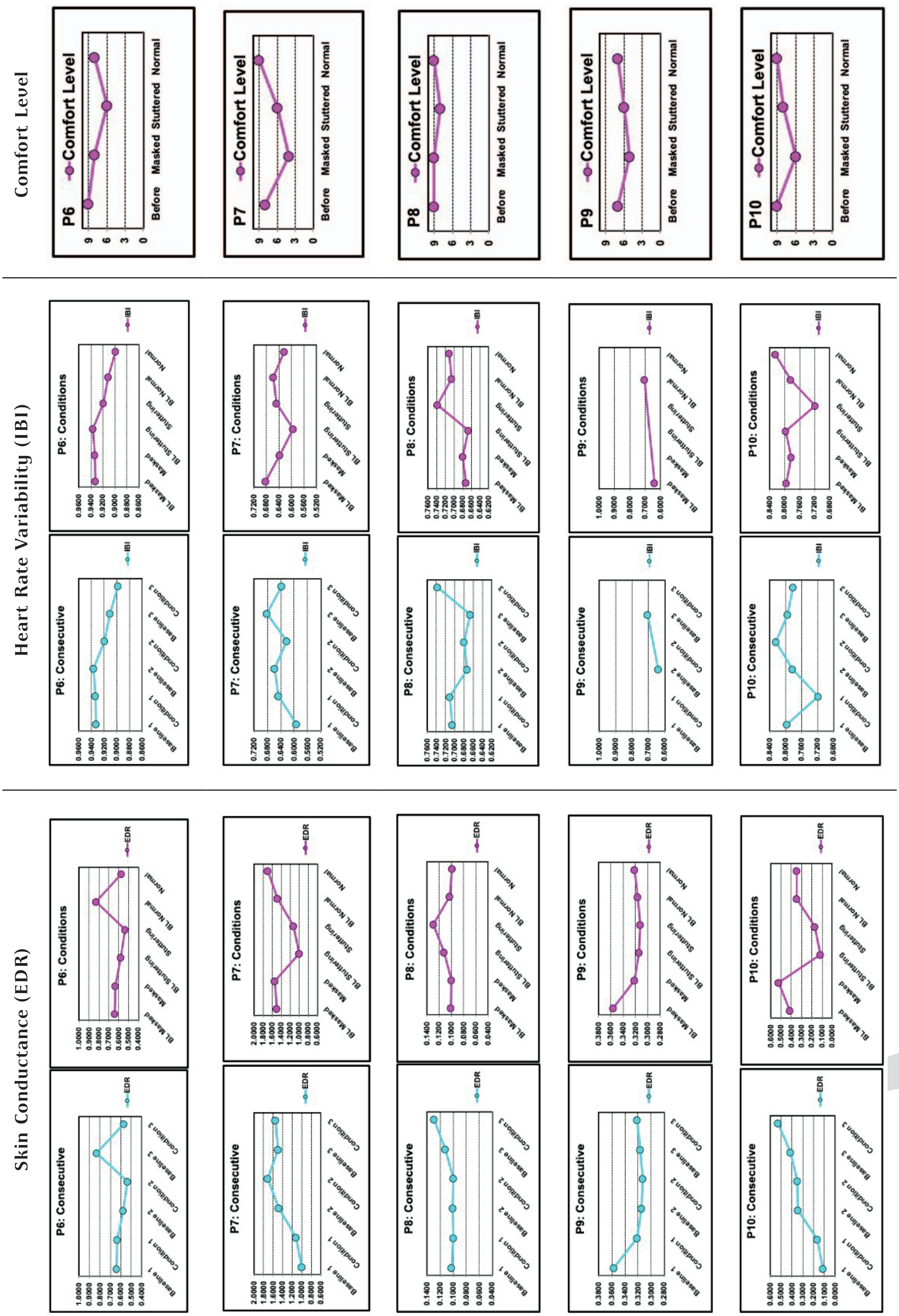
### 6.3. Individual data

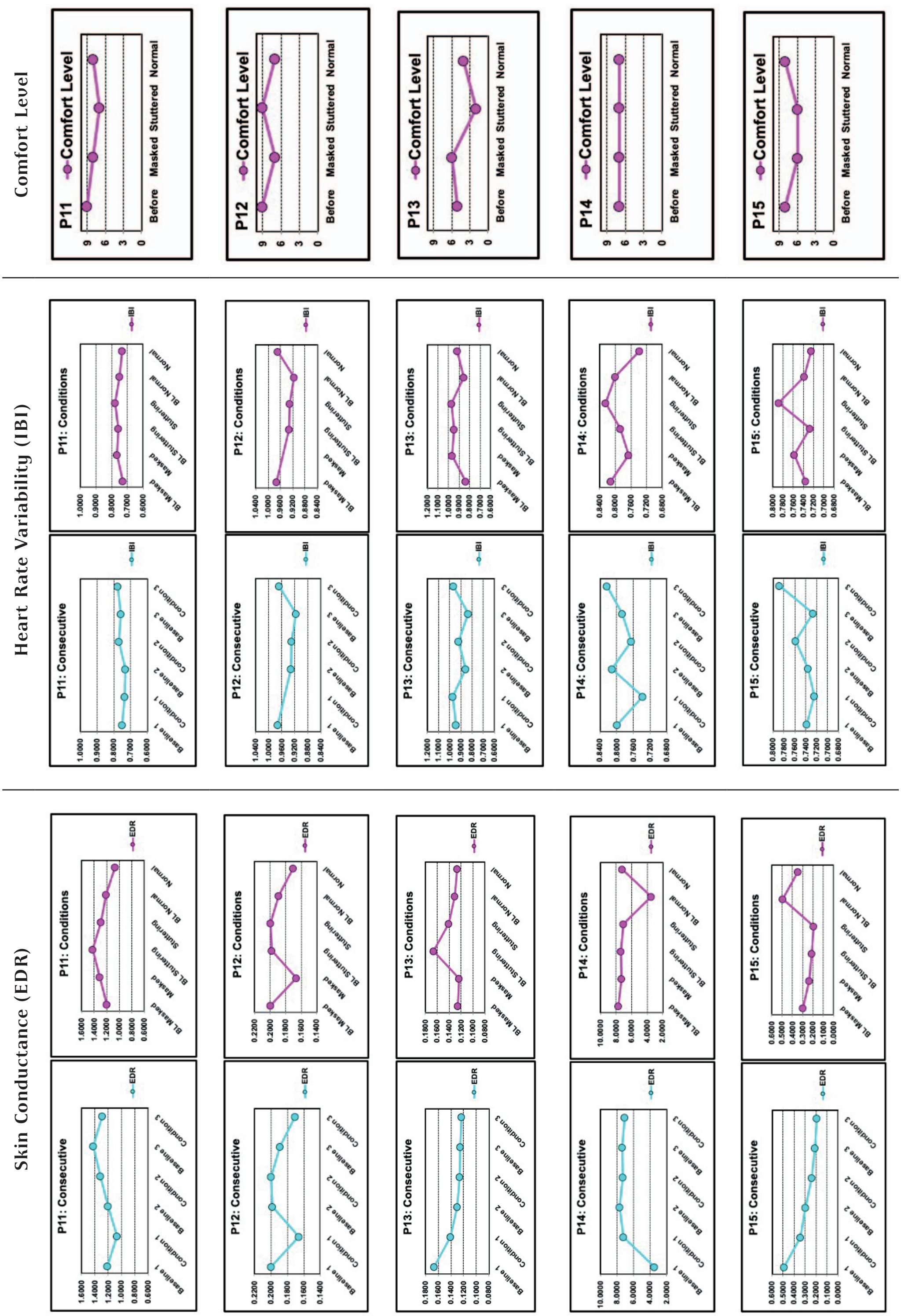
#### 6.3.1. Autonomic reactions

Figure 2 shows profiles for the two physiological responses and the self-report comfort ratings individually from left to right for all 18 participants. Regarding EDR and IBI reactivity, the left tracing in each pair of graphs in blue-green color shows the consecutive responses, and the right shows them for the three conditions in pink color, each preceded by its baseline. It must be noted that in one-third of the cases, by design, the consecutive and conditions were the same, that is, P1, P4, P6, P9, P12, and P16 whose experimental sequences were: (1) baseline, (2) masked, (3) baseline, (4) stuttered, (5) baseline, and (6) normal. On the far right are the four comfort ratings in pink for the pre-experimental rating and then after each of the speech conditions, i.e., masked, stuttered, and normal. These means and standard deviations for the physiological data are shown in tabular form in Appendices C and D.

Table 3 summarizes the individual data from Figure 2 in terms of change from baseline for the EDR and IBI profiles and from the pre-experimental (considered a baseline) and the three speech conditions for the comfort level ratings. The table illustrates the following: increase from baseline with the > symbol, decrease from baseline with the < symbol, and equal (or virtually equal) with the = symbol. It also color-codes these in terms of expected results as follows for EDR and IBI: green if masked or stuttered speech elicited greater autonomic responses compared to baseline while normal speech elicited equal or smaller


Comfort Level
Heart Rate Variability (IBI)
Skin Conductance (EDR)
P1 Comfort Level
P2 Comfort Level
P3 Comfort Level
P4 Comfort Level
P5 Comfort Level
Before
Masked
Stuttered
Normal
P1: Conditions
P2: Conditions
P3: Conditions
P4: Conditions
P5: Conditions
P1: Consecutive
P2: Consecutive
P3: Consecutive
P4: Consecutive
P5: Consecutive
BL Masked
Masked
BL Stuttering
Stuttering
BL Normal
Baseline 1
Condition 1
Baseline 2
Condition 2
Baseline 3
Condition 3
IBI
EDR


Comfort Level
Heart Rate Variability (IBI)
Skin Conductance (EDR)
P6: Consecutive
P6: Conditions
P7: Consecutive
P7: Conditions
P8: Consecutive
P8: Conditions
P9: Consecutive
P9: Conditions
P10: Consecutive
P10: Conditions
P6 Comfort Level
P7 Comfort Level
P8 Comfort Level
P9 Comfort Level
P10 Comfort Level
Before
Masked
Stuttered
Normal
Baseline 1
Condition 1
Baseline 2
Condition 2
Baseline 3
Condition 3
BL Masked
Masked
BL Stuttering
Stuttering
BL Normal
Normal
IBI
EDR


Comfort Level
Heart Rate Variability (IBI)
Skin Conductance (EDR)
P11 Comfort Level
P12 Comfort Level
P13 Comfort Level
P14 Comfort Level
P15 Comfort Level
Before Masked Stuttered Normal
P11: Conditions
P12: Conditions
P13: Conditions
P14: Conditions
P15: Conditions
P11: Consecutive
P12: Consecutive
P13: Consecutive
P14: Consecutive
P15: Consecutive
IBI
EDR
BL Masked Masked BL Stuttering Stuttering BL Normal Normal
Baseline 1 Condition 1 Baseline 2 Condition 2 Baseline 3 Condition 3

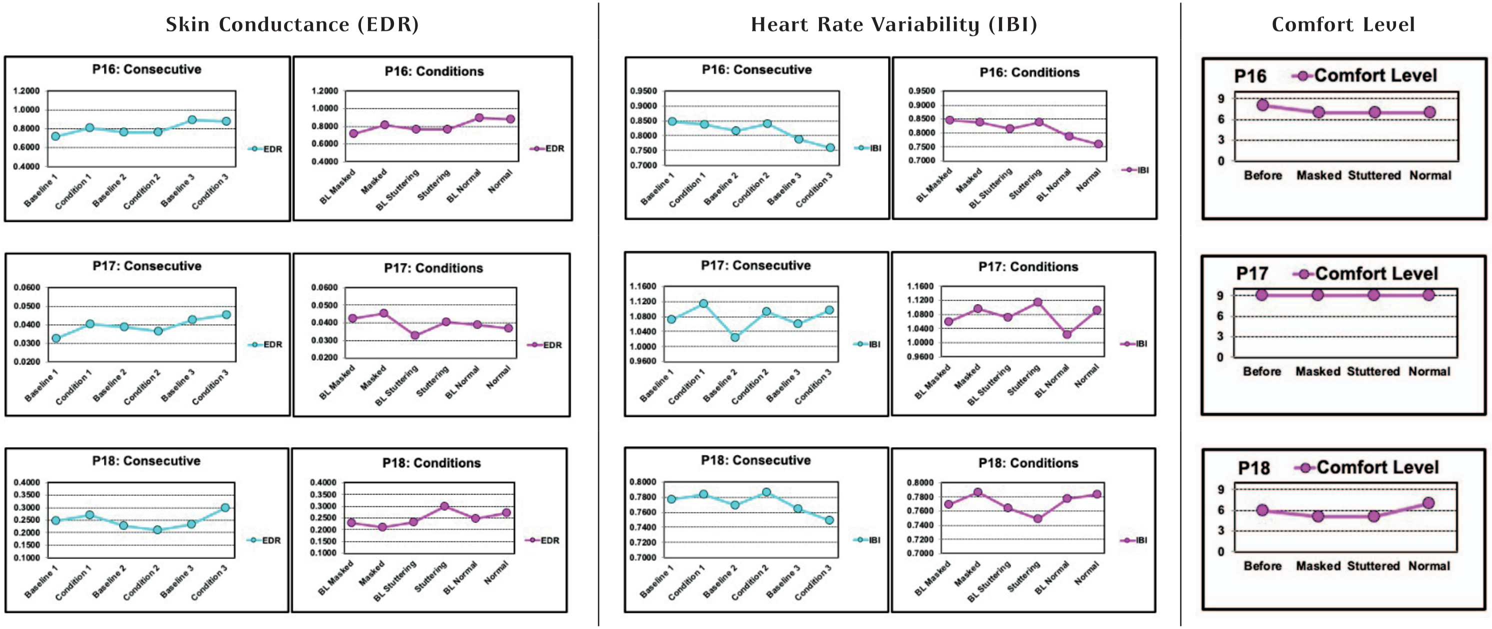



*Figure 2*. Profiles for 18 individual participants for autonomic reactions of skin conductance (EDR) in microsiemens and heart rate variability (IBI) in seconds followed by subjective comfort levels. Blue-green profiles show mean levels for consecutive baselines and conditions while pink profiles show conditions and their preceding baselines for three speaking conditions: masked, stuttered, and normal. Pink comfort level profiles show 1–9 ratings after a pre-experimental rating and after each speaking condition.

autonomic responses; red if the opposite occurred. Equal signs for no change for masked or stuttered conditions are shown in blue. Comfort ratings were similarly coded, but since higher numbers on the 1–9 scale indicated greater comfort, the color codes were reversed for > and < symbols. At the bottom, the total number and percent of each symbol and color code are shown. Omitted items are included in the percentages. The text to the right of each triad of conditions shows whether or not reversals occurred in the autonomic responses in the consecutive graphs shown in Figure 2, designated by "yes", "no", or "maybe". In those cases where progressive increases or decreases occurred, i.e., P2, P5, and P15 for EDR and either no changes or incomplete data were generated for IBI, i.e., P11 and P9, respectively, the data were not included in these individual analyses. Similarly, the results for comfort ratings were not included for P14 and P17, for whom all four 1–9 ratings were the same. Finally, the letter "P" follows "yes" in the text when all three predicted changes occurred: greater autonomic reactivity occurred for masked and stuttered speech compared to baseline and less for normal speech compared to baseline, i.e., P1, P10, and P17 (3/18) for EDR and P3 and P15 (2/18) for IBI. Predicted ratings for all three speech conditions for comfort ratings occurred for P2, P4, P7, P9, P10, P15, and P18 (7/18).

Table 3

*Results of individual profile analysis of 18 participants in terms of changes from baseline for autonomic reactions of skin conductance (EDR) and heart rate variability (IBI) as well as change from pre-experimental ratings for subjective comfort. Greater than (>) symbols indicate an increase from baseline; less than (<) symbols indicate a decrease from baseline. Equal (=) symbols represent no change from baseline. Green symbols indicate expected results assuming that greater autonomic arousal and lower comfort ratings are associated with masked and stuttered speech; red symbols indicate unexpected less autonomic arousal and higher comfort ratings associated with masked or stuttered speech. For normal speech, green indicates expected equal or less than baseline (or equal or greater comfort levels), and red indicates unexpected greater than baseline (or equal or lower comfort levels). Pink cells indicate that the responses were invalid due to progressive increases or decreases in consecutive baseline conditions or no change in the comfort conditions. "Yes-P" indicates predicted profiles for all three conditions.*

| Participant | EDR: Masked | EDR: Stuttering | EDR: Normal | EDR: Reversals in Consecutive Graphs (P = Predicted for 3 Conditions) | IBI: Masked | IBI: Stuttering | IBI: Normal | IBI: Reversals in Consecutive Graphs (P = Predicted for 3 Conditions) | Comfort: Masked | Comfort: Stuttering | Comfort: Normal | Comfort: Change from Initial Rating (P = Predicted for 3 Conditions) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1 | > | > | < | Yes–P | < | < | > | Yes | < | < | < | Yes |
| 2 | | Progressive Increase | | No | > | < | > | Yes | < | < | > | Yes–P |
| 3 | > | = | > | Maybe | > | > | < | Yes–P | = | < | > | Yes |
| 4 | > | < | < | Yes | < | > | < | Yes | < | < | > | Yes–P |
| 5 | | Progressive Increase | | No | > | > | > | Yes | < | < | < | Yes |
| 6 | = | < | < | Yes | > | < | < | Yes | < | < | < | Yes |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | > | > | > | Yes | < | > | < | Yes | < | < | > | Yes–P |
| 8 | = | > | < | Yes | > | > | > | Yes | = | < | = | Yes |
| 9 | < | < | > | Yes | Incom-plete | Incom-plete | Incom-plete | N/A | < | < | = | Yes–P |
| 10 | > | > | = | Yes–P | < | < | > | Yes | < | < | = | Yes–P |
| 11 | > | < | < | Yes | No Change | | | No | < | < | < | Yes |
| 12 | < | = | < | Yes | Incom-plete | = | > | Maybe | < | = | < | Yes |
| 13 | = | < | < | Maybe | > | > | > | Yes | > | < | < | Yes |
| 14 | < | < | > | Yes | < | > | < | Yes | All Equal | | | No |
| 15 | Progressive Decrease | | | No | > | > | < | Yes–P | < | < | = | Yes–P |
| 16 | > | = | < | Yes | < | > | < | Yes | < | < | < | Yes |
| 17 | > | > | < | Yes–P | > | > | > | Yes | All Equal | | | No |
| 18 | < | > | > | Yes | > | < | = | Yes | < | < | > | Yes–P |
| Pre-dicted | | | | 3/18 pre-dicted | | | | 2/18 pre-dicted | | | | 7/18 pre-dicted |
| > | 8 | 6 | 6 | | 9 | 10 | 8 | | 1 | 0 | 9 | |
| < | 4 | 6 | 9 | | 6 | 5 | 8 | | 13 | 15 | 7 | |
| = | 3 | 3 | 0 | | 0 | 1 | 0 | | 2 | 1 | 0 | |
| Omit | 3 | 3 | 3 | | 3 | 2 | 2 | | 2 | 2 | 2 | |
| > | 44% | 33% | 33% | | 50% | 56% | 44% | | 6% | 0% | 50% | |
| < | 22% | 33% | 50% | | 33% | 28% | 44% | | 72% | 83% | 39% | |
| = | 17% | 17% | 0% | | 0% | 6% | 0% | | 11% | 6% | 0% | |
| Omit | 17% | 17% | 17% | | 17% | 11% | 11% | | 11% | 11% | 11% | |

It is clear from Figure 2 and Table 3 that each of the 18 participants responded differently to the experimental stimuli. Inspecting the percentages at the bottom of Table 3, only one-third (33%) of the 18 participants reacted with increased skin conductance (EDR) to stuttering as predicted. Only 44% reacted as expected to masked speech and 50% to normal speech. Fifty-six percent demonstrated increased heart rate variability (IBI) to stuttering and 50% to masked speech. An equal number demonstrated increased or decreased variability to normal speech. The percentages for less self-rated comfort were 83% for stuttering and 72% for masked speech. Equal or increased comfort, compared to the first rating, occurred for 50% of participants after normal speech.

### 6.4. Correlations of stuttering attitudes with anxiety measures

Pearson correlation coefficients between the components, subscores, and OSS of the *POSHA–S* and the various measures of anxiety or comfort are shown in Table 4. With only

18 participants, a correlation coefficient of $R = \pm.47$ is required for statistical significance at $p \leq .05$ (identified with asterisks) and ±.41 at $p \leq .01$. These are all shown in shading to identify potential relationships. Intercorrelations among the *STAI* and comfort ratings are boxed in a matrix and shown twice.

*STAI* state and trait anxiety were highly correlated ($R = .78$), and for the eight respondents who also filled out the short form of the *STAI* state measure, the correlation was even higher at $R = .92$. Similarly, the four comfort ratings were all intercorrelated between .53 and .81, except between the post-masked and post-normal speech conditions. *STAI* ratings were moderately correlated between both pre-experimental and post-normal speech comfort ratings ($R = .43$–.64) but less or unrelated to post-masked or stuttered speech ($R = .06$–.31).

Inspecting *STAI* versus *POSHA–S* correlations, the only ones large enough to reach the $p < .10$ or .05 thresholds of significance were in the Beliefs subscore and two of its components, i.e., Traits/Personality and Help From ($R = .43$–.55). This indicates that the greater the amount of trait and state anxiety, even though lower than normal in our sample, the more positive were participants' beliefs about stuttering. In fact, of the 10 correlations for Beliefs, all but one were positive. These stand in contrast to the Self Reaction correlations, wherein none reached the .41 threshold but eight of the ten correlations for components and the subscore were negative. These results suggest that higher anxiety ratings were associated with less positive Self Reactions to stuttering. We looked at one *POSHA–S* item in the Social Distance/Sympathy component, "If I were speaking to a person who stutters, I would feel comfortable", in order to compare it with the comfort ratings. As could be expected, it correlated most highly ($R = .42$) with comfort after the stuttered condition.

Aside from this item rating, otherwise, the correlations between comfort ratings and other *POSHA–S* summary scores were generally very low but with a possible trend for the opposite signs of the comfort after stuttered speech and Beliefs and Self Reactions subscore correlations. This would be consistent with the above-mentioned findings with *STAI*-measured anxiety, assuming that comfort is the inverse of anxiety. It is further confirmed at the bottom of the table in the first two columns where the pre-experimental comfort rating and post-normal speech were negatively correlated with the two *STAI* raw scores ($R = -.43$ to $-.64$).

The EDR autonomic reactions following stuttered speech were mostly uncorrelated with *POSHA–S* components or subscores, but there were exceptions that could not be easily interpreted. These were (a) a negative correlation between EDR and Potential ($R = -.48$) (e.g., greater skin conductance associated with less positive beliefs about a stuttering person's potential to do any job they wanted), (b) a negative correlation between EDR and Social Distance/Sympathy ($R = -.65$) (e.g., less skin conductance associated with being worried or concerned if a sibling stuttered), and (c) a positive correlation between EDR and Helping/Accommodating ($R = .41$) (e.g., greater skin conductance associated with affirming that the respondent should help a person who stutters). Only one *POSHA–S* rating correlated significantly with IBI, that is, Knowledge/Experience ($R = -.43$). This suggests lower heart rate variability is associated with more knowledge or experience with stuttering. Higher heart rate variability correlated as well with only one comfort rating, inexplicably with higher ratings after masked speech ($R = .50$). None of the anxiety or comfort measures correlated with ratings related to obesity or mental illness.

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Table 4

*Pearson correlation coefficients between summary scores of the POSHA–S and the various subjective and physiological measures of anxiety or discomfort. Also shown are inter-correlations among the anxiety/discomfort measures. Shading represents correlations significant at p ≤ .01; asterisks show correlations significant at p ≤ .05.*

| | STAI State | STAI Trait | Comfort Pre | Comfort Masked | Comfort Stuttering | Comfort Normal | EDR Stuttering | IBI Stuttering |
|---|---|---|---|---|---|---|---|---|
| ***Overall Stuttering Score*** | 0.17 | 0.30 | 0.03 | 0.30 | 0.03 | 0.42 | −0.28 | 0.00 |
| **Beliefs about People Who Stutter** | 0.43 | 0.55* | −0.22 | 0.08 | −0.28 | 0.37 | −0.10 | 0.27 |
| Traits/Personality | 0.43 | 0.53* | −0.22 | 0.13 | −0.45 | 0.26 | 0.01 | 0.28 |
| Help From | 0.39 | 0.52* | 0.28 | −0.08 | −0.20 | 0.19 | −0.07 | −0.10 |
| Cause | 0.32 | 0.25 | −0.27 | −0.20 | −0.09 | 0.12 | 0.14 | 0.29 |
| Potential | −0.13 | 0.06 | 0.29 | 0.40 | 0.13 | 0.43 | −0.48* | 0.15 |
| **Self Reactions to People Who Stutter** | −0.21 | −0.13 | 0.29 | 0.41 | 0.37 | 0.28 | −0.35 | −0.31 |
| Helping/Accommodating | −0.03 | 0.22 | 0.35 | 0.46 | 0.13 | 0.49* | 0.41 | −0.11 |
| Social Distance/Sympathy | −0.26 | −0.22 | 0.37 | 0.49* | 0.22 | 0.47* | −0.65* | 0.15 |
| Item: Comfort Talking with a Person Who Stutters | −0.40 | −0.36 | 0.26 | 0.38 | 0.42 | 0.20 | −0.25 | 0.06 |
| Knowledge/Experience | 0.00 | −0.10 | −0.03 | 0.08 | 0.11 | −0.28 | 0.04 | −0.43 |
| Knowledge Source | −0.16 | −0.06 | 0.14 | 0.14 | 0.34 | 0.17 | −0.30 | −0.28 |
| **Obesity/Mental Illness** | −0.04 | 0.19 | 0.04 | 0.10 | 0.00 | 0.23 | −0.07 | −0.02 |
| Impression | −0.19 | 0.07 | 0.17 | 0.30 | 0.12 | 0.40 | −0.18 | 0.36 |
| Want/Have | −0.16 | −0.17 | 0.01 | −0.04 | 0.08 | −0.01 | −0.15 | −0.25 |
| Amount Known | 0.17 | 0.33 | −0.10 | −0.09 | −0.14 | 0.03 | 0.09 | −0.27 |
| *STAI* State | | 0.78* | | | | | 0.25 | 0.04 |
| *STAI* Trait | 0.78* | | | | | | 0.27 | −0.16 |
| *STAI* State (Short Form) | 0.92* | | | | | | | |
| Comfort Pre | −0.54* | −0.59* | | 0.60* | 0.81* | 0.65* | −0.07 | −0.02 |
| Comfort Masked | −0.30 | −0.06 | 0.60* | | 0.74* | 0.16 | −0.06 | 0.50* |
| Comfort Stuttering | −0.30 | −0.31 | 0.81* | 0.74* | | 0.53* | 0.00 | 0.20 |
| Comfort Normal | −0.43 | −0.64* | 0.65* | 0.16 | 0.53* | | −0.09 | −0.24 |

## 7. Discussion

A number of intriguing results emerged from this preliminary study of the relationships between public attitudes toward stuttering and people's levels of anxiety or discomfort. The few studies available (e.g., Guntupalli et al., 2006, 2007, 2012; Zhang et al., 2010) led us to predict that listening to severe stuttering would occasion increased autonomic arousal in the form of increased skin conductance (EDR) and heart rate variability (IBI) as well as reduced self-rated comfort in most participants. That decidedly did *not* occur in a preponderance of participants. Group parametric analyses of both EDR and IBI ANOVAs revealed no significant differences for the main effect of speaking condition or even of baselines preceding them, but both were associated with significant interactions. By contrast, *t*-test comparisons of the post-speech comfort levels showed significant reductions from the pre or normal speech ratings for both stuttering and masked speech, but no differences between these two "abnormal" speech conditions.

Using the multiple baseline strategy, we found that every single participant reacted differently to these two autonomic and one self-report measures. Two or three *different* participants showed no identifiable reactions to any of the three speaking conditions across the three measures, with no change or progressively increasing or decreasing reactions from the beginning to the end of the experiment. Excluding these respondents and inspecting changes from baseline in the EDR and IBI reactions to masked, stuttered, or normal speech, or changes from pre- to post-speech comfort ratings, only about a third to a half of the participants changed in the expected direction for the autonomic measures. Considering changes from pre- to post-speech comfort ratings, about half of the post-normal speech ratings were expected, but about three-fourths to five-sixths of the post-stuttered and post-masked speech comfort ratings were lower as expected. Taking a more conservative view wherein all three speech conditions (masked, stuttered, and normal) occasioned the expected results, only a small minority (two or three of 18 participants) reacted autonomically as expected. About half rated all three comfort levels as predicted.

We are unaware of any previous normative study of subjective anxiety and public attitudes toward stuttering. State and trait anxiety, measured by the *STAI* at the outset of the experiment revealed that our participants were less anxious than Spielberger's (1977) normative samples. Even so, their scores for both state (current) and trait (habitual) anxiety were related in intriguing ways to their attitudes toward stuttering. It appeared that self-rated anxiety—but not physiological indices—might well have predictive potential for public attitudes toward stuttering. We recognize that our sample size was too small to offer any firm conclusions, but we highlight the following correlational trends. Beliefs on the *POSHA–S*, which are opinions that do not involve the respondent personally, appear to be improved when accompanied by increased levels of trait and state anxiety. By contrast, Self Reactions, all ratings of which involve the respondents themselves, appear to show the opposite trend, that is, they are improved when associated with reduced levels of trait and state anxiety. And the same trends occur, in the predicted opposite directions, in post-stuttered speech comfort ratings. Interestingly, the post-stuttered speech comfort ratings in this study were only moderately correlated with the *POSHA–S* item related to feeling comfortable while interacting with a stuttering person.

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The question arises, "Why did we fail to replicate the findings of previous research showing that observing or listening to stuttering produces unconscious increases in autonomic arousal?" It is impossible to answer that question conclusively from our results; yet, the question remains as an important issue to be explained. We offer several hypotheses to explain our disparate results.

Guntupalli et al.'s (2006, 2007, 2012) and Zhang et al.'s (2010) studies involved participants watching videos of a number of different stuttering and normal speakers. It is possible that the visible aspects of stuttering were more impactful on their autonomic ratings than the auditory aspects. (Evidence for listener reaction to stuttering being related to their eye gaze [Bowers et al., 2010] might be related to visible symptoms of stuttering.) Relatedly, it is also possible that differences in the speakers, unrelated to their stuttered or fluent speech, such as their age, gender, race, facial expressions, accent or dialect, language content, stuttering severity, or other variables were more than minimally influential in participants' autonomic reactions. Alternatively, it could be that we controlled potentially confounding variables to such an extent that we removed much of the "shock value" of stuttering. We do not believe that is so, given the severity of the stuttering recorded and played; however, the content was designed for all ages and perhaps it was too "childish" for the university students (see Appendix A) such that they did not take it seriously.

Another possibility for our failure to replicate the autonomic results was that the Empatica E4 Wristband was not as sensitive as the laboratory-style equipment utilized in previous research. Again, we doubt that because a few of our respondents demonstrated wide variability in their reactivity to the various baselines and experimental conditions. A related issue that potentially affected our results was the number of tokens available for analysis within each two-minute baseline and 30-second speech condition was much lower for IBI than for EDR. IBI readouts only occurred when a threshold of heart rate variability occurred—not every 250 msec as with EDR.

The testing environment can have important influences on autonomic arousal (Boucsein et al., 2012). It is possible that differences in laboratory conditions may have played a role in our different findings. For example, we monitored the temperature of the room where the physiological recording took place, and it ranged from 70–76 degrees Fahrenheit.

Participant characteristics can also play a role in autonomic arousal (Boucsein et al., 2012). We doubt that these affected our results in any meaningful way, but, for example, our initial questionnaire asked participants to report their ingestion of water and alcohol in the previous 24 hours as well as any drugs they had taken (see Appendix B).

## 8. Cautions and future directions

The results of this study should be considered preliminary but clearly indicate a number of important directions for future research. Following are some cautions and suggested studies.

Our results were based on a small number of participants for a group study, yet, a larger than usual number for individual analyses. The ANOVAs, *t*-tests, and correlations were based on only 18 participants; therefore, small differences would not be statistically significant. A considerably larger sample size, perhaps at least 100 participants, would confirm or de-confirm our important finding that subjective anxiety might well play different roles in the "other-centered" Beliefs about people who stutter and "personally centered" Self Reactions to people who stutter. And, with adults at least, rather than carrying out the complex and difficult enterprise of measuring physiological reactivity, subjective measures of comfort or related feelings might permit a more user-friendly way of determining at least an estimate of autonomic arousal to exemplars of stuttering in adults. This option would be attractive in light of our preliminary finding that adults may have little or no physiological reactions to observed stuttering.

The participants in this study had more positive attitudes and less subjective anxiety than many other samples of adults. It would seem important to carry out at least the *STAI* and *POSHA–S* aspects of this study with samples from populations found in previous research to have much less positive stuttering attitudes and to compare them to samples found to have quite positive attitudes. It would be advisable to have a much increased sample size over this study in order to consider such variables as the sex of the participants, particularly because males and females report different levels of anxiety on the *STAI* (Spielberger, 1977).

Comparing only the *POSHA–S* and *STAI* would also control for another potential confounding factor in the current study, that is, that the *POSHA–S* had to be administered after participants had witnessed severe stuttering, and, thus, may not be entirely comparable to previous *POSHA–S* means and percentiles. Yet, we hasten to point out that this potential weakness is also a strength of the current study. We expected that the measured attitudes of the university students would be negatively affected by the previous exposure to severe stuttering and their ratings of comfort following it. It is possible that it did, and their attitudes would have been even more positive had they been given the *POSHA–S* before hearing the speech samples, but similar studies argue for the conclusion that our exemplars made little difference in participants' attitudes. For example, a recent unpublished study of 39 undergraduate students in a small Midwestern city, not majoring in speech-language pathology, with a mean age of 21 and with approximately the same sex ratio as the current study had a mean OSS of 28 (Nelson, 2020). Another study of 50 USA non-SLP undergraduate students had an OSS of 24 (St. Louis et al., 2014). These compared closely to the OSS of 26 for our participants.

We believe this study should be replicated with children, perhaps as young as 3 or 4 years of age. The instrumentation and design of this study could be utilized with young children. Also, a child version of the *POSHA–S* is available (*POSHA–S*/Child, Weidner & St. Louis, 2014), as is a child version of the *STAI*. If such a study could expose young children to severe stuttering before they know what it is (see St. Louis et al., 2018; Weidner et al., 2015), and if they were to react physiologically more strongly than adults, it would help explain why preschool children have been shown in several samples to manifest the most negative stuttering attitudes (Weidner et al., 2015; Weidner et al., 2017; Glover et al., 2019; Weidner et al., 2020). Moreover, it would suggest that maturity fosters the ability to ignore or cognitively blunt stuttering's emotional impact in older children and adults.

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## Appendix A

Content of the speech samples. All were recorded for masked and normal samples; only the non-italicized versions were recorded for the stuttered samples in order to generate complete samples of about 30 seconds.

**Sample 1**
My name is Robert.
I live in a small town in West Virginia.
I have one brother; his name is Sam.
My brother and I go to the same school.
We also play basketball on the same team.
He is a really good player.
*My father is a truck driver.*
*He drives a very big truck.*
*He goes to work very early in the morning.*

**Sample 2**
My name is Jacob.
My family lives in Ohio.
We live in a small, red house on the corner.
Our street has big trees on both sides.
My father works in a car factory,
And my mother is a teacher.
*She teaches children in the sixth grade.*
*Her school is close to our home.*
*She can walk to school.*

**Sample 3**
My name is Jonathon.
I have lived in Pennsylvania all my life.
I have two sisters.
One of my sisters is married and has a baby.
My other sister is at the university.
She wants to become a doctor,
*and would like to work in a hospital.*
*I want to be a teacher when I grow up.*
*I hope I can teach art and music.*

## Appendix B

Summary of participants' self reports prior to the experiment.

| Participant | Age | Sex (M/F) | Hand Preference (L/R/N) | Days Since First day of Last or Current Period | Birth Control Pills (Y/N) | Pregnant (Y/N) | Race (List All) | Chronic Illness (List All) | Medications (Y/N) | Hearing or Vision Impairment (Y/N) | Hearing or Vision Impairment (List) | Drink ≥ 8 oz. Water | Take Prescribed Medication (Y/N) | Alcoholic Beverages (Y/N) | Caffeinated Beverages (Y/N) | Non-prescribed drugs (Y/N) | Smoke cigarettes (Y/N) | Room Temperature (Fahrenheit) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 27.7 | F | R | 37 | Y | N | Caucasian | – | Y Taytulla (Birth Control) | N | – | Y | Y Taytulla (Birth Control) | Y | Y | N | N | 75 |
| 2 | 20.1 | M | R | – | – | – | Caucasian | – | N | N | – | Y | N | N | N | N | N | 74 |
| 3 | 22.2 | F | R | 33 | Y | N | Caucasian | – | N | N | – | N | N | N | N | N | N | 72 |
| 4 | 22.6 | M | R | – | – | – | Caucasian | – | N | Y | Contacts & Glasses | Y | N | N | N | N | N | 71 |
| 5 | 19.4 | F | R | ~2 yr | Y (shot) | N | Caucasian | – | N | N | – | Y | N | N | Y | N | N | 71 |
| 6 | 21.8 | M | R | – | – | – | Caucasian | – | N | N | – | Y | N | N | N | N | N | 75 |
| 7 | 22.2 | M | R | – | – | – | Caucasian | – | N | N | – | Y | N | N | Y | N | N | 74 |
| 8 | 21.5 | F | R | 5 | N | N | Caucasian | – | N | Y | Glasses & Contacts | Y | N | N | N | N | N | 73 |
| 9 | 22.3 | M | R | – | – | – | Caucasian | – | N | N | – | Y | N | N | N | N | N | 75 |
| 10 | 25.7 | M | R | – | – | – | Caucasian | – | Y Naproxen | N | – | Y | N | N | N | N | N | 70 |
| 11 | 23.7 | M | R | – | – | – | Caucasian | – | N | N | – | Y | N | N | N | Y Tylenol | N | 71 |
| 12 | 20.3 | F | R | 8 | Y | N | Caucasian | – | Y | N | – | Y | Y Sprintec | N | Y 2 Cups Coffee | N | N | 71 |
| 13 | 22.0 | F | Not Reported | 56 | Y | N | African-American | – | N | N | – | Y | N | N | N | N | N | 70 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 21.6 | M | R | – | – | – | Caucasian | – | N | N | – | Y | N | N | N | N | N | 72 |
| 15 | 21.0 | F | R | 34 | Y | N | Caucasian | – | Y Mononessa Allergy Medi- cations Vitamin | N | – | Y | Y Birth Control | N | Y Tea (Small Me- dium) | Y Allergy Medi- cation | N | 76 |
| 16 | 22.6 | F | R | 22 | N | N | Caucasian | Other (Not Specified) | N | Y | Contacts | Y | N | N | Y 2 16 oz coffees | N | N | 70 |
| 17 | 21.0 | F | R | 15 | Y | N | Caucasian | Other (Not Specified) | N | N | – | Y | Y Birth Control | N | N | N | N | 70 |
| 18 | 20.8 | F | R | 5 | N | N | Middle Eastern | – | N | N | – | Y | N | N | Y 4 Caffei- nated drinks | N | N | 74 |

## Appendix C

Means and standard deviations (in italics) of the skin conductance in microsiemens (EDR) results for the 18 participants.

| Participant | Baseline Masked | Masked | Baseline Stuttering | Stuttering | Baseline Normal | Normal |
|---|---|---|---|---|---|---|
| 1 | 0.9745 | 1.3500 | 1.2574 | 1.6354 | 1.5286 | 1.1411 |
| | *0.1154* | *0.0727* | *0.1335* | *0.1718* | *0.1722* | *0.0578* |
| 2 | 0.0422 | 0.0470 | 0.0201 | 0.0274 | 0.0332 | 0.0380 |
| | *0.0023* | *0.0009* | *0.0018* | *0.0013* | *0.0027* | *0.0009* |
| 3 | 0.0782 | 0.0820 | 0.0836 | 0.0838 | 0.0627 | 0.0730 |
| | *0.0021* | *0.0009* | *0.0010* | *0.0008* | *0.0060* | *0.0008* |
| 4 | 0.6841 | 0.7636 | 0.7331 | 0.4396 | 0.3031 | 0.1844 |
| | *0.0948* | *0.0457* | *0.2300* | *0.0205* | *0.0604* | *0.0120* |
| 5 | 3.3261 | 3.5005 | 1.6817 | 2.2597 | 2.5990 | 3.0307 |
| | *0.2414* | *0.3006* | *0.2688* | *0.1675* | *0.2388* | *0.1019* |
| 6 | 0.6386 | 0.6339 | 0.5778 | 0.5342 | 0.8282 | 0.5727 |
| | *0.0520* | *0.0346* | *0.0174* | *0.0113* | *0.1218* | *0.0288* |
| 7 | 1.4954 | 1.5446 | 0.9993 | 1.1216 | 1.4875 | 1.7044 |
| | *0.1258* | *0.0766* | *0.1048* | *0.0308* | *0.1124* | *0.0557* |
| 8 | 0.1005 | 0.0997 | 0.1119 | 0.1297 | 0.1026 | 0.0992 |
| | *0.0013* | *0.0008* | *0.0025* | *0.0099* | *0.0034* | *0.0010* |
| 9 | 0.3565 | 0.3217 | 0.3143 | 0.3123 | 0.3167 | 0.3214 |
| | *0.0367* | *0.0030* | *0.0036* | *0.0018* | *0.0016* | *0.0015* |
| 10 | 0.4120 | 0.5251 | 0.1130 | 0.1681 | 0.3458 | 0.3468 |
| | *0.0456* | *0.0384* | *0.0176* | *0.0097* | *0.0383* | *0.0234* |
| 11 | 1.2038 | 1.3141 | 1.4259 | 1.2868 | 1.2117 | 1.0691 |
| | *0.0708* | *0.0559* | *0.0987* | *0.0347* | *0.0702* | *0.0488* |
| 12 | 0.1999 | 0.1660 | 0.1977 | 0.1996 | 0.1886 | 0.1706 |
| | *0.0056* | *0.0068* | *0.0103* | *0.0034* | *0.0062* | *0.0016* |
| 13 | 0.1254 | 0.1230 | 0.1666 | 0.1405 | 0.1302 | 0.1263 |
| | *0.0022* | *0.0005* | *0.0138* | *0.0026* | *0.0033* | *0.0025* |
| 14 | 7.7059 | 7.3259 | 7.3864 | 7.0558 | 3.4673 | 7.2259 |
| | *0.4892* | *0.1119* | *0.1145* | *0.0844* | *0.4351* | *1.5619* |
| 15 | 0.2989 | 0.2372 | 0.2090 | 0.1928 | 0.4938 | 0.3451 |
| | *0.0344* | *0.0049* | *0.0093* | *0.0014* | *0.0655* | *0.0105* |
| 16 | 0.7167 | 0.8105 | 0.7601 | 0.7617 | 0.8899 | 0.8779 |
| | *0.0703* | *0.1234* | *0.0833* | *0.0530* | *0.0662* | *0.0310* |
| 17 | 0.0426 | 0.0454 | 0.0327 | 0.0402 | 0.0387 | 0.0366 |
| | *0.0024* | *0.0008* | *0.0062* | *0.0008* | *0.0038* | *0.0009* |
| 18 | 0.2282 | 0.2089 | 0.2329 | 0.2992 | 0.2469 | 0.2705 |
| | *0.0148* | *0.0090* | *0.0256* | *0.0054* | *0.0333* | *0.0016* |
| All | 1.0350 | 1.0611 | 0.9057 | 0.9271 | 0.7930 | 0.9796 |
| | *0.0782* | *0.0493* | *0.0635* | *0.0340* | *0.0801* | *0.1079* |

## Appendix D

Means and standard deviations (in italics) of heart rate variability in seconds (IBI) results for the 18 participants.

| Participant | Baseline Masked | Masked | Baseline Stuttering | Stuttering | Baseline Normal | Normal |
|---|---|---|---|---|---|---|
| 1 | 0.6350 | 0.6228 | 0.6390 | 0.6371 | 0.6430 | 0.6544 |
| | *0.0650* | *0.0291* | *0.0393* | *0.0354* | *0.0454* | *0.0388* |
| 2 | 0.8616 | 0.8933 | 0.8671 | 0.8025 | 0.8344 | 0.8533 |
| | *0.0581* | *0.0451* | *0.0736* | *0.1231* | *0.0683* | *0.0436* |
| 3 | 0.7997 | 0.8564 | 0.7944 | 0.8420 | 0.8059 | 0.8032 |
| | *0.0583* | *0.0724* | *0.0459* | *0.0464* | *0.0614* | *0.0482* |
| 4 | 0.8074 | 0.7837 | 0.7958 | 0.8183 | 0.7835 | 0.7825 |
| | *0.0600* | *0.0496* | *0.0627* | *0.0345* | *0.0405* | *0.0275* |
| 5 | 0.6265 | 0.6299 | 0.6217 | 0.6488 | 0.6150 | 0.6380 |
| | *0.0338* | *0.0379* | *0.0310* | *0.0226* | *0.0419* | *0.0409* |
| 6 | 0.9329 | 0.9339 | 0.9368 | 0.9193 | 0.9111 | 0.8985 |
| | *0.0681* | *0.0338* | *0.0648* | *0.0755* | *0.0763* | *0.0376* |
| 7 | 0.6823 | 0.6378 | 0.5938 | 0.6470 | 0.6585 | 0.6223 |
| | *0.0563* | *0.0496* | *0.0504* | *0.0518* | *0.0653* | *0.0579* |
| 8 | 0.6728 | 0.6802 | 0.6663 | 0.7383 | 0.7054 | 0.7104 |
| | *0.0539* | *0.0486* | *0.0542* | *0.1382* | *0.0709* | *0.0656* |
| 9 | 0.6407 | – | – | – | 0.7058 | – |
| | *0.3094* | – | – | – | *0.2127* | – |
| 10 | 0.7947 | 0.7818 | 0.7965 | 0.7184 | 0.7832 | 0.8249 |
| | *0.0698* | *0.0450* | *0.0807* | *0.0478* | *0.0955* | *0.0494* |
| 11 | 0.7292 | 0.7675 | 0.7565 | 0.7776 | 0.7484 | 0.7348 |
| | *0.0398* | *0.0322* | *0.0394* | *0.0712* | *0.0424* | *0.0368* |
| 12 | 0.9719 | – | 0.9323 | 0.9297 | 0.9159 | 0.9679 |
| | *0.1079* | – | *0.0971* | *0.0773* | *0.0808* | *0.0656* |
| 13 | 0.8347 | 0.9674 | 0.9451 | 0.9730 | 0.8563 | 0.9187 |
| | *0.1003* | *0.1440* | *0.1216* | *0.1084* | *0.1250* | *0.0889* |
| 14 | 0.8112 | 0.7657 | 0.7869 | 0.8238 | 0.7994 | 0.7375 |
| | *0.0904* | *0.0709* | *0.0900* | *0.0992* | *0.0984* | *0.0953* |
| 15 | 0.7355 | 0.7584 | 0.7268 | 0.7881 | 0.7379 | 0.7249 |
| | *0.0512* | *0.0468* | *0.0592* | *0.0666* | *0.0594* | *0.0517* |
| 16 | 0.8456 | 0.8367 | 0.8154 | 0.8381 | 0.7859 | 0.7588 |
| | *0.1144* | *0.1279* | *0.0899* | *0.1020* | *0.0832* | *0.0694* |
| 17 | 1.0597 | 1.0966 | 1.0723 | 1.1135 | 1.0230 | 1.0927 |
| | *0.1054* | *0.0953* | *0.1525* | *0.0769* | *0.0741* | *0.0361* |
| 18 | 0.7692 | 0.7866 | 0.7645 | 0.7486 | 0.7771 | 0.7832 |
| | *0.0500* | *0.0375* | *0.0655* | *0.0304* | *0.0472* | *0.0615* |
| All | 0.7895 | 0.7999 | 0.7948 | 0.8097 | 0.7828 | 0.7945 |
| | *0.0829* | *0.0604* | *0.0716* | *0.0710* | *0.0772* | *0.0538* |