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Research Article

Affective States and Heart Rate Response: Measuring Foreign Language Speaking Performance Reactions in a Japanese University Classroom

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ABSTRACT

While psychologists often use a combination of physiological and self-reported data to examine the dynamic effects of stress on performance, the impact of affective states on Foreign Language (FL) speaking performance has almost exclusively been assessed using self-report methodology (e.g., questionnaires, interviews). In fact, studies that correlate physiological data with self-report measures in a classroom context are extremely rare due to both cost and logistical restraints. This study set out to address this gap in language learning research by employing Fitbit smart watches as a tool to unobtrusively collect heart rate (HR) response data. Participants in this study were undergraduate Japanese language students (5 males and 5 females, mean age = 19.7 years, *SD* = .95) at a private university in Japan. Over three sessions, students wore Fitbit smart watches and performed three different class-observed dialogs (with randomized partners and performance order) while seated at their desks. Students were also asked to report their affective state (to index their feelings in the moment) across three intervals within each class session: class start, pre-performance, and post-performance. Using multi-level modeling statistical analysis, elevated self-reported state feelings of distress and embarrassment were found to be significantly positively related with elevated HR response. To further understanding of how affective states unfold in classroom environments, researchers should consider both physiological and self-report measures. With advances in wearable technology, similar research designs to this study may become more commonplace.

Keywords: Foreign language learning, affective states, self-report data, heart rate, language classroom

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INTRODUCTION

In language learning classrooms, students will experience a wide-range of feelings and emotions. Ideally, positive attitudes and emotions push language learners toward their goals. In contrast, negative attitudes or emotions toward language learning will be detrimental. (Horwitz, 2001; Kim, 1998; MacIntyre et al., 2009). One such negative affective state is Foreign Language Anxiety (FLA)—an area of sustained research interest in the field of second language learning mainly due to its debilitating effects on speaking performance (Kondo & Ying-Ling, 2004; MacIntyre, 2018; Maftoon & Ziafar, 2013; Ohata, 2005). It is important to consider, however, that individuals can experience a wide-range of anxiety-related emotions (and intensities) depending on the context. So while we acknowledge the body of literature that has examined FLA, we aim to focus our examination of affective states during a learner's speaking performance task by including a broader perspective of human feeling.

Measuring the degree to which affective states impact language learning has predominantly been assessed using self-report methods, where students rate their own levels with questionnaires (e.g., Falout et al., 2009; Horwitz et al., 1986; Shachter, 2018; Williams & Andrade, 2008). While self-reports have their strengths (e.g., psychometric properties, ease of use), assessing affective states as they unfold requires more dynamic measurement (Gregersen, et al., 2014). Indeed, in fields beyond language learning, performance psychologists implement a range of methodologies, which include the triangulation of physiological measures (Fairclough et al., 2006; Ganster et al., 2018; Kassam & Mendes, 2013; Schmidt et al., 2020).

Research studies which track affective changes using a combination of subjective and objective measures (e.g., heart rate response) in a language learning setting, however, are extremely rare. This may be because such methodologies are generally viewed as impractical, obtrusive and/or prohibitively expensive in a "live" classroom environment (i.e., outside of a controlled laboratory setting) (Giannakos et al., 2020; Gregersen, et al., 2014; Kantor et al., 2001). However, with the introduction of affordable "wearable technology" such as Fitbit and Apple "smart watches," an inexpensive and non-invasive method of collecting physiological measures in a classroom is now possible. "Non-invasive" may be the key term, as other researchers have cited limitations in bulky and/or distracting measuring equipment (Gregersen, et al., 2014; Kantor et al., 2001).

Using wearable HR monitors, there is now an opportunity to more effectively track affective states as they unfold in a language learning classroom. In this proof-of-concept study, we aim to advance the field by collecting data and testing a methodology that has the potential to provide more insights on language learner state feelings over the course of a speaking task, class, series of classes, or school term. Informed by these methodological insights, researchers and educators may be able to test the efficacy of a variety of interventions (e.g., reduce FLA, increase motivation, improve performance) with more accuracy.

LITERATURE REVIEW

Liebert and Morris (1967) were early proponents of the theory that anxiety reactions can be categorized as either automatic-emotional responses or cognitive worry. Autonomic-emotional responses are reactions triggered by the sympathetic nervous system (e.g., "sweaty palms, rapid heart rate, shortness of breath and dry mouth") (Endler et al., 1989, p. 2). Cognitive worry responses are thoughts that focus on "inadequacies and potential failures" (Endler et al., 1989, p. 2). Both internal and external cues can trigger physiological and cognitive responses.

When experiencing anxiety or anxiety-related feelings, language learners have reported that they can feel their heart beat and this uncomfortable somatic reaction is distracting and detrimental to the learning process (Gregersen, et al., 2014; Horwitz et al., 1986; King, 2013; Oxford, 2018; Şimşek & Dörnyei, 2018). Moreover, physiological responses (e.g., becoming aware of a racing heart) can trigger cognitive worry and vice-versa. An extreme result of this vicious cycle is a performance catastrophe (Hardy & Parfitt, 1991).

It should be highlighted, though, that not every experience of anxiety is overwhelmingly debilitative, and some may argue that a certain degree of arousal is conducive to performance (Schmidt et al., 2020; Teigen, 1994). Indeed, Yerkes and Dodson (1908) found that both extreme low and extreme high-levels of stress are detrimental to performance. However, in a given activity, and depending on the person and environment, determining

the pattern and intensity level of affect with complete accuracy can be difficult. High-level performers aim for a "flow-state," where one is completely focused on the task at hand and is free from debilitating thoughts or uncomfortable somatic reactions (Nakamura & Csikszentmihalyi, 2014). In these states, certain levels of affect (e.g., stress, arousal, excitement, interest) support peak performance. A flow-state, although ideal, can be difficult to enter or maintain, especially in learning situations, due to mental and physical distractions.

Before Horwitz et al.'s (1986) publication of the Foreign Language Classroom Anxiety Scale (FLCAS), research into the effects of affect on language learner performance was relatively limited, and results were at times unclear and conflicting (MacIntyre, 2018; MacIntyre & Gardner, 1991; Scovel, 1978). However, with a validated measure that could be used to assess student levels of anxiety, the FLCAS ushered in a new era of research. Research using the FLCAS aimed to clarify (a) the components of FLA, and (b) the degree in which FLA impeded learner development. In short, the FLCAS is commonly used to identify students who experience negative feelings or associations towards language learning. As highlighted, however, anxiety is a broad term with many related feelings and emotions. Negative associations can include embarrassment, apprehension, nervousness, anxiety, and so on. The FLCAS does not, however, allow for the precise measure of a wide-range of affective states.

Another limitation of the FLCAS is that it does not collect state data (i.e., how individuals are feeling "right now"). Possibly because of the previously highlighted difficulties and constraints involved (e.g., cost, logistics), few researchers have investigated the impact of state feelings over the course of a given class or series of classes using more direct methods. To possibly (a) address this apparent gap in FLA research designs and measurements and to (b) recognize the emergence of complex dynamic systems theory in FL contexts, MacIntyre introduced the Idiodynamic Method in 2012.

With the idiodynamic method, language learners watch a recording of themselves and retrospectively self-report levels of anxiety on a second-by-second basis. This method was employed and triangulated with recorded HR response measures and targeted interviews in a study by Gregersen, MacIntyre and Mesa (2014). Informed by complex dynamic systems theory (see Larsen-Freeman & Cameron, 2008), Gregersen at al. (2014) argued that the idiodynamic method (in conjunction with HR response and targeted interviews) could provide a more robust assessment of how affective states impact learner performance. The main weakness of the idiodynamic method is that participants are asked to recall state feelings and are not actually surveyed in the moment. This is problematic because individuals may not report accurate state feelings due to recall bias (Coughlin, 1990). Even with potential problems to the research design (e.g., participants were allowed free movement which affected HR readings), Gregersen et al. (2014) showed that physiological measures are possible in educational settings. Gregersen et al. (2014) also highlighted that an obtrusive and complicated data collection protocol can negatively affect participants.

Notwithstanding Gregersen et al. (2014), though, the existence of affective states and the degree to which it impacts language learner speaking performance has almost exclusively been assessed using self-report scales (with the majority of these not being state assessments). This is in contrast to the broader field of psychological research, where self-reports are routinely correlated with objective physiological responses. Indeed, triangulating subjective state affect with physiological measures can help researchers more precisely identify how students are feeling over time; this converging data helps to pinpoint how and why individuals reach peak performance or avoid performance setbacks (Ganster et al., 2018; Hardy, 1999; Schmidt et al., 2020; Teigen, 1994).

While FL researchers acknowledge insights from complex dynamic systems theory and understand the complexity of emotional impact, the question remains why so few researchers have triangulated objective and subjective patterns of change over the course of a class or series of classes. Collecting longitudinal state self-reports is not necessarily difficult (e.g., Shachter, 2018), so the answer most likely pertains to the logistical constraints involved with physiological measures. When reviewing the literature both within and outside of language learning, the low number of studies which collect physiological data can mainly be attributed to (a) the constraints of a laboratory environment, (b) the cost of laboratory equipment, and (c) the obtrusive nature of physiological monitoring equipment (e.g., electrocardiograms). Impediments to research also exist outside of the laboratory—in fact, physiological data

collection in a classroom setting has widely been considered impractical and expensive (Giannakos et al., 2020; Gregersen, et al., 2014; Kantor et al., 2001).

With the recent advances in smart watches and consumer wearable HR monitors, researchers are presented with an opportunity to unobtrusively and relatively inexpensively track HR responses related to moment-to-moment feelings during FL speaking performance. Regarding the accuracy of wearable HR monitors, Shcherbina et al. (2017) concluded that the Fitbit's HR measurements were within an "acceptable error range" (p. 8). A separate study by Wang et al. (2017) found that the accuracy of wrist-worn monitors was best at lower HR (i.e., not during strenuous fitness).

The findings of Wang et al. (2017) are particularly relevant because in the present study HR data will be collected in a classroom, where students are seated at their desks, therefore alleviating the chance to "introduce additional variability into the heart rate measure" (Gregersen et al., 2014, p. 584). While there is still some debate regarding the reliability of wearable HR monitors in clinical settings, their usage in human physiology research has been unanimously accepted since 2016 (Wright et al., 2017; Benedetto, 2018). Using state-of-the-art technology, this study extends Gregersen, et al.'s, (2014) work to help shed more light on the dynamic nature of affective states as they unfold in a FL classroom.

While various physiological measures are used in psychological research (e.g., cortisol, blood pressure, skin conductance) (Ganster et al., 2018), there is justification for using HR as a stand-alone physiological measure in FL performance research. There are three main reasons for this: (a) fast HR is the most common reaction to phobic stimuli (Barlow, 2001; Couyoumdjian et al., 2016); (b) across multiple studies, language learners commonly self-report an increased HR as a reaction to or somatic symptom of anxiety in a FL environment (Gregersen, et al., 2014; Horwitz et al., 1986; King, 2013, 2014; King & Smith, 2018; Oxford, 2018; Rolls, 2007; Şimşek & Dörnyei, 2018); and (c) HR can be used to infer first-hand student learner experience with "good accuracy" (Giannakos et al., 2019, p. 9).

The complexity of emotional states and the impact on learner performance is not necessarily novel. However, due to a variety of cost and logistical constraints, educational researchers have mainly limited their scope of data collection to self-reports. In the field of language learning specifically, investigations into the range and patterns of affective states have been limited. The fact that technology has progressed to the point where more insightful research can be conducted in a live classroom, suggests that a new era of research may emerge that furthers understanding of the impact of affective states on language learner speaking performance.

The Present Study: Aims and Hypotheses

In the present study, we assessed moment-to-moment feelings in a university classroom by evaluating the relationship between self-report affective states and HR measures. Our aim was to explore the correlation between HR and self-reported data regarding how students were feeling before, during and after a speaking activity performed by Japanese English learners in a university classroom. By exploring the correlation between HR and self-reports, our goal was to gain further insight into the nature of affective states in a FL classroom during a language speaking performance.

In regards to the relationship between self-reports and HR response, we predicted that HR response and the negative emotional items on our survey (*nervous*, *anxious*, *scared*, *embarrassed* and *distressed*) would follow a similar pattern of change: they would rise pre-performance, they would fall post-performance, and they would decrease over the three sessions. We also predicted that HR response and the item *relaxed* would follow an inverse pattern (i.e., they would decrease pre-performance, they would increase post-performance, and they would increase over the three sessions). The rationale for this hypothesis is that across multiple studies, language learners commonly self-report an increased HR as a reaction to or somatic symptom of anxiety in a FL environment (King, 2013, 2014; King & Smith, 2018; Oxford, 2018; Şimşek & Dörnyei, 2018). Therefore, it is logical to predict that HR would decrease in an inverse pattern as students become more relaxed.

For the positive emotional items *confident*, *interested*, *excited* and *enthusiastic*, we hypothesized that the relationship between self-reports and HR response would vary from individual-to-individual. The rationale for this hypothesis is that previous longitudinal studies have found

that university student attitudes towards learning English may vary from person-to-person, and certain dynamic factors (e.g., confidence, motivation) may affect individuals at unpredictable instances and intensities depending on circumstances within or outside of the learning environment (e.g., the teacher, classmates, a part time job, time constraints, perceptions regarding the value of English) (Fryer & Ainley, 2019; Kikuchi, 2017; Leeming, 2017).

METHOD

Participants

Ten Japanese language learners (5 males and 5 females, mean age = 19.7 years, *SD* = .95) were recruited as participants from a private university in Japan. Students currently or previously enrolled in Level 3 compulsory English classes at the university were sent a message via the online Moodle system, which provided a comprehensive overview of the proposed study (in Japanese) and explained that volunteers would receive a ¥5,000 voucher (approximately US$50) if they completed all 3 sessions. Level 3 students at the university are the highest of 3 levels in the compulsory English program and are considered to be at the A2 level according to the European Common Framework of Reference for Languages (CEFR) (North, 2014). All participants gave written informed consent, and were informed that this study was for research purposes only and not associated with a particular class or the general curriculum.

Measures

The Fitbit Charge 3

In functionality tests (Shachter & Stewart, 2020; Shachter et al., 2020), the Fitbit Charge 2, Fitbit Inspire and Fitbit Charge 3 were piloted and rated for (1) accuracy, (2) user interface and (3) bluetooth connectivity with the Fitbit Data Collection System. In all three categories the Fitbit Charge 3 was found to be the best device (Shachter & Stewart, 2020; Shachter et al., 2020). Consequently, all volunteers in the current study were given their own Fitbit Charge 3 to wear over the period of three classes. At the time of this study, the Fitbit Charge 3 was approximately US$160. The "start run" and "end run" function was extremely useful in allowing us to track time stamps of speaking performances cycles.

The Fitbit Data Collection System (FCDS)

The Fitbit Data Collection System (FDCS) is a research application designed to facilitate measuring HR response related to state feelings in a classroom. Using Fitbit Wristbands and the Fitbit Cloud, the FDCS can track the HRs for multiple test subjects on-demand or automatically. The FDCS was specifically designed and successfully pilot-tested to unobtrusively collect HR measures in the foreign language classroom. This HR data can be aggregated, synchronized and transferred directly to a statistical program for further analysis. For more detailed information about pilot testing and design specifications, see Shachter et al. (2020) and Shachter and Stewart (2020).

Heart Rate as an Indicator of Anxiety

As it was not feasible for the purposes of this study to collect data on participants' resting HRs outside of the classroom context, baseline HR data was collected at the start of each class. In particular, HR data was monitored intermittently throughout the class, enabling the researchers to calculate each participant's relative baseline HR level. This is crucial given that there is high variability in resting HR responses. That is, someone might have a high HR at the time of the testing, making it appear that they are experiencing apprehension or excitement, but in fact their HR is always high. With intermittent tracking of HR responses throughout the class session, this enabled evaluations of how HR changes correlate with participants' own self-report awareness of affective states throughout the course of each targeted learning session.

State Affect Scale (SAS)

Developed by Kangas and Shachter for the purposes of this study, the State Affect Scale (Appendix A) is a 10-item scale comprising four items adapted from: (a) Shachter's (2018) Nervousness Metric, based on a 10-point Likert scale (ranging from 1 = not at all, to 10 = extremely). In particular, two negative affective state items (*nervous*, *anxious*) and two positive affective state items (*relaxed*,

confident) were included based on the 10 point Nervousness Metric scale. A further five items were taken from the PANAS scale (Watson & Clark, 1999) which were based on a 5-point scale (ranging from 1 = very slightly or not at all, to 5 = extremely). The PANAS scale is widely used in affective state research (Crawford & Henry, 2004; Humboldt et al., 2017). Specifically, the five items comprised of two negative affective responses (*scared*, *distressed*) and three positive states (*interested*, *excited*, *enthusiastic*). A sixth item was also added to assess *embarrassed*. "Embarrassed" was added because in multiple studies measuring Japanese FLA, students often report feeling embarrassed when making mistakes in language classes (Botes et al., 2020; Gkonou et al., 2018; Harumi, 2011; King et al., 2020). Moreover, *taijin kyofusho* (i.e., the fear of embarrassing others) is a condition categorized as region-specific (i.e., known to occur in Japan) (Barlow, 2000). "Anxious" is also not listed in the PANAS but was included in the Nervousness Metric section of the self-report because of the link between LL nervousness and FLA (Shachter, 2018).

Tables 1 and 2 show a breakdown of PANAS classifications concerning 8 words used in this data collection (anxious and embarrassed is not listed in PANAS). A professional translator was hired to translate the terms from English to Japanese.

Table 1. *PANAS Classification for Items Based on Nervousness Metric (10-Point Likert)*

Item	PANAS Classification
*nervous (-)	General Dimension Scales (negative affect)
	Basic Negative Emotion Scales (fear)
*relaxed (+)	Other Affective States (serenity)
anxious (-)	Not listed
confident (+)	Basic Positive Emotion Scales (self-assurance)

Note. * Included with original Nervousness Metric (Shachter, 2018)

Table 2. *PANAS Classification for Items Based on PANAS Scales (5-Point Likert)*

Item	PANAS Classification
interested (+)	General Dimension Scales (positive affect)
scared (-)	General Dimension Scales (negative affect)
	Basic Negative Emotion Scales (fear)
excited (+)	General Dimension Scales (positive affect)
	Basic Positive Emotion Scales (joviality)
embarrassed (-)	Not listed
enthusiastic (+)	Basic Positive Emotion Scales (joviality)
distressed (-)	General Dimension Scales (negative affect)

Procedure

Following institutional ethics approval and written participant consent, participant HR measures were monitored via the Fitbit Charge 3 and HR data were aggregated via the Fitbit Data Collection System (FDCS). HR data were correlated with self-reported feelings at three instances: class-start, pre-performance and post-

performance. A class-observed pair dialogue served as the performance component of this study. The State Affect Scale (Appendix A) was used as a self-report assessment.

During the time of data collection all classes in the previous two terms had been delivered online. Sessions one and two were separated by 27 days and sessions two and three were scheduled on consecutive days. This was done to accommodate conflicts and ensure all participants could attend all three sessions. All sessions were held in the afternoon but not at precisely the same times. The first session was held directly before the winter break in the second (final) term of the 2020 school year. Sessions two and three were held after the winter break and after all online language classes had been completed (i.e., all assignments submitted and all tests taken). Before session two, one female participant left the study; therefore, to accommodate for the odd number of remaining participants in sessions two and three, a female volunteer (no data collected) was paid an hourly rate to make even pairs. All remaining (N = 9) participants (5 male, 4 female) attended sessions two and three. The task-design was the same in each session. Performance order, performance pairs, and performance scripts (all CEFR level A2) were all randomized.

Students were first placed in a circular seating arrangement to accommodate a class-observed pair dialogue performance and to ensure students did not need to leave their desks for the duration of the time required to measure HR. After participants reported their "class start" feelings (i.e., after being seated/before receiving scripts), the researcher collected and logged the class-start reports showing when students started the class. Performance scripts (not seen before) were then dispersed to all pairs. All pairs practiced the dialog for approximately 5 minutes. Just before pressing "start run" on their Fitbit, the first performing pair was instructed to complete and submit the State Affect Scale (SAS) for pre-performance feelings. Before a performing pair of students began the class observed practice, participating students were asked to press "start run" on Fitbit and begin performance. Then, in a pre-determined randomized order, pairs performed the dialog uninterrupted for approximately two minutes. To accommodate slower readers, students were told that they did not need to finish the dialog. After the performing pair performed the dialog for the class, participating students were directed to press "stop run" on the Fitbit. Performing pairs were again asked to rate their post-performance feelings on the SAS. State self-reported data were manually transferred into a raw data Excel file. These were paired with HR response data (using HR download settings in the FDCS). Self-reported state feelings and HR measures were organized in Excel at 3 instances over 3 sessions. Manual time logs for class start and time stamps from the "start run" and "end run" (downloaded from the FDCS) allowed for the alignment of state self-reports and HR response.

Data Analysis

The internal validity of the two sections of the SAS was assessed using the statistical software Stata (Version 16). Also using Stata, the hypotheses were tested using multi-level modeling (MLM) to test the relationships between HR response and state affect reports over 3 sessions (3 instances per session). Significance level was set at $p < .05$.

RESULTS

Reliability of the State Affect Scale

The internal consistency of the Nervousness Metric component (4-item/10-point response scale) and the PANAS component (6-item/5-point response scale) of the State Affect Scale were analyzed separately using Stata. The Nervousness Metric component had a coefficient alpha of .90 and the PANAS component had a coefficient alpha of .75. These scores are considered within the acceptable range of .70 to .90 (Tavakol & Dennick, 2011).

Data Overview

Of the initial 10 participants in this study (5 male, 5 female), 9 participants attended all three data collection sessions, whilst one female participant did not attend sessions 2 or 3. However, session 1 data from this female participant was included in the MLM analysis using maximum likelihood estimation which allows for analysis of all available data points including participants with some missing data. Therefore, of the possible 90 observations (10 participants, 3 sessions, 3 instances per session) the following analysis comprises 84 observations.

Examining the Strength of Association Between Self-Assessments and HR Response

For statistical analysis, we organized our MLM layers as follows: intervals (3) within sessions (3) within people (10). This model was used to examine the relationship between the two continuous variables (HR and SAS scores). A series of MLMs were conducted, each with HR as the dependent variable and a different item from the SAS as the independent variable in each analysis.

Firstly, an empty model was tested to see if there was an effect related to the nesting (of instances, within sessions, within people). For the nested nature of the data set, 40% (intraclass correlation = .40) of the variance was due to the effect of session within participant and 33% (intraclass correlation = .33) of the variance was due to individual differences between participants. Next we examined the interaction between intervals (3 instances over 3 sessions) and the SAS item score in predicting HR separately for each SAS item. These interactions were not significant for any SAS item, indicating that the relationship between SAS item and HR did not differ significantly across instances. Therefore, in subsequent analyses only the main effect terms were entered into the models.

Analyses were conducted to test the association between HR and each self-report item individually. Table 3 shows the strength of association on the four items based on a 10-point Likert scale (Nervousness Metric) and Table 4 shows the strength of association on items with a 5-point Likert scale (PANAS).

Table 3. *Strength of Association with HR-Items on 10-Point Likert Scale*

Item	Unstandardized Coefficient	*p*
nervous	0.593	0.094
anxious	0.535	0.146
relaxed	–0.445	0.209
confident	–0.452	0.364

Table 4. *Strength of Association with HR-Items on 5-Point Likert Scale*

Item	Unstandardized Coefficient	*p*
distressed	1.59	*0.034**
embarrassed	1.606	*0.038**
excited	1.762	*0.056*
enthusiastic	0.158	*0.878*
scared	1.004	*0.212*
interested	1.272	*0.261*

Note. *$p < .05$.

Only two items (distress and embarrassment) had a statistically significant positive association with HR ($p < .05$). Unstandardized coefficients results showed that as the scores on these two items increased so did participants' HR response. This was also inversely true (albeit statistically insignificant) in the case of the relaxed and confident items (as the self-reported scores declined so did the HR response). Both the distress and embarrassment items also had similar unstandardized coefficients. These findings indicate that these two items are of approximately equivalent magnitude (1.6) to HR response.

It should be highlighted that because each item was entered separately into the MLMs, the different Likert scales do not influence the results. Such scaling differences would be important if multiple predictors, on different scales, were entered simultaneously into the MLMs. In such a scenario, standardizing the scores (for example, transforming to *z*-scores) would be crucial for interpretation. In the current analyses, however, changing the scale of the scores does not alter the results. All *p* values remain unchanged if predictors are instead entered as *z*-scores.

Patterns of Change Across Three Sessions

Patterns of change were examined by averaging participant HR and SAS scores over the 3 sessions (3 assessment intervals per session). Table 5 shows the patterns of change for HR response.

Table 5. *HR Response Patterns of Change*

Session	Class Start	Pre-Performance	Post-Performance
1	83.3	84	81.1
2	86.2	85.6	85.6
3	83.9	84	79.2

The highest average HR measure was at class start in session 2 (86.2) and the lowest average HR measure was post-performance in session 3 (79.2). The HR measures in session 2 (all instances) were higher than both sessions 1 and 3. The HR measures for sessions 1 and 3 were similar in pattern from class start to pre-performance—there was a slight increase from class start to pre-performance and a larger decrease from pre-performance to post-performance. In session 2, there was a slight decrease from class start to pre-performance and no change from pre-performance to post-performance.

Table 6 shows the patterns of change over 3 sessions (3 instances per session) for the four SAS items measured on the 10-point Likert scale (nervous, anxious, relaxed, confident). None of these four items were found to have a significant relationship with HR response. The three assessment intervals (i.e., class start, pre-performance, post-performances) are categorized within 3 sessions.

Table 6. *Patterns of Change for Self-Reported Measures on 10-Point Scale*

	Session 1			Session 2			Session 3		
	Start	Pre	Post	Start	Pre	Post	Start	Pre	Post
Nervous	4.9	7.1	5.6	3.7	4.6	4.1	2.3	4.4	3.2
Anxious	4.5	5.8	3.8	3.6	4.8	2.7	3.1	3.9	3.3
Relaxed	2.3	4.4	3.2	6.1	4.1	5.8	7.1	6.1	6.7
Confident	4.5	4	4.9	5	4.4	4.6	5.5	5.3	6.1

Regarding nervousness, over the 3 sessions, students consistently reported a rise from class start to pre-performance and a drop from pre-performance to post-performance. The largest increase of nervousness occurred in session 1 (4.9 class start, 7.1 pre-performance) and the largest decrease also occurred in session 1 (7.1 pre-performance, 5.6 post-performance). Self-reports of anxiety followed similar patterns of change as nervousness over the three sessions (e.g., the largest increases and decreases in anxiety were reported in session 1). However, the levels of change were not as large as nervousness. Over the 3 sessions, *nervous* and *anxiety* both started (session 1, class start) and ended (session 3, post-performance) in close proximity: nervousness (4.9–3.2), anxiety (4.5–3.3).

The highest rating (7.1) from the four items on the 10-item scale occurred twice: (a) session 3 (post-performance) for the item *relaxed* and (b) session 1 (class start) for the item *nervous*. Moreover, the lowest rating (2.3) for the four items on the 10-item scale also occurred twice: (a) session 3 (post-performance) for the item *nervous* and (b) session 1 (class start) for the item *relaxed*.

In session 1, reported levels of *relaxed* slightly increased at pre-performance and then decreased at post-performance. This pattern, however, was different than the pattern reported in sessions 2 and 3. In sessions 2 and 3 students reported a decrease on the *relaxed* item from class start to pre-performance and an increase from to pre-performance to post-performance. The largest decrease of the relaxed item occurred in session 2 from class start to pre-performance. The highest self-report of *confidence* occurred in session 3 (post-performance) and the lowest occurred at session 1 (pre-performance). The item *confident* had the lowest range of the four items (4.4–6.1). The highest self-report of *confidence* occurred in session 3 (post-performance) and the lowest occurred at session 1 (pre-performance).

Over the 3 sessions, negative items (nervous, anxious) decreased and positive items (confident, relaxed) increased.

Notwithstanding the item *relaxed* in session 1 (where there was an increase from class start to pre-performance and then a decrease from pre-performance to post-performance), all items followed a similar pattern over the 3 instances. Positive items (confident, relaxed) generally decreased from class start to pre-performance and then increased from pre-performance to post-performance. Negative items (nervous, anxious) were the inverse—there was an increase from class start to pre-performance and a decrease from pre-performance to post-performance.

Table 7 shows the patterns of change over 3 sessions (3 instances per session) for self-reported measures on the 5-point scale (scared, embarrassed, distressed, interested excited, enthusiastic). As noted, only *embarrassed* and *distressed* were found to have a significant relationship with HR response.

Over all 3 sessions the item *scared* followed similar patterns to negative items (i.e., there was a slight increase from class start to pre-performance and a decrease from pre-performance to post-performance). Within these four items, *scared* had the largest increase between instances occurring at session 1 (pre-performance) and the item *excited* had the largest decrease also occurring at session 1 (pre-performance). Regarding the *scared* item, there was a large decrease from session 2 (post-performance) to session 3 (class start). At times, the items *interested*, excited and *enthusiastic* were reported to move at different directions. However, at multiple instances, there were no reported changes in feelings. Overall, *scared* had the lowest ratings.

Distressed and *embarrassed* also moved similarly to other negative items. There were reported increases from class start to pre-performance and reported decreases from pre-performance to post-performance. This was consistent over the 3 sessions. Compared to the *embarrassed* item, *distress* was reported at higher levels in sessions 2 and 3. Moreover, the highest levels of *distress* were reported in session 2 (this aligned with HR response). Both items finished at similar levels (1.7, 1.8) even though *distressed* started at a higher level (2.5, 2). Notwithstanding the *embarrassed* item in session 3 (where the increase and decrease was of equivalent level), the reported decreases of *distressed* and *embarrassed* were larger at post-performance than the reported increases at pre-performance.

Table 7. *Patterns of Change for Self-Reported Measures on 5-Point Likert Scale*

	Session 1			Session 2			Session 3		
	Start	Pre	Post	Start	Pre	Post	Start	Pre	Post
Scared	2.1	2.7	2.6	2.3	2.7	2.4	1.7	2.2	1.8
Embarrassed	2	2.9	2.3	2.4	2.8	2.2	1.8	2.3	1.8
Distressed	2.5	2.7	2	2.6	3.2	2	1.8	2.6	1.7
Interested	4.2	3.9	3.9	3.4	3.4	3.8	3.6	3.7	3.7
Excited	4.1	3.1	3.2	3.4	3.2	3.8	3.9	3.9	3.6
Enthusiastic	3.9	3.9	3.7	3.4	3.8	3.2	3.9	3.9	3.6

DISCUSSION

In this study we tested correlates of subjective affective states that are linked to language speaking performance task reactions in a FL classroom. Only the affective items *distressed* and *embarrassed* were found to have a significant positive relationship with HR response, while the relationship between HR response and self-reported level of *excited* was approaching significance at $p < .05$. Moreover, the unstandardized coefficients of *distress* and *embarrassed* were of similar magnitude proving a significant relationship in this small sample size. *Excited* also had a similar magnitude to *distress* and *embarrassed*. This suggests that students immersed in speaking task performance also show signs of arousal (reflecting excitement). These preliminary results suggest that, with a larger sample size, HR response

measures would significantly align with the feeling of *excited*.

In this study, distress and embarrassment were found to be particularly sensitive to HR. Self-reports indicate that individuals experienced the most distress and embarrassment in session 2 (this aligns with HR response being the highest in session 2). Both items had similar *p* values and almost identical magnitudes. These findings suggest that the students in this study experienced similar feelings of distress, embarrassed and associated somatic reactions as they pertain to HR response. We now turn to a discussion of the eight items with non-significant associations with students' HR response. Following this, we will discuss factors that the literature suggests contribute to Japanese English language learners' feelings of distress and embarrassment during language speaking task performance.

Associations with HR Response: Non-Significant Items

Nervous

The hypothesis that self-reports of nervousness would correlate with HR response was not found to be true in this dataset. The rationale behind this hypothesis was that there is evidence that when language learners become anxious (or nervous) in the classroom, they may experience increased HR levels (King, 2013, 2014; King & Smith, 2018; Oxford, 2018; Şimşek & Dörnyei, 2018). Although not found to have a significant relationship, HR levels did increase as self-report levels increased (albeit at a magnitude of about 1/3 the strength of significant items). These findings indicate that although students report levels of nervousness in similar directions to HR response, the patterns and intensities of change are not aligned consistently.

The predicted pattern of change for self-reported nervousness did occur (i.e., rising at pre-performance, lowering at post-performance, and lowering over time). Shachter (2018) found that self-reports of nervousness steadily decreased over time with the largest decrease occurring between the 1st and 2nd weeks of data collection. In the current study, self-assessments of nervousness were also reported to decrease from session 1 to session 2 even though there was a 27 day break between sessions and data was collected at slightly different times each session. The lowest levels were reported in session 3 which suggest that levels of self-reported nervousness are likely to continue to decrease over time (see also Shachter, 2018). In Shachter (2018), these decreases were attributed to how students became adjusted to the language learning environment.

Self-reported pattern of change findings align with the results of a recent longitudinal empirical study measuring language learning anxiety in university students (Elahi Shirvan & Taherian, 2021). However, results from Pan and Zhang (2021), another recent longitudinal empirical study measuring language learning anxiety in university students, suggest that language learning anxiety does not decrease steadily over time and should instead be considered as a dynamic construct that may be affected by multiple factors (e.g., motivation, attitude, personality traits) at varying intensities over time. The results in Dewaele and Dewaele (2017) also showed that anxiety does not decrease steadily overtime. One difference in the latter study was that students were aged 12–18. Our study's more narrow scope (i.e., in which there were only 3 sessions, with paid recruitment, where students were only required to practice and perform a dialogue, with only 10 university students of the same age, and no grading) may be a reason as to why this data appears less dynamic then the previously mentioned studies (Dewaele & Dewaele, 2017; Pan & Zhang, 2021), which found more inconsistent patterns over time.

Anxious

Like nervous, the hypothesis that self-reports of anxiety would correlate with HR response was also not found to be true in this data collection. The rationale for this hypothesis was identical to the rationale for nervous: previous studies (e.g., King, 2013, 2014; King & Smith, 2018; Oxford, 2018; Şimşek & Dörnyei, 2018) have found that language learning anxiety increases, so does HR. Although neither item was found to have a significant association with HR response, as predicted, the findings for nervousness and anxiety in this study were similar. For example, HR and self-reports for both nervous and anxiety travelled in the same direction with magnitudes of similar strength (approximately 1/3 of the strength of significant items). Like nervousness, levels of anxiety also gradually decreased as predicted over the 3 sessions. As noted, these findings (i.e., anxiety/nervousness will decrease steadily over time) support other empirical longitudinal studies tracking language learning anxiety (e.g., Elahi Shirvan & Taherian, 2021; Shachter, 2018).

There were however, slight differences between the findings for nervousness and anxiety. For example, the rate of decrease for anxiety was more consistent over the 3 sessions; unlike nervous, there was not a large decrease from session 1 to session 2. Another slight difference was that the lowest levels of post-performance anxiety were reported in session 2 (nervous was session 3). Even though nervousness and anxiety are often used interchangeably in the language learning anxiety literature (Gkonou et al., 2018; Shachter, 2018; Waninge, 2015), the findings in this study, albeit from a small sample size, suggest that individuals experience nervousness and anxiety in varying degrees (i.e., the items are not perceived as identical in meaning).

Relaxed

We predicted that there would be a significant relationship between HR response and self-reported relaxed feelings and that this relationship would resemble an inverse pattern to the predicted relationship between HR response and nervousness. Self-reported levels of the item relaxed did decrease as HR decreased but the predicted significant relationship to HR response was not found. However, as predicted, students did gradually become more relaxed over the 3 sessions with the highest levels reported in sessions 3.

There are a few reasons why language learners may have gradually felt more relaxed over the 3 sessions. Firstly, students in this study were not required to produce their own original thoughts or ideas nor interact with other students and teachers in a conventional communicative lesson. Additionally, students in this study remained seated at the same desk in each session and only spoke to one person each session (albeit a different person and desk each session). Secondly, it has been found that anxious language learners are more relaxed with teachers who serve a role as more of a facilitator, guiding students through activities (Gkonou et al., 2018). The researcher in the current study avoided any error correction and served as a facilitator rather than as a teacher.

In regards to the required speaking tasks in this study, dialogue practice and dialogue performance, Bao (2020) highlights how certain tasks (e.g., spontaneous reaction, discussion) are more anxiety-provoking than others. Because students were only required to practice and perform a dialogue without teacher correction there was no opportunity for students to be singled out for making mistakes. Through targeted interviews, Bao (2020) found that students are more relaxed when engaging in informal tasks that do not involve a right or wrong answer, as was the case in this study. The findings of this study show a clear pattern of change for self-reported feelings of relaxed over 3 sessions, but the relationship with HR response and those feelings remains unclear.

Confident

We predicted that confidence levels would vary from person-to-person and may not follow a consistent pattern when averaged over time or correlated with HR response. However, our findings suggest that individuals in this study did in fact experience relaxation and confidence in similar and relatively consistent patterns and intensities (i.e., consistently lowering at pre-performance, rising at post-performance, rising over time). Although insignificant, self-reports of confidence decreased as HR response decreased with a magnitude similar to self-reports of relaxed (about 1/3 of the magnitude of significant items). Like the item relaxed, self-reports of confidence over the 3 sessions suggest that the student confidence levels gradually increased over the 3 sessions with the highest report occurring at post-performance session 3.

Similar to the findings regarding relaxed, these increases could be attributed to the fact that students became more accustomed to the tasks required and subsequently their confidence increased (Bao, 2020). Moreover, no official assessment was associated with the required speaking tasks in this study. Leeming (2017) found that confidence levels of Japanese language learners increased during speaking activities when they were reminded that specific elements (e.g., grammar accuracy) are not officially assessed. Another factor that should be considered is the possibility that individuals who volunteered for this study may have been confident English speakers (i.e., low-confidence individuals avoid this type of performance scenario). This could account for rising confidence levels as low anxious language learners are more likely to be confident and optimistic about their performance than high anxious language learners (Oxford, 2018).

Interested

In recent years, research into the role that language learner interest plays in their motivation has increased (e.g., Claro, 2019; Fryer & Ainley, 2019; Muir, 2020). In a series of semi-structured interviews with university English language learners, Waninge (2015) concluded that interest was a powerful dynamic attractor state that can influence learner motivations. However, accurately identifying patterns and intensities of interest over groups in longitudinal studies can be difficult due to the fact that interest often varies considerably between individuals over time (Fryer & Ainley, 2019; Kikuchi, 2017; Leeming, 2017).

In this study, as predicted, patterns of changed for self-reported feelings of interested varied from person-to-person; and, when averaged and examined over 3 sessions, no consistent pattern was found. Even though HR response and interested were found to move in similar upward directions (i.e., when self-report levels increased so did HR response), the findings suggest that when aligned, the association was very weak. Even with a small sample size and shorter timeframe than other longitudinal studies (e.g., Fryer & Ainley, 2019; Kikuchi, 2017; Leeming, 2017), findings from this study suggest that learner interest does indeed vary between individuals and in different intensities over time.

Enthusiastic

Of the eight non-significant items, the magnitude of relationship between enthusiastic and HR was the lowest of all 10 items. This suggests that when aligned relationships were very weak. Muir (2020) highlights the importance of building off the enthusiasm that language learners may have at the beginning of the term or when starting new projects. Self-reports of enthusiasm did not exceed levels reported in session 1 which suggests that language learner enthusiasm for this project did occur at the start of this research project. Of the non-significant items, the *p* values for correlations between HR response-excited and HR response-enthusiastic were closest in proximity. These findings suggest that the relationships between HR response-excited and HR response-enthusiastic are similar. However, because of the low magnitude of the HR response-enthusiastic relationship, it is unclear how similar the intensity of these feelings (excited, enthusiastic) may be on an individual-to-individual basis.

In empirical research focusing on British high school language learners, Dewaele et al. (2018) found that the personality and attitudes of a teacher can greatly boost the enthusiasm of language learners. However, in this study, the researcher (or other students) provided neither positive nor negative feedback. This suggests that levels of enthusiasm reported in this study were most likely limited to the construct of interaction (e.g., sitting in a circle, practicing and performing an English dialogue, participating in research, wearing Fitbits, or the prospect of receiving compensation for participating in a research activity).

Excited

The concept of positive arousal has been consistently cited in performance psychology research since the experiments of Yerkes and Dodson (1908) (e.g., Teigen, 1994; Hardy, 1999; Schmidt, et al., 2020). When stimulating mice with varying intensities of electric shock to instigate performance (i.e., choosing the correct door in a maze), the findings of Yerkes and Dodson (1908) suggested that peak performance is associated with moderate levels of stimulus. Furthermore, an inverted U shape was evident where weaker performance occurred at very high and low levels of shock. Building off the incipient research of Yerkes and Dodson (1908) performance psychology researchers over the past century (e.g., Hardy, 1999; Schmidt, et al., 2020) have found that peak performance occurs when individuals experience stimulus in degrees that can boost arousal without inducing debilitating stress.

Of the non-significant items, the magnitude of excited was very similar to several significant items (distressed, embarrassed). This suggests that HR response and self-reported feelings of excited travelled in the same direction and with similar intensities. However, when looking at averaged self-reports over 3 sessions, no clear pattern was evident. In fact, all 3 sessions had completely unique patterns of change. Excited was the only item where this phenomenon occurred (i.e., clear patterns in self-reports were not evident over the 3 sessions, yet the relationship between HR response and self-reports approached significance). As noted, rising and falling HRs is a common symptom in individuals experiencing anxiety (Lindquist,

2020). However, both the range of change for HR response and self-reports for excited were less pronounced than the range pertaining to self-reports for significant items (distressed, embarrassed). As there were no formal assessments or post-performance interviews, the findings of this study are unclear regarding the intensity at which individuals experienced positive arousal as opposed to debilitating stress.

Scared

Of the non-significant items, scared had a magnitude of approximately 2/3 the strength of significant items. Reported changes *within* sessions followed a predictable pattern (i.e., increasing from class start to pre-performance and decreasing from pre- to post-performance); and like nervous and anxious, the lowest levels of scared were reported in session 3. Also, there were more pronounced decreases from pre- to post-performance over the 3 sessions, with the most pronounced decrease occurring in session 3. However, scared differed from anxious and nervous in that self-reported feelings did not gradually decrease over the 3 sessions. Results from this study suggest that learners experienced similar feelings of being scared in sessions 1 and 2 followed by a clear decrease in session 3. This is in contrast to reports of nervous where the largest decrease occurred between sessions 1 and 2 (and anxious being more even over the 3 sessions).

There are a variety of reasons why Japanese language learners may experience being scared or fearful in the classroom, including fear of negative evaluation, fear of making mistakes, fear of embarrassment, or fear of alienation (Humphries et al., 2020; King, 2014; King et al., 2020; Ohata, 2005; Sim & Roger, 2016). In this study, however, there were no opportunities for formal or informal assessments, feedback, individuals to speak alone, students to quickly react or instigate conversations, or for casual conversations of any kind that may have isolated individuals within the group.

Therefore, it is possible that students in this study experienced the fear of making mistakes and the fear of negative evaluation more through the lens of a social evaluation rather than academic assessment. It is also possible individuals experienced an anxiety condition specific to Japan: *taijin kyofusho* (i.e., the fear of embarrassing others). However, this is unlikely because individuals with existing anxieties will most likely avoid social situations of this kind (i.e., non-compulsory English speaking activities) (King, 2014). In summary, feelings of being scared did follow a hypothesized pattern of change, and there is evidence the individuals may experience being scared, nervous and anxious in varying intensity levels over time.

We now turn to a discussion of factors that the literature suggests contributes to Japanese language learners' feelings of distress and embarrassment during language speaking task performance.

Factors Contributing to Distress and Embarrassment

As highlighted, the feelings of distress and embarrassment had a significant positive correlation with HR response. Previous studies (e.g., King, 2013, 2014; King & Smith, 2018; Oxford, 2018; Şimşek & Dörnyei, 2018) have found that when negative affective states increase, so does HR. While there are many possible reasons why Japanese English language learners may experience distress or embarrassment during speaking task performance in the language classroom (e.g., low proficiency, personality traits), the literature suggests that the fear of making mistakes and perfectionism, interactional domains, and cultural communication styles are leading factors.

Fear of Making Mistakes and Perfectionism

One of the predominant factors that can lead to embarrassment and distress in the L2 classroom is the fear of making mistakes (Botes et al., 2020; Gkonou et al., 2018; Humphries et al., 2020; King et al., 2020). Moreover, embarrassment (or the fear of embarrassment) is consistently cited as a reason why learners fear making mistakes (Gkonou et al., 2018; Ohata, 2005; Woodrow, 2006). Individuals with an extreme aversion to mistakes may actually be perfectionists or often experience perfectionistic tendencies (Wang et al., 2018). While perfectionism is not necessarily a negative trait, an individual's tolerance for mistakes (or lack thereof) can cause distress in a language learning environment (Dewaele, 2018). In L2 empirical research, perfectionism has positively correlated with anxiety (Dewaele, 2018;

Gregersen & Horwitz, 2002; Pishghadam & Akhondpoor, 2011). In particular, Dewaele (2018) found a significant correlation between perfectionism and FLA across multiple nationalities (Japanese, Saudi, French, German, etc.). In a study focusing on Japanese language learners specifically, some students reported that they were willing to sacrifice fluency (in the form of frequent pausing) for accuracy (Fujio, 2010).

It should be noted that high levels of perfectionism in students (especially anxious ones) are found in university samples around the world (e.g., Al-Naggar, 2013; Dewaele, 2018; Vicent et al., 2019). More broadly, perfectionism can interfere with a healthy approach to learning any subject: perfectionists have an aversion to learning activities that involve trial and error (Dewaele, 2018; Flett et al., 2016). And in turn, aversion to mistakes can be directly attributed to the fear of social embarrassment (Oxford, 2018). In regards to language learning specifically, individuals with perfectionist tendencies are more likely to remain silent in the classroom (Flett et al., 2016). This of course is an extreme continuation of Fujio's (2010) finding that Japanese students preferred frequent pauses and periods of silence to avoid mistakes.

Interactional Domains

Group formation used in communicative language pedagogy (i.e., CLT) has been found to negative influence learners' willingness to communicate (Matsumoto, 2008). Interestingly, CLT in of itself has also been cited as a potential cause of distress or embarrassment for Japanese language learners (Cutrone, 2009; Glasgow, 2014; Humphries & Burns, 2015; Maftoon & Ziafar, 2013). In CLT, a variety of groups are formed with the goal of acquiring language cooperatively (Ju, 2013). This pedagogy is in contrast to the traditional educational system in Japan where information is generally transferred directly from the teacher to the student (Glasgow, 2014; Maftoon & Ziafar, 2013; Ono, 2007; Saito 2006). In CLT, interpersonal relationships and dynamics between individual students, groups of students, and the teacher can shift frequently in a single class session. In the Japanese education system, however, students in some pre-university language classes are expected to remain seated quietly at their desks for the duration of a language class (Glasgow, 2014; Humphries & Burns, 2015; Matsumoto, 2008). Compared to Western students who are more familiar with CLT, Japanese students may experience more distress when interpersonal class dynamics or interactional domains are shifted (Cutrone, 2009; Glasgow, 2014). Distress or embarrassment associated with these variables can influence a learner's motivation or willingness to communicate (MacIntyre, 2007; Macintyre et al., 1998). It should be noted that there were in fact no abrupt shifts regarding interactional domains in this study. However, the volunteers in this study did participate in class-observed pair activities with a stranger (while desks were placed in a circle), which is something students in Japan would most likely not have done in pre-university language classes (Glasgow, 2014; Humpries & Burns, 2015). Moreover, classes at the university where this study was conducted rarely employ a circular seating arrangement. In fact, many lecture halls in the university where this study was held have seats bolted to the floor in a rank and file order. These seats are facing a stage where the professor lectures from.

Regarding the circular arrangement of desks, one study found that placing desks in a circular design had a positive effect on the social dynamics by increasing empathy in a Japanese L2 classroom (Falout, 2014). By moving desks into a circle, Falout (2014) claimed that classroom dynamics were shifted from a rank-and-file lecture hall to a collaborative social environment. So while students may be distressed or embarrassed by frequent changes to interactional domains (Cutrone, 2009; Macintyre et al., 1998; Maftoon & Ziafar, 2013), a consistent circular classroom arrangement may help create an empathetic environment where language learners support each other's mistakes and consequently lower the intensity, and possible occurrence, of distress and embarrassment in the L2 classroom (Falout, 2014).

The findings of the current study, however, suggest that students' feelings of distress and embarrassment were not mitigated by a circular seating arrangement. As for why this might be, students in the Falout (2014) study had class time allotted to offer support and positive feedback to their classmates. Falout (2014) claimed that these actions helped to form a more cohesive, supportive group of students. Falout's findings are supported by Rubio-Alcalá (2018) who also found that allocating class time to support student concerns relieved students' anxiety. In this study, however, there was no interaction between students, or between the students and researcher, beyond the practice session and the

performance. Moreover, the circular seating arrangement ensured all students could observe every performance.

Cultural Norms Related to Relationships and Communication Style

Another factor that can cause embarrassment and distress in language speaking performance contexts (especially in a paired activity) pertain to relationships and communication styles. Watzlawick et al. (1967) identified two styles of relationships and communication styles: symmetrical or complimentary. With symmetrical communication, partners tend to reinforce equality—this can be done my mirroring speech, idioms, or gestures. Symmetrical relationships are more prevalent in Western countries (Ishii, 1987). With complimentary relationships on the other hand, individuals take effort to define status and hierarchal roles (Sakuragi, 2004). Japanese people spend considerable effort and cognitive resources to ensure complimentary relationships are defined and maintained. For example, honorifics and Kiego (a formal form of Japanese) are used in a variety of occasions. Sakuragi (2004) posits that both the effort needed to maintain polite behavior and the fear of making etiquette mistakes causes some Japanese people to remain silent in social situations, and therefore, they may categorize themselves as shy. From a broader psychological perspective, communication apprehension may be considered a form of shyness (Sakuragi, 2004). Especially when there are no icebreakers or chances for individuals to establish relationship parameters (e.g., age), these dynamics may cause distress and embarrassment to Japanese language learners during speaking task performance. Indeed, in the current study, no such opportunities were offered to the participants.

CONCLUSION

In this pilot study, we examined how affective states unfold in a university language classroom by analyzing the relationships between self-assessments of state feelings and HR response before, during, and after a speaking activity. In response to previous studies warning how obtrusive methodologies may affect participants in naturalistic settings (e.g., Gregersen et al., 2014; Kantor et al., 2001), we collected HR data using Fitbit smart watches while students were seated at their desks. Although feelings of excitement approached significance, only the feelings of distress and embarrassment were found to have a significant relationship with HR response. From our sample of 10 discrete feelings, this indicates distress and embarrassment are more sensitive to elevated HR response reactions. With larger sample sizes, however, excitement may also prove to be significant. We have noted that the literature suggests that Japanese language learners' feelings of distress and embarrassment during speaking performance are often linked to the fear of making mistakes and perfectionism, interactional domains, and cultural norms related to relationships and communication style.

Our findings support the need for further investigations that consider physiological parameters in FL performance research designs. With the wider availability and access to technology, we hope that other researchers will also be able to track affective states and physiological changes in a classroom with more ease than in previous generations. Considering the dynamic nature of emotions in the FL classroom, the real-time (i.e., moment-to-moment) assessment of affective states has the potential to assist in identifying when shifts in affect occur, with the potential for these shifts to inform future interventions. Using a combination of subjective and objective measures may be a more appropriate research design when drawing conclusions concerning language learner state affect and corresponding behavior.

One limitation of this study was that we were only able to obtain a sample of 10 participants. However, because we used MLM statistical analysis, we were able to examine 84 of a possible 90 data observations. The fact that a significant relationship was still found in this study between HR response and the self-reported feelings of distress and embarrassment is a motivating factor to continue investigating strength of relationships between HR response and momentary state assessments in classroom environments. With a larger sample size, the relationship between HR and other discrete emotions may prove significant. We encourage the replication of this study with the aim of verifying and extending our findings. Additionally, longitudinal experimental classroom research could be conducted with control groups and interventions aimed at reducing negative affective states and improving speaking performance. In addition to targeted self-report scales and interviews, objective HR measures may help researchers to determine with more accuracy the

effectiveness of a specific intervention and to more accurately determine how language learners are feeling at specific moments during a class and over longer-term periods.

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Authors' Contributions

The lead author participated in the design of the study, completed the data collection, assisted in data analysis and primarily drafted the manuscript. The second author assisted in the design the State Affect Scale and contributed significant edits to manuscript. The third author lead the statistical analysis and contributed edits to manuscript. The 2nd and 3rd author also contributed input to the design, research proposal and ethics process. The fourth author helped craft the initial research design, provided guidance during data collection, and edits to the final draft.

Ethics Approval & Consent to Participate

This study was approved by the Macquarie University Research Ethics Committee (approval no. 52019592912516). All participants provided written informed consent prior to enrollment and data collection in the study.

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APPENDIX

State Affective Scale (SAS)

On a scale of 1 to 10, please indicate how you are feeling right now.

1) Nervous:

1	2	3	4	5	6	7	8	9	10

(Not at all nervous) (*Extremely nervous)*

2) Relaxed

1	2	3	4	5	6	7	8	9	10

(Not at all relaxed) (*Extremely relaxed)*

3) Anxious

1	2	3	4	5	6	7	8	9	10

(Not at all anxious) (*Extremely anxious)*

4) Confident

1	2	3	4	5	6	7	8	9	10

(Not at all confident) (*Extremely confident)*

Please indicate the extent you are NOW currently feeling:

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
	1	2	3	4	5
5. Interested	1	2	3	4	5
6. Scared	1	2	3	4	5
7. Excited	1	2	3	4	5
8. Embarrassed	1	2	3	4	5
9. Enthusiastic	1	2	3	4	5
10. Distressed	1	2	3	4	5