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Department of English Studies, Faculty of Pedagogy and Fine Arts, Adam Mickiewicz University, Kalisz
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Heart rate variability and personality traits as predictors of Arabic language proficiency and gains during study abroad in Jordan

Kirk Belnap ✉
Brigham Young University, Provo, USA
https://orcid.org/0000-0003-4607-4366
belnap@byu.edu

Dan P. Dewey
Brigham Young University, Provo, USA
https://orcid.org/0000-0003-1453-4153
ddewey@byu.edu

Patrick Steffen
Brigham Young University, Provo, USA
https://orcid.org/0000-0002-3647-0456
steffen@byu.edu

Annika Barrick Bickmore
Brigham Young University, Provo, USA
https://orcid.org/0009-0009-4667-9921
annikabarrick@gmail.com

Khalil Yousef
Brigham Young University, Provo, USA
https://orcid.org/0000-0002-9222-0048
khiyousef1@gmail.com

Abstract

High stress predicts mood and anxiety disorders and can necessitate clinical intervention (Steffen et al., 2014). Language learners often experience high stress during intensive study abroad (SA) programs (Dewey et al., 2018), which can hinder communication (Buttaro, 2004; Peck, 1974). Acculturative stress is common among second language (L2) speakers and can coincide with stress related to the inability to communicate one's thoughts and ideas (Savicki, 2010), further complicating communication. Therefore, reducing stress in immersive settings can be crucial due to the link between stress, L2 use, and psychological well-being (Dewaele & Dewaele, 2021). We report an exploratory investigation of the relationship between heart rate variability – a physiological measure of adaptation and positive functioning in stressful conditions – and personality and how these relate to the linguistic development of 21 students studying L2 Arabic intensively for 13 weeks, including heart rate variability (HRV), personality assessments, and language proficiency. This research demonstrates a key link: Personality traits predicted HRV, and HRV predicted Arabic language acquisition and its progression during SA. These findings highlight the potential of using HRV data, alongside other metrics, to improve L2 learners' SA experience by addressing the influence of anxiety and emotions.

Keywords: heart rate variability; personality; second language proficiency; anxiety; conscientiousness

1. Introduction

MacIntyre (2017) characterized anxiety as "the most widely studied emotion in second language acquisition (SLA), perhaps because it is both an intense and a frequent experience" (p. 11). In the context of SLA, anxiety generally refers to "the feeling of tension and apprehension specifically associated with second language contexts, including speaking, listening, and learning" (MacIntyre & Gardner, 1994, p. 284). The majority of research on SLA and anxiety has involved classroom learning, but learners can experience significant anxiety outside of the classroom as well. For example, Dewey et al. (2018) found that some learners participating in an intensive Arabic study abroad (SA) program in Amman, Jordan, experienced anxiety at a level comparable to someone who had recently been through a divorce.

A large percentage of anxiety-related research has involved survey data, perhaps both for practical and empirical reasons: Surveys are cost-effective and easy to administer, and those typically used in SLA studies have been well validated and widely used. However, there are other ways of measuring anxiety, including the use of physiological measures, such as increased blood pressure, heart rate, breathing rate, and galvanic skin response, among others (Irving et

al., 2009). Such physiological measures have been less practical than surveys in the past due to cost, inaccessibility and lack of training. However, the invention of simple electronic devices, such as fitness bands and small portable blood pressure cuffs, is making such measures more practical.

While anxiety can be a clinical state and is used to refer to that state in the literature on psychopathology, it is also typically viewed as an anticipatory stressor or a worry about an event that has occurred, is occurring, or might occur (Anisman, 2015). SLA anxiety-related research tends to focus on this latter type of anxiety. In the current study, we use heart rate (HR) and heart rate variability (HRV) as indicators of such anxiety, and we combine these measures with survey data, weekly reports and interviews.

HRV, the variation in time between heartbeats, is a measure of adaptive regulation, which impacts how well the body handles stress. Given that relatively inexpensive technologies such as the Apple Watch are able to measure HRV, language learners can now monitor if their ability to learn is compromised due to stress or other factors (Hernando et al., 2018). This study examines HRV, personality and linguistic performance, and their ability to predict oral proficiency gains during SA.

2. Literature review

2.1. HR and HRV as predictors of second language (L2) acquisition

In studies related to second language acquisition, physiological measures such as HR, HRV and blood pressure have been used to examine connections between these physiological measures. Fox (2017) included HRV among multiple predictor variables and found that HRV did not prove to be a significant predictor, but "changes in heart rate and skin conductance levels influenced performance on the paired-associates vocabulary-learning task" (p. ii). Shachter et al. (2022) had students engage in classroom speaking practice tasks while wearing HR monitors and later self-report their stress levels. They found that "elevated self-reported state feelings of distress and embarrassment were found to be significantly positively related with elevated HR response" (p. 1). Their interest, however, was more in how affective states unfold rather than in linguistic development, so they did not connect affect with linguistic performance or development. In another SLA-related study, Hardacre et al. (2021) studied the effects of anxiety on teacher credential candidates and found that factors such as having been born outside of the country and length of time living in the country were predictors of stress levels measured by HR, etc. Linguistic abilities in the language these teachers were being tested in were likely a contributor to these participants' anxiety.

Outside the SLA field, HR-related measures have been used to study exam-related stress. For example, Kumar et al. (2013) studied medical students, taking HRV measures during a college cultural week (baseline), at the time of a viva voce examination, and during a professional examination. They found that ". . . almost all HRV features measuring heart rate complexity were decreased in the stress period results indicating a decline in HRV during stress" (p. 83). In short, HRV changes were indicative of exam-related stress levels. Evidence from HR and HRV measures of stress is common in research on test anxiety (Lucini et al., 2002).

HRV and HR have been used to examine cognitive load as well. In two domains where errors have severe consequences, medicine and air flight, HR and HRV have been used to predict errors, mental fatigue, and clinical reasoning. For example, Lämsä et al. (2023) found that HRV could predict pilots' performance during virtual flight (with low HRV correlated with poor performance). Similarly, Solhjoo et al. (2019) found that HR and HRV were predictors of the accuracy of clinical judgments and self-reported cognitive load for medical practitioners. Mental fatigue, a factor that can come from long hours practicing medicine, comes with time on task and can be predicted using HRV (Melo et al., 2017). Finally, in research focused on nurses, Goodyke et al. (2022) found that social support is associated with HRV (the more social support, the greater HRV).

In their study of stress, anxiety, and SLA during SA in the Middle East, Dewey et al. (2018) operationalized stress using cortisol level sampling. Cortisol, a hormone released by the adrenal glands that increases in response to stress, helps the body manage energy and maintain homeostasis, but prolonged high levels of cortisol due to chronic stress can lead to negative effects, such as weakened immune function, impaired cognitive performance, and increased risk of health issues such as hypertension and anxiety. High levels of cortisol are also associated with diabetes mellitus, depression, osteoporosis and chronic obstructive pulmonary disease (Schoorlemmer et al., 2009). Given the negative effects of this level of stress on one's health and cognitive performance, better understanding and hopefully assisting students to deal with the anxiety arising from language learning could be key to their thriving, as has proven to be the case in other settings. Cortisol levels are typically significantly correlated with HR and HRV when stress levels are high (Looser et al., 2010). Given that HR and HRV data can be measured on-the-spot without complex sampling and lab testing, this data is much more practical than cortisol level assessment.

2.2. Study abroad, anxiety and personality

SA literature regularly addresses the need to focus on the learner as a whole and not just on language learning (see Allen & Herron, 2003; Jackson, 2011,

Kinginger, 2008, 2009, for examples). Helping learners deal with the psychological challenges of living and learning abroad through pre-departure preparation is a major theme in this literature, as is provision of in-country support. Through such pre-departure preparation and in-country support, learners are able to better cope with challenges such as ebbs and flows of motivation, self-regulation and time-management issues, and stress and anxiety resulting from intensive language instruction and daily immersion in their L2.

Research on SA and anxiety is not scarce, yet there remains a need for more comprehensive exploration. In the existing scholarship, there are studies connecting anxiety levels with acculturation (e.g., Savicki, 2010) and others examining stress management and psychological well-being (e.g., Armstead, 2017). One influential study by Allen and Herron (2003) employed a mixed-methods approach to analyze anxiety patterns in 25 learners of French during a 6-week program in Paris. To assess different dimensions of language learning anxiety, the researchers used three instruments: the *Foreign Language Classroom Anxiety Survey* (FLCAS) to evaluate anxiety within the classroom setting (Horwitz et al., 1986), the *French Use Anxiety Scale* to measure anxiety during communicative interactions outside the classroom (Tremblay & Gardner, 1995), and a custom *State Anxiety Questionnaire* designed to gauge learners' anxiety levels during the language assessments conducted as part of the study. This quantitative data was complemented with open-ended surveys and post-SA interviews, providing insights into the sources and manifestations of anxiety. The study found a reduction in anxiety across all measures as the SA period progressed. Early insecurities about language competence and cultural unfamiliarity gradually gave way to greater confidence and calm, a shift attributed to the students' success in everyday interactions involving "goods and services, wants and needs, and communication with native speakers" (Allen & Herron, 2003, p. 378). These achievements likely contributed to the observed decrease in anxiety as students adapted to daily life abroad.

The pattern of declining anxiety over the duration of SA found by Allen and Herron (2003) was supported by subsequent studies. Hessel (2016), for instance, observed that anxiety related to using English decreased significantly over the first three months for 143 German students in the UK. Employing a set of new items to measure anxiety in out-of-class interactions with native and non-native English speakers, the study provided further evidence of anxiety reduction over time. Focusing on a different group of learners and taking a cross-sectional, post-SA approach, Thompson and Lee (2014) found that Korean learners of English with extended time abroad (a year or more) reported lower FLCAS scores compared to those with limited SA experience. Their findings suggest that while initial time abroad may heighten anxiety, longer stays tend to reduce it, mirroring MacIntyre and Gardner's (1994) observation that anxiety decreases

with prolonged exposure abroad. Roitblat et al. (2017) also noted that anxiety tends to peak in the initial weeks of SA, indicating that this early period may be particularly challenging for students.

In exploring the link between anxiety and L2 proficiency, research has shown anxiety can be used both as a predictor of L2 proficiency gains over SA and as a variable to be predicted by L2 proficiency. For example, Hessel (2016) found that anxiety, along with other variables, could help predict L2 proficiency improvements among German learners. Conversely, Alhammad (2017) noted that English proficiency was a strong predictor of classroom anxiety levels among Saudi students learning English in Ireland. This ongoing question of causation – whether anxiety influences L2 proficiency or vice versa – remains unresolved in both SLA and SA research (MacIntyre, 2017), particularly given the mix of language exposure during SA, where acquisition occurs both in and outside the classroom.

Personality is a key variable associated with individual differences in SLA. Chen et al. (2022), in a large meta-analysis of studies, found that the factors of conscientiousness, extraversion, agreeableness, and openness were positively associated with L2 learning achievement, whereas neuroticism had a non-significant negative correlation. Personality traits have been shown to correlate significantly with perceived L2 proficiency gains during SA (Arvidsson et al., 2018; Ożańska-Ponikwia & Dewaele, 2012) but did not prove to be a significant predictor in Baker-Smemoe et al.'s (2014) regression model involving oral proficiency test scores. They did, however, prove to correlate significantly with Iranian students' International English Language System (IELTS) scores and overseas academic success (Erfani & Mardan, 2017). Specifically, they found large positive correlations between language proficiency and conscientiousness, extraversion, agreeableness, and openness, and a large negative correlation between language proficiency and neuroticism. Anxiety is a key factor in neuroticism, and people who score higher on the personality trait of neuroticism are more likely to experience anxiety across many aspects of life, including L2 learning.

Personality has been linked with HR variables as well. Several studies have found that neuroticism is related to negative health outcomes and conscientiousness is related to positive health outcomes (Bibbey et al., 2013; Bogg & Roberts, 2013; Brouwer et al., 2014). Furthermore, neuroticism can predispose a person to higher state-related anxiety, which can in turn hinder academic performance (Shin et al., 2023). Extraverted learners may be less susceptible to language learning anxiety in communicative contexts due to greater sociability and risk-taking tendencies (Liu, 2012), and it is possible that high conscientiousness might buffer anxiety through better preparation and organization, leading to increased confidence (Chen et al., 2022). It is important to note that personality is not static but does change over time in response to significant life events, interventions, and consistent effort and focus (Hudson et al., 2019; Roberts et al., 2017). Emphasizing

positive personality traits, and reducing neuroticism and anxiety, can have positive effects on both learning and personality development in student learners.

In short, because personality may both moderate and mediate anxiety levels (Dewaele & MacIntyre, 2019), we assess it as part of this study. In fact, Dewaele and MacIntyre (2019) argue that personality plays a key foundational role in each person's unique way of approaching language learning as well as in how they learn in general. Understanding that there are significant individual differences in how people learn a new language has the potential to improve how we approach language teaching and learning. Given that personality is linked to both learning and heart rate variables, it potentially represents a way to integrate studies of the whole person in the context of second language acquisition. We hope that understanding these moderating and mediating effects will help practitioners understand the needs of various personality types in terms of anxiety moderation. This study builds on prior work by utilizing HRV as a proxy for wellness and stress and employing an established personality inventory (Costa Jr. & McCrae, 2000), investigating their relationship with gains in oral proficiency during SA. Unlike prior studies that focus on shorter periods, this study examines anxiety across a 13-week SA experience, providing a more temporally extensive view of the effect of wellness and personality traits. It builds on past work using physiological indicators, such as Dewey et al. (2018) and Gregersen et al. (2014). The former used hair cortisol samples taken at the beginning and end of study abroad to examine stress over the course of a semester in the Middle East, and the latter used heart rate monitors while giving a video presentation in a Spanish as a foreign language class.

3. The study

3.1. Aims and research questions

This study aims to inform theory, research, and practice related to wellness during SA, in relation to personality traits and oral proficiency gains. In this study, wellness is conceptualized as the inverse of chronic stress and anxiety, a state of physiological and psychological regulation and balance. We operationalize wellness using heart rate variability, a widely used physiological marker associated with adaptive stress regulation and emotional well-being. The research questions guiding our study are:

1. How are HRV and personality traits, as measured by the IPIP-NEO-120 questionnaire (discussed below), related to each other during SA?
2. Does HRV change significantly over the course of SA?
3. Does initial L2 proficiency correlate significantly with HRV?

4. Does initial L2 proficiency correlate significantly with neuroticism and is this suggestive of greater likelihood of experiencing anxiety during SA?
5. Do anxiety-related personality measures predict language gains over the course of SA?

3.2. Participants and the SA program

Participants were L2 learners of Arabic (8 females, 13 males, ages 20-28) enrolled in an intensive, semester-long SA program in Amman, Jordan, all from a large private university in the United States where the emphasis prior to SA was to use Levantine for speaking and formal Arabic for reading and writing. All were native speakers of English. One was born in Sudan and exposed to Arabic at home, but this student's English was indistinguishable from the others and her speaking ability in Arabic was on par with other students at the beginning and end of the SA. Apart from one student who learned Arabic during military service, all of the students completed four rigorous semesters of Arabic instruction (50 minutes per day, 5 days per week) prior to leaving for Jordan and were required to pass with at least a B- in the third- and fourth-semester classes to be accepted into the program. One student arrived in Jordan in early May for an internship and benefitted from regular coaching from an experienced Arabic teacher; accordingly, this student scored *advanced low* at the outset of the SA program and *advanced high* at the end on the American Council on the Teaching of Foreign Languages (ACTFL) Oral Proficiency Interview (OPI) (see http://www.languagetesting.com for details on the interview and scoring). The average score at the start was *intermediate mid*, roughly equivalent to A2/B1 according to the descriptors in the *Common European Framework of Reference for Languages* (Council of Europe, 2001).

The study abroad program was directed by a faculty member from the home institution and followed a structured weekday schedule. Each day included a two-hour content class in Arabic, focused on discussing key societal issues in Jordan. This was followed by a 75-minute language course centered on vocabulary and structures from current Arabic news, which students were expected to read and listen to independently for about two hours daily. The course occasionally featured guest speakers. Classroom discussions and lectures blended vernacular Arabic with a more formal register. Throughout the week, the program director and two teaching assistants, also from the home university, provided ongoing support in language acquisition and cultural adaptation, both during and outside of class. Students also participated in a weekly 20-minute group reflection session to discuss cross-cultural and language learning challenges, sharing strategies for understanding and coping with these challenges among themselves and with instructional staff in English. Students were required to engage in two hours of daily Arabic conversation with native speakers.

This was partly met through daily 30-minute sessions with trained Arab tutors, typically in a more informal register. Each week, students also completed three 15-minute oral presentations and two 15-minute composition review meetings with native tutors. Nineteen participants lived in apartments near the institute with other program members. Two were married to each other and shared an apartment, while two others lived with spouses who spoke little or no Arabic.

The anxiety that these students experienced stemmed from various causes. They chose to study Arabic aware, to at least some degree, of the considerable cross-cultural differences they would encounter as well as the significant linguistic differences between Arabic and English. Many were drawn to Arabic because it presented a challenge. Most of the participants were experienced second language learners and many had already lived outside the United States for an extended period of time. Some were required to participate in this SA program in Jordan as part of their Middle East Studies major and had come to see that language learning was not their strong suit, at least not at the start of the program. Such learners are prone to compare their progress to faster, more experienced learners and often become discouraged. Competition between peers is another significant source of stress. Female participants embarked also knowing they would likely encounter unwelcome attention from Arab men.

Positively, the students in this research benefited from 25 years of experimentation and program improvement. Students are drawn to this SA program for its reputation as a truly intensive experience that helps them acquire considerable facility in speaking and reading Arabic. External program evaluators regularly report that students are generally at ease despite working hard to meet program requirements. Students were encouraged to recognize and deal with anxiety during pre-departure orientations, and this coaching continued in Jordan, in class and in weekly interviews. The female teaching assistant facilitated a women's group that met periodically to address concerns of women who had experienced or were concerned about experiencing sexual harassment. Every day students were given time in class to respond to the following prompts: "What went well for you yesterday? (listing several things is fine)" and "Why did this go well for you? (think specifically about actions you've taken, but feel free to mention other things as well)." In other words, a variety of interventions were in place to help students cope with various stressors and work through the challenges of SA in Jordan.

3.3. Data collection

To determine how HR varied, personality, and language development were related, how they changed during SA, and how students experienced stress while abroad in Jordan, we gathered data on each as described below.

3.3.1. Instruments

Arabic proficiency was measured using the ACTFL OPI. This is an oral interview conducted by a certified rater (www.languagetesting.com) with ratings of *novice*, *intermediate*, *advanced* or *superior*, and sub-levels of *high*, *mid* and *low*. Students were interviewed face to face by testers during their first and last weeks in Jordan. This study also took into consideration an additional and more comprehensive measure of students' Arabic coming into the SA program, namely, their fourth-semester final exam scores, which covered reading, writing, speaking, and grammar.

As a proxy measurement for wellness and stress, heart rate variability data were collected in the second and penultimate weeks of the program using the BioTrace+ Mind Media system, a respiration belt and pulse oximeter connected to a clinical-grade Nexus biofeedback device. Prior to each session, participants completed a brief guided meditation to establish a baseline. Ten minutes of HRV data were recorded while participants sat quietly and breathed normally.

As for personality measurement, the IPIP-NEO-120, a validated measure of the *Five-Factor Model of Personality* (Goldberg et al., 2006), was administered mid-semester in English. This instrument measures the following factors, with subscales/facets in parentheses: openness (intellectance, novel experience seeking, and nontraditionalism), conscientiousness (self-discipline, dutifulness, deliberation, achievement striving, and order), extraversion (positive temperament, sociability, ascendance, venturesomeness, and frankness), agreeableness (empathy, trust, straightforwardness, and modesty), and neuroticism (anxiety, depression, anger proneness, somatic complaints, and envy). It is publicly available, along with full information on its validity and reliability through the IPIP website (https://ipip.ori.org/). Each trait is assessed through multiple items and associated subscales.

This study employed a qualitative, semi-structured interview methodology rooted in interpretive paradigms of inquiry, aiming to explore students' psychological well-being and coping strategies during their study abroad experience in Jordan. The interviews were not originally designed for research purposes but were later repurposed for thematic analysis, offering rich, contextual insights into learner stress and motivation. The interview process followed a progressive engagement model, wherein the interviewer – a local scholar and language educator external to the program – first established rapport through classroom observations and participation in sociocultural activities. This immersion facilitated trust-building and contextual familiarity, enhancing the depth and authenticity of subsequent interviews.

Two rounds of interviews were conducted with the participants, each lasting approximately 20-25 minutes, the first round after participants' initial six weeks in Jordan, the second after ten weeks. The interviews were conducted in English, to put the students at ease and given that the interviewer's English was

much better than the students' Arabic. Interviews were structured around two thematic domains: (1) interaction with locals and sociocultural adaptation (first round) and (2) stress management and motivational strategies (second round)

Each round was guided by a set of open-ended questions designed to elicit narrative responses, with flexibility for follow-up probing (see Appendix). This approach aligns with semi-structured interviewing techniques that allow for both consistency across participants and responsiveness to individual experiences (Rubin & Rubin, 2011). The interviewer's role was both facilitative and observational, fostering an environment in which participants could articulate their experiences openly.

3.4. Data analysis

Quantitative data were analyzed using both descriptive and inferential statistical methods. Descriptive statistics, including means and standard deviations, were computed for all primary variables of interest (e.g., personality trait scores, heart rate, HRV measures, and language proficiency scores). The data met assumptions of normality. To assess relationships between variables, we used Pearson's *r* correlation coefficients. Correlation analyses were conducted to explore three key areas: (a) the relationships between personality traits and heart rate data, including subscale-level analyses for neuroticism and conscientiousness; (b) associations between stress and L2 proficiency (as measured by pre- and post-program OPI scores and exam scores); and (c) physiological measures of parasympathetic regulation, specifically RMSSD (root mean square of successive differences, a reflection of parasympathetic/vagal activity) and HF-HRV (high frequency heart rate variability, also an indicator of parasympathetic/vagal activity). Effect sizes were interpreted according to Plonsky and Oswald's (2014) guidelines for SLA research: $r \approx .25$ (small), .40 (medium), and .60 (large).

Interviews were analyzed using thematic analysis, following Braun and Clarke's (2006) six-phase framework: familiarization with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. One addition was the possibility of the interviewer follow-up for elaboration or clarification after reviewing his notes. This method of thematic analysis enabled the identification of recurring patterns while preserving the nuances of individual responses. To enhance the trustworthiness of the analysis, initial categories were reviewed, refined, and reduced by a second coder. These refined categories were subsequently cross-validated by an additional researcher, contributing to the credibility and confirmability of these findings.

The interview data were triangulated with classroom observations and informal group discussions, enhancing the credibility and contextual richness of the

findings. While not originally designed as a formal research instrument, the interviews yielded valuable qualitative data that illuminate the interplay between personality, stress, and language development in immersive learning environments.

4. Findings

4.1. Personality-related results

There were several significant correlations between the various personality-related measures and heart rate, two with large and three with medium effect sizes (see Table 1). There was a strong significant positive correlation between those higher on neuroticism and higher heart rate ($r = .62$, $p < .01$). Neuroticism consists of six subscales, with anxiety and vulnerability subscales typically showing the strongest relationships with health. We found that the anxiety subscale positively correlated with heart rate ($r = .45$, $p = .05$) and so did the vulnerability subscale ($r = .64$, $p < .01$). Conscientiousness also demonstrated a strong relationship with heart rate; in this case the relationship was negative, with higher conscientiousness related to lower heart rate ($r = -.54$, $p < .05$). Conscientiousness has six subscales; the self-efficacy subscale showed the strongest relationship with heart rate ($r = -.48$, $p < .05$).

Table 1 Correlations between personality traits and heart rate

Personality trait	Subscale	*r*	*p*	Effect size
Neuroticism	Total score	.62	< .01	Large
Neuroticism	Anxiety	.45	= .05	Medium
Neuroticism	Vulnerability	.64	< .01	Large
Conscientiousness	Total score	-.54	< .05	Medium
Conscientiousness	Self-efficacy	-.48	< .05	Medium

Note. All correlations represent Pearson's *r* values. HR = heart rate. Effect sizes are based on Plonsky & Oswald (2014)

4.2. L2 proficiency predictors

Proficiency-related measures yielded eight significant correlations with HRV or HR, seven with medium effect sizes and one with a small effect size (see Table 2). Two key measures of HRV are the RMSSD and high frequency HRV (HF-HRV), and both are considered measures of parasympathetic functioning and the ability to be calm and relaxed. Pre-OPI scores positively correlated with both RMSSD ($r = .478$, $p < .05$) and HF-HRV ($r = .489$, $p < .05$). Post-OPI scores were also positively

related to RMSSD (r = .558, p = .01) and HF-HRV (r = .518, p < .05). Those who improved most from pre- to post-OPI also showed positive changes in RMSSD (r = .498, p < .05) and HF-HRV (r = .407, p = .053). For the pre-SA Arabic final exam, those with higher HF-HRV had higher scores on their final exam (.36, p < .05) and lower heart rate (-.44, p < .05), indicative of positive health outcomes.

Table 2 Correlations between L2 proficiency measures and HRV or heart rate

Variable	HRV/Heart rate measure	*r*	*p*	Effect size
Pre OPI score	RMSSD	.48	< .05	Medium
Pre OPI score	HF-HRV	.49	< .05	Medium
Post OPI score	RMSSD	.56	= .01	Medium
Post OPI score	HF-HRV	.52	< .05	Medium
OPI score improvement	RMSSD	.50	< .05	Medium
OPI score improvement	HF-HRV	.41	= .053	Medium
Arabic final exam (Pre-SA)	HF-HRV	.36	< .05	Small
Arabic final exam (Pre-SA)	Heart rate	-.44	< .05	Medium

Note. RMSSD and HF-HRV are indicators of parasympathetic nervous system activity. HRV = heart rate variability; HR = heart rate. Effect sizes are based on Plonsky & Oswald (2014)

4.3. Insights from interviews with participants

Thematic analysis of the 11 participant interviews carried out roughly halfway through the program and again near the end revealed three key themes related to stress, adaptation, and social integration during study abroad: (a) initial challenges and cultural transition; (b) coping and growth over time; and (c) gendered experiences and navigational strategies.

4.3.1. Initial challenges and cultural transition

Participants' experiences of the initial transition to life in Jordan varied. While five students described the adjustment as relatively smooth, often attributing this to prior contact with Arabic speakers or Muslims, others reported discomfort linked to language limitations and social anxiety. One student reflected: "My Arabic just isn't good enough to talk to people here. I don't know the dialect. That makes it hard to make friends." Social anxiety and fears of cultural missteps were mentioned by several others, often centered on public interactions or classroom participation. All of the participants who reported being stressed when interviewed at the start of their SA reported being less stressed by the time of their second interview, approximately one month later.

4.3.2. Coping and growth over time

By the time of the second interview, most participants described a reduction in stress and a sense of progress. The only stressor mentioned at this time, two weeks before the end of their time in Jordan, was the homework load. One student who scored *intermediate low* at the start and initially reported feeling overwhelmed daily said: "Yes, every day," when asked about stress but in the second interview emphasized how meaningful it was to experience breakthroughs in local conversations: "I feel like I've accomplished about 70% of what I came here to do." Another participant emphasized the role of social connection: "Making friends outside the school and talking to them about cultural issues – that really helped me feel like I belonged." The same student had down-heartedly reported having no friends outside of the program in the first interview. One interviewee said that he initially "had discomfort when dealing with strangers" but added that by the time of the second interview, it had become easy for him because he often accompanied a classmate who enjoyed talking with people. These narratives suggest that personal agency, peer support, and successful communication were central to the development of emotional resilience. These helped learners effectively deal with social anxiety, cultural misunderstandings, and other such stressors.

4.3.3. Gendered experiences and navigational strategies

Issues of unwanted male attention emerged across interviews, especially among female participants. All three female interviewees and three of the male interviewees referred to instances of harassment or discomfort experienced by women in the group. However, by the end of the program, these female participants described having developed strategies to navigate these encounters. One of them noted: "I avoid certain places and only talk with women and a few men I trust." These adaptations reflect both the emotional toll and the resilience involved in navigating gendered cultural challenges abroad.

5. Discussion

This study contributes to ongoing efforts to understand how students experience and manage stress during study abroad, particularly in relation to language learning outcomes. Prior research has shown that students face a range of psychological challenges before, during, and after international programs (Armstead, 2017), and that these challenges can influence both well-being and intercultural

adjustment. Stress management, including strategies to address negative affect, feelings of threat, and cultural disorientation, has been proposed as an important factor in facilitating successful adaptation (Savicki, 2010). Consistent with this view, our findings suggest that students who demonstrate stronger coping strategies may be better positioned to gain proficiency in Arabic before and during SA. This aligns with Botes et al.'s (2020) meta-analysis, which identified affective factors, such as emotion regulation and resilience, as significant moderators of the relationship between foreign language anxiety and achievement.

Regarding the first two research questions, while heart rate is often associated with anxiety, the relationship is complex. First, elevated HR has often been thought to be a sign of increased anxiety, and there is evidence that stressors tend to increase HR for healthy, high-worry and clinically high-anxiety individuals (Fisher & Neman, 2013). Other studies have shown that perceptions of heart rate are more closely connected with anxiety than actual heart rate (e.g., Trotman et al., 2019), and that social anxiety can lead to elevated heart rate (Rösler et al., 2021). Our finding of a positive anxiety-HR correlation aligns with these previous findings. The connection between social anxiety and elevated HR may be relevant in our study because learners are required to interact with locals, and social anxiety, whether related to general aversion to socializing or concern over not being able to communicate in Arabic, may come into play, in addition to other factors mentioned in the interviews. An elevated heart rate also correlated with a lower score on the pre-SA final exam, suggesting that less linguistically prepared students may have already been dealing with some degree of debilitating anxiety before the SA experience.

Vulnerability can be connected to HR in multiple ways. Feeling vulnerable can trigger a heightened state of alertness, increasing HR and reducing HRV as the body prepares for perceived threats (Thayer et al., 2012). This stress-ready state, while adaptive for real danger, can hinder cognitive and emotional flexibility if prolonged (Porges, 2007; Sapolsky, 2004). Because of the potential long-term ill effects, helping learners deal with vulnerable situations through training, such as that given to the group mentioned here, could be valuable. On the positive side, embracing vulnerability in a safe environment engages the parasympathetic nervous system, promoting steadier HR and increased HF-HRV and RMSSD, which facilitates emotional regulation and resilience (Thayer et al., 2012). This regulatory capacity enables calm states and effective emotional processing, highlighting the critical role of vulnerability and the associated perceived sense of safety in dealing with potentially stressful situations, such as those encountered by the participants in this study (Porges, 2007).

The negative link between conscientiousness and HR aligns with research showing that HR increases with stress (Bibbey et al., 2013). Conscientious individuals

manage stress better through practicing healthy habits (Brouwer et al., 2014) and exhibit stable heart rates, even under stress (Bibbey et al., 2013). Furthermore, conscientiousness is strongly associated with higher HRV, indicating better emotional regulation and resilience (Dermody et al., 2016). This suggests that conscientious participants in our study may have engaged in more self-regulation, prioritizing personal care and reducing increased stress-related HR. More research is needed to help study abroad professionals know how they might better coach students according to various personality traits. Perhaps more important is how to help students planning on SA to become more self-aware and therefore in a better position to make necessary adjustments. Exposing them to summaries of relevant research and encouraging them to learn more about themselves through an instrument such as the IPIP-NEO-120 could be helpful.

Regarding questions 3-5, which involve connections between personality, HRV and proficiency, higher pre-departure Arabic exam scores correlated with higher HF-HRV, reflecting greater parasympathetic activity and capacity for relaxation. This suggests that those with stronger language skills may be calmer and more relaxed during SA, highlighting the importance of pre-departure language preparation for managing stress and maximizing language acquisition (Jackson, 2011; Kinginger, 2008, 2009). Such preparation fosters confidence and facilitates engagement in immersive experiences, accelerating linguistic development and cultural adjustment (Allen & Herron, 2003).

RMSSD was significantly correlated with both pre- and post-OPI scores. This suggests a potential link between stress management and success in language learning. Students who manage stress well may perform better linguistically, or, conversely, higher proficiency may lead to greater stress resilience (Kim et al., 2018). This result supports the idea that strong language skills can enhance coping mechanisms during SA. The learner's attaining higher proficiency prior to SA is likely to be closely connected with the increased emotional regulation and resilience associated with higher RMSSD (Thayer et al., 2012). We note, however, that Thomas and Viljoen (2019) did not find RMSSD to predict general academic performance in first-year university students. One wonders what they might have found had they controlled for personality. However, they did find that overall HRV correlated significantly with the academic performance of female students.

Given constraints on SA preparation and the typical amount of variation in proficiency, it is not usually feasible for only those who have high levels of proficiency to participate in SA. It is important to keep in mind the importance of providing opportunities for success and confidence development, as Allen and Herron (2003) have suggested. Small successes might promote greater resilience to stressors that may be the result of inadequate proficiency but also of cross-cultural differences, lifestyle changes, and other non-linguistic factors. One such

intervention that is now a key component of the SA program from which the participants in this study benefitted refers to the daily speaking appointments with tutors where the student is in control of the topic and the tutor is tasked with assisting the learner in experiencing an encouraging conversation that stretches but does not overwhelm (see Bird & Belnap, 2018 for details on this and other interventions).

One might be inclined to think SA unwise for some students, especially given the potential negative effects of longer-term high levels of anxiety as indicated by cortisol levels reported for some participants in Dewey et al. (2018).[1] Students do need to be carefully screened and advised of the rigors of overseas intensive language study and the dangers of buying into the pervasive myth that immersion will somehow magically bequeath them L2 fluency (Wilkinson, 1998). The participants in this study had a number of advantages that helped them persevere. Most, if not all, would have known students who participated in the program in previous years and all had regular association with the teaching assistants, who were selected with an eye to their serving as near-peer role models who provide the kind of vicarious experiences that can lead to increased self-efficacy (Mills, 2014). Both before and during the SA, participants were likewise exposed to such role models in the form of case studies of students who had previously participated in the program, as well as others, which are now available for learners generally at https://projectperseverance.byu.edu/. Some of these illustrate that even the most anxious SA participants benefit considerably from their overseas intensive experience. Mistretta (2008) provides an overview of research documenting such benefits.

[1] Given that the results reported in that study were correlations, one cannot say that the increase in cortisol levels was caused by their study abroad experience. A variety of personal or other factors could have contributed to some or all of the most dramatic cases of increase in cortisol. It is noteworthy that Dewey et al. (2018) conclude: "Although overall anxiety levels increased over SA they were not as high as might be expected leading us to believe that the methods for coping with the challenges associated with studying abroad in Jordan taught to the students are beneficial for moderating levels of anxiety during SA . . ." (p. 157). That study and this study would have benefited from a comparison with comparable cohorts of students studying in their country of origin, given that Pitt et al. (2017) found that students at an Australian university reported ever increasing levels of stress over the course of a semester. Dewey et al.'s (2014) study gives some sense of the variety of SA programs and their practices and expectations, even within a single institution, and found that SA program was a significant predictor of reported L2 use. Program expectations, that is, academic rigor, doubtless are a source of stress for some students. Dewaele (2009) provides an overview of research on multiple individual factors, including personality and anxiety, that had been shown by that time to play a role in SLA. In spite of a good deal of new research, many questions remain, but the fact that healthier cortisol levels and healthier HRV scores were significant predictors of oral proficiency gains is grounds for serious consideration on how to better assist students in achieving their L2 learning objectives.

Most interviewees reported rich cultural and linguistic engagement during their SA experience, which aligns with observed gains in oral proficiency. All but two participants advanced at least one sublevel on the ACTFL scale. One who showed no measurable gain started the program at *advanced low*. According to Meredith (1990) and others, such apparent plateaus are not uncommon due to the uneven intervals of the ACTFL scale. His interview responses highlighted increased competence in listening and local dialects, which Vande Berg et al. (2009) argue are often not fully captured by OPI scoring, particularly when gains are pragmatic or dialectal in nature.

As for research questions 2 and 3, quantitative data indicated a decrease in anxiety over time, especially among students who showed measurable proficiency gains. Those with higher post-program OPI scores also demonstrated improved HRV measures (RMSSD and HF-HRV), both of which are associated with greater parasympathetic activation and emotional regulation. Interview responses corroborated this trend, with students describing increased comfort and confidence as the semester progressed. These findings align with previous studies suggesting that foreign language anxiety tends to decrease during extended immersion experiences. For instance, MacIntyre and Gardner (1994) as well as Thompson and Lee (2014) reported reduced anxiety over the course of long-term SA programs. Similarly, Dewey et al. (2018) found declining classroom anxiety and increased enjoyment in students studying abroad in Jordan.

Despite these positive trends toward decreased anxiety, low proficiency and high anxiety are of concern. Students with lower initial proficiency showed less optimal HRV profiles, raising questions about the long-term physiological impact of early-stage language anxiety associated with low proficiency. This also suggests the value of establishing solid proficiency prior to departure, and it signals the importance of substantive early intervention. Dewaele and MacIntyre (2016) found that learners who rated themselves as low intermediate reported significantly higher foreign language classroom anxiety often linked to negative social comparisons. Likewise, Bailey et al. (2003) showed that students who eventually dropped out of language courses reported higher anxiety levels than those who persisted. These patterns underscore the importance of integrating effective support strategies into the early stages of L2 learning, particularly in SA settings where learners face additional social and cognitive demands. We strongly recommend that training begin as early as possible with students, well before SA and ideally from the first day of their first class in the target language. Students need to understand that taking on new challenges is regularly associated with some anxiousness. They could be shown a chart from studies such as Dewaele and MacIntyre (2016) to help them see that anxiety lessens and joy increases over time and that they can be agents in expediting this process and finding joy in their language learning. Results from

this study could be used to encourage learners to use biofeedback to help them make adjustments, such as prioritizing quality sleep, that will result in greater overall well-being and increased success in their language study and other endeavors. Students could benefit from knowing that HRV training, where one uses real-time HRV monitoring and deep, slow breathing to improve HRV, has been shown to increase cognitive functions such as attention and executive control in highly stressful situations (Tinello et al., 2022).

Limitations to this study include the sample size and the fact that the HRV data did not always meet the requirements for clinical HRV research, largely due to the non-clinical nature of the study. For example, the research assistant gathering HRV data reported that two students talked during the HRV data collection even though they were asked not to do so. Next, all but one of the participants in the current study had virtually identical Arabic language learning experience, were instructed in the same program and manner, came from the same US academic culture, and were relatively close in age, so these potentially influential extraneous variables were controlled. However, motivation, learner beliefs and attitudes, and other such extraneous variables might have had an influence. Such variables might mask, moderate, or mediate anxiety and its connections with SLA. We chose to focus on personality largely because of its relatively stable nature, but an inclusion of some of the more dynamic variables mentioned could give greater clarity, specifically when it comes to the complexity of personality-anxiety-proficiency relationships. Situational variation could also be addressed by replicating in a different setting. Another addition could be HRV data collection at several more time points throughout the SA experience.

6. Conclusion

The present study showed that more effective language learners exhibited HR data indicative of better ability to self-regulate. They were also characterized by greater conscientiousness, as measured by the IPIP-NEO-120. Those with lower oral proficiency gains were more likely to have higher HR and lower HRV, indicators of heart functions related to poor performance and negative health consequences. HR monitoring has become relatively practical with the use of devices that students regularly wear, such as the Apple Watch or Fitbit fitness bands. Teaching students, from the earliest stages, about the value of stress management and teaching them to monitor and understand HR data in order to maintain their own health and potentially enhance their language learning and cross-cultural experience is a practice that appears to have potential to benefit students abroad as well as at home. However, given the stressors inherent in SA, especially at the outset, and that

higher levels of proficiency contribute to a less stressful in-country experience, students would be wise to be aware of this from the beginning so that they may begin well ahead of SA to become adept at using biofeedback and making other choices that will result in more effective learning and overall well-being and thereby prepare well in order to have the linguistic resources to optimize their SA experience. Monitoring one's HRV is no magic pill, but it is a tool that can lead to better self-regulation and potentially greater self-awareness, a powerful combination. We agree with Savicki (2010), who notes: "Attention to and remediation of psychological factors such as negative affect and feelings of threat and loss are likely to help students in their struggles to fit in with a foreign culture. Psychological adjustment is part and parcel of the study abroad experience" (p. 220).

References

Alhammad, M. (2017). Motivation, anxiety and gender: How they influence the acquisition of English as a second language for Saudi students studying in Ireland. *PEOPLE: International Journal of Social Sciences*, *3*(2), 93-104. https://doi.org/10.20319/pijss.2017.32.93104

Allen, H. W., & Herron, C. (2003). A mixed-methodology investigation of the linguistic and affective outcomes of summer study abroad. *Foreign Language Annals, 36*(3), 370-385. https://doi.org/10.1111/j.1944-9720.2003.tb02120.x

Anisman, H. (2015). *Stress and your health: From vulnerability to resilience*. John Wiley & Sons.

Armstead, R. T. (2017). *The effects of stress management on college students' performance in internationalization programs* [Unpublished doctoral dissertation]. Delaware State University.

Arvidsson, K., Eyckmans, J., Rosiers, A., & Forsberg Lundell, F. (2018). Self-perceived linguistic progress, target language use and personality development during study abroad. *Study Abroad Research in Second Language Acquisition and International Education, 3*(1), 144-166. https://doi.org/10.1075/sar.16024.arv

Bailey, P., Onwuegbuzie, A. J., & Daley, C. E. (2003). Foreign language anxiety and student attrition. *Academic Exchange Quarterly*, *7*(2), 304-308.

Baker-Smemoe, W., Dewey, D. P., Bown, J., & Martinsen, R. A. (2014). Variables affecting L2 gains during study abroad. *Foreign Language Annals, 47*(3), 464-486. https://doi.org/10.1111/flan.12093

Bibbey, A., Carroll, D., Roseboom, T. J., Phillips, A. C., & de Rooij, S. R. (2013). Personality and physiological reactions to acute psychological stress. *International Journal of Psychophysiology, 90*(1), 28-36. https://doi.org/10.1016/j.ijpsycho.2012.10.018

Bird, M. T., & Belnap, R. K. (2018) Lessons from 25 years of experimenting with an Arabic study abroad program. In J. L. Plews & K. Misfeldt (Eds.), *Second language study abroad: Programming, pedagogy, and participant engagement* (pp. 49-82). Palgrave Macmillan. https://doi.org/10.1007/978-3-319-77134-2_3

Bogg, T., & Roberts, B. W. (2013). The case for conscientiousness: Evidence and implications for a personality trait marker of health and longevity. *Annals of Behavioral Medicine*, *45*(3), 278-288. https://doi.org/10.1007/s12160-012-9454-6

Botes, E., Dewaele, J.-M., & Greiff, S. (2020). The foreign language classroom anxiety-achievement relationship: A meta-analysis. *Modern Language Journal, 104*(3), 549-569. https://doi.org/10.1111/modl.12661

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Brouwer, A. M., Van Schaik, M. G., Korteling, J. E., van Erp, J. B., & Toet, A. (2014). Neuroticism, extraversion, conscientiousness and stress: Physiological correlates. *IEEE Transactions on Affective Computing*, *6*(2), 109-117. https://doi.org/10.1109/taffc.2014.2326402

Buttaro, L. (2004). Second-language acquisition, culture shock, and language stress of adult female Latina students in New York. *Journal of Hispanic Higher Education*, *3*(1), 21-49. https://doi.org/10.1177/1538192703255525

Chen, X., He, J., Swanson, E., Cai, Z., & Fan, X. (2022). Big Five Personality Traits and second language learning: A meta-analysis of 40 years' research. *Educational Psychology Review, 34*(2), 851-887. https://doi.org/10.1007/s10648-021-09641-6

Costa Jr., P. T., & McCrae, R. R. (2000). *Neo Personality Inventory*. American Psychological Association.

Council of Europe (2001). *Common European Framework of Reference for Languages: Learning, teaching, assessment.* Cambridge University Press. http://www.coe.int/t/dg4/linguistic/Cadre1_en.asp

Dermody, S. S., Wright, A. G., Cheong, J., Miller, K. G., Muldoon, M. F., Flory, J. D., Gianaros, P. J., Marsland, A. L., & Manuck, S. B. (2016). Personality correlates of midlife cardiometabolic risk: The explanatory role of higher-order factors of the five-factor model. *Journal of Personality*, *84*(6), 765-776. https://doi.org/10.1111/jopy.12216

Dewaele, J.-M. (2009). Individual differences in second language acquisition. In W. C. Ritchie & T. K. Bhatia (Eds.), *The new handbook of second language acquisition*. (pp. 623-646). Emerald Insight.

Dewaele, J.-M., & Dewaele, L. (2021) Fluctuations in mental well-being during study abroad. *Study Abroad Research in Second Language Acquisition and International Education*, *6*(2), 215-244. https://doi.org/10.1075/sar.21002.dew

Dewaele, J.-M., & MacIntyre, P. D. (2016). Foreign language enjoyment and foreign language classroom anxiety: The right and left feet of the language learner. In P. D. MacIntyre, T. Gregersen, & S. Mercer (Eds.), *Positive Psychology in SLA* (pp. 215-236). Multilingual Matters. https://doi.org/10.21832/9781783095360-010

Dewaele, J.-M., & MacIntyre, P. D. (2019). The predictive power of multicultural personality traits, learner and teacher variables on foreign language enjoyment and anxiety. In M. Sato & S. Loewen (Eds.), *Evidence-based second language pedagogy: A collection of instructed second language acquisition studies* (pp. 263-286). Routledge. https://doi.org/10.4324/9781351190558-12

Dewey, D. P., Belnap, R. K., & Steffen, P. (2018). Anxiety: Stress, foreign language classroom anxiety, and enjoyment during study abroad in Amman, Jordan. *Annual Review of Applied Linguistics*, *38*, 140-161. https://doi.org/10.1017/s0267190518000107

Dewey, D. P., Bown, J., Baker, W., Martinsen, R. A., Gold, C., & Eggett, D. (2014). Language use in six study abroad programs: An exploratory analysis of possible predictors. *Language Learning, 64*, 36-71. https://doi.org/10.1111/lang.12031

Erfani, S. S., & Mardan, H. (2017). The relationship between Big-Five Personality Traits, English language proficiency scores on IELTS, and academic success of Iranian foreign students. *Theory and Practice in Language Studies*, *7*(11), 1046-1058. https://doi.org/10.17507/tpls.0711.13

Fisher, A. J., & Newman, M. G. (2013). Heart rate and autonomic response to stress after experimental induction of worry versus relaxation in healthy, high-worry, and generalized anxiety disorder individuals. *Biological Psychology, 93*(1), 65-74. https://doi.org/10.1016/j.biopsycho.2013.01.012

Fox, J. K. (2017). *The bridge: Linking mood induction, self-report, and psychophysiology to vocabulary learning on a paired-associates learning task* [Unpublished doctoral dissertation]. Michigan State University. https://doi.org/10.25335/by7e-st09

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. G. (2006). The international personality item pool and the future of public-domain personality measures. *Journal of Research in Personality, 40*(1), 84-96. https://doi.org/10.1016/j.jrp.2005.08.007

Goodyke, M. P., Hershberger, P. E., Bronas, U. G., & Dunn, S. L. (2022). Perceived social support and heart rate variability: An integrative review. *Western Journal of Nursing Research*, *44*(11), 1057-1067. https://doi.org/10.1177/01939459211028908

Gregersen, T., MacIntyre, P. D., & Meza, M. D. (2014). The motion of emotion: Idiodynamic case studies of learners' foreign language anxiety. *Modern Language Journal, 98*(2), 574-588. https://doi.org/10.1111/modl.12084

Hardacre, B., Hafner, A., & Nakama, P. (2021). The impact of test anxiety on teacher credential candidates. *Teacher Education Quarterly*, *48*(3), 7-28.

Hernando, D., Roca, S., Sancho, J., Alesanco, Á., & Bailón, R. (2018). Validation of the Apple Watch for heart rate variability measurements during relax and mental stress in healthy subjects. *Sensors*, *18*(8), 2619. https://doi.org/10.3390/s18082619

Hessel, G. (2016). *The impact of participation in ERASMUS study abroad in the UK on students' overall English language proficiency, self-efficacy, English use anxiety and self-motivation to continue learning English: A mixed methods investigation* [Doctoral dissertation]. University of Oxford.

Horwitz, E. K., Horwitz, M. B., & Cope, J. (1986). Foreign language classroom anxiety. *Modern Language Journal*, *70*(2), 125-132. https://doi.org/10.2307/327317

Hudson, N. W., Briley, D. A., Chopik, W. J., & Derringer, J. (2019). You have to follow through: Attaining behavioral change goals predicts volitional personality

change. *Journal of Personality and Social Psychology, 117*(4), 839-857. https://doi.org/10.1037/pspp0000221

Irving, J. A., Dobkin, P. L., & Park, J. (2009). Cultivating mindfulness in health care professionals: A review of empirical studies of mindfulness-based stress reduction (MBSR). *Complementary Therapies in Clinical Practice*, *15*(2), 61-66. https://doi.org/10.1016/j.ctcp.2009.01.002

Jackson, J. (2011). Host language proficiency, intercultural sensitivity, and study abroad. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *21*(1), 167-188. https://doi.org/10.36366/frontiers.v21i1.308

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation*, *15*(3), 235-245. https://doi.org/10.30773/pi.2017.08.17

Kinginger, C. (2008). Language learning in study abroad: Case studies of Americans in France. *Modern Language Journal*, *92*(s1), 1-124. https://doi.org/10.1111/j.1540-4781.2008.00821.x

Kinginger, C. (2009). *Language learning and study abroad: A critical reading of research*. Palgrave Macmillan.

Kumar, Y., Agarwal, V., & Gautam, S. (2013). Heart rate variability during examination stress in medical students. *International Journal of Physiology*, *1*(1), 83-86.

Lämsä, J., Mannonen, J., Tuhkala, A., Heilala, V., Helovuo, A., Tynkkynen, I., Lampi, E., Sipiläinen, K., Kärkkäinen, T., & Hämäläinen, R. (2023). Capturing cognitive load management during authentic virtual reality flight training with behavioural and physiological indicators. *Journal of Computer Assisted Learning*, *39*(5), 1553-1563. https://doi.org/10.1111/jcal.12817

Liu, M. (2012). Predicting effects of personality traits, self-esteem, language class risk-taking and sociability on Chinese university EFL learners' performance in English. *Journal of Second Language Teaching & Research*, *1*(1), 30-57. https://doi.org/10.5420/jsltr.01.01.3318

Looser, R. R., Metzenthin, P., Helfricht, S., Kudielka, B. M., Loerbroks, A., Thayer, J. F., & Fischer, J. E. (2010). Cortisol is significantly correlated with cardiovascular responses during high levels of stress in critical care personnel. *Psychosomatic Medicine*, *72*(3), 281-289. https://doi.org/10.1097/psy.0b013e3181d35065

Lucini, D., Norbiato, G., Clerici, M., & Pagani, M. (2002). Hemodynamic and autonomic adjustments to real life stress conditions in humans. *Hypertension, 39*(1), 184-188. https://doi.org/10.1161/hy0102.100784

MacIntyre, P. D. (2017). An overview of language anxiety research and trends in its development. In C. Gkonou, M. Daubney, & J.-M. Dewaele (Eds.), *New insights into language anxiety: Theory, research and educational implications* (pp. 11-30). Multilingual Matters.

MacIntyre, P. D., & Gardner, R. C. (1994). The subtle effects of language anxiety on cognitive processing in the second language. *Language Learning, 44*(2), 283-305. https://doi.org/10.1111/j.1467-1770.1994.tb01103.x

Melo, H. M., Nascimento, L. M., & Takase, E. (2017). Mental fatigue and heart rate variability (HRV): The time-on-task effect. *Psychology & Neuroscience*, *10*(4), 428-436. https://doi.org/10.1037/pne0000110

Meredith, R. A. (1990). The oral proficiency interview in real life: Sharpening the scale. *Modern Language Journal*, *74*(3), 288-288. https://doi.org/10.2307/327625

Mills, N. (2014) Self-efficacy in second language acquisition. In S. Mercer & M. Williams (Eds.), *Multiple perspectives on the self in SLA* (pp. 6-19). Multilingual Matters.

Mistretta, W. (2008). *Life-enhancing: An exploration of the long-term effects of study abroad.* [Unpublished doctoral dissertation]. State University of New York at Buffalo.

Ożańska-Ponikwia, K., & Dewaele, J.-M. (2012). Personality and L2 use: The advantage of being openminded and self-confident in an immigration context. *EUROSLA Yearbook*, *12*(1), 112-134. https://doi.org/10.1075/eurosla.12.07oza

Peck, E. C. (1974). The relationship of disease and other stress to second language. *International Journal of Social Psychiatry*, *20*(1-2), 128-133. https://doi.org/10.1177/002076407402000119

Pitt, A., Oprescu, F., Tapia, G., & Gray, M. (2017). An exploratory study of students' weekly stress levels and sources of stress during the semester. *Active Learning in Higher Education*, *19*(1), 61-75. https://doi.org/10.1177/1469787417731194

Plonsky, L., & Oswald, F. L. (2014). How big is "big"? Interpreting effect sizes in L2 research. *Language Learning*, *64*, 878-912. https://doi.org/10.1111/lang.12079

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology, 74*(2), 116-143. https://doi.org/10.1016/j.biopsycho.2006.06.009

Roberts, B. W., Luo, J., Briley, D. A., Chow, P. I., Su, R., & Hill, P. L. (2017). A systematic review of personality trait change through intervention. *Psychological Bulletin, 143*(2), 117-141. https://doi.org/10.1037/bul0000088

Roitblat, Y., Cleminson, R., Kavin, A., Schonberger, E., & Shterenshis, M. (2017). Assessment of anxiety in adolescents involved in a study abroad program: A prospective study. *International Journal of Adolescent Medicine and Health, 32*(2), 1-10. https://doi.org/10.1515/ijamh-2017-0101

Rösler, L., Göhring, S., Strunz, M., & Gamer, M. (2021). Social anxiety is associated with heart rate but not gaze behavior in a real social interaction. *Journal of Behavior Therapy and Experimental Psychiatry, 70*, 101600. https://doi.org/10.1016/j.jbtep.2020.101600

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data* (3rd ed.). SAGE Publications. https://doi.org/10.4135/9781452226651

Sapolsky, R. M. (2004). *Why zebras don't get ulcers: The acclaimed guide to stress, stress-related diseases, and coping* (3rd ed.). Henry Holt and Co.

Savicki, V. (2010). Implications of early sociocultural adaptations for study abroad students. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *19*(1), 205-223. https://doi.org/10.36366/frontiers.v19i1.283

Schoorlemmer, R. M. M., Peeters, G. M. E. E., Van Schoor, N. M., & Lips, P. T. A. M. (2009). Relationships between cortisol level, mortality and chronic diseases in older persons. *Clinical Endocrinology*, *71*(6), 779-786. https://doi.org/10.1111/j.1365-2265.2009.03552.x

Shachter, J., Sweller, N., Kangas, M., & Stewart, J. (2022). Affective states and heart rate response: Measuring foreign language speaking performance reactions in a Japanese university classroom. *Journal for the Psychology of Language Learning*, *4*(2), 1-23. https://doi.org/10.52598/jpll/4/2/2

Shin, J., Lee, H. J., Park, H., Hong, Y., Song, Y. K., Yoon, D. U., & Oh, S. (2023). Perfectionism, test anxiety, and neuroticism determines high academic performance: A cross-sectional study. *BMC Psychology*, *11*, 410. https://doi.org/10.1186/s40359-023-01369-y

Solhjoo, S., Haigney, M. C., McBee, E., van Merrienboer, J. J. G., Schuwirth, L., Artino, A. R., Jr, Battista, A., Ratcliffe, T. A., Lee, H. D., & Durning, S. J. (2019). Heart rate and heart rate variability correlate with clinical reasoning performance and self-reported measures of cognitive load. *Scientific Reports*, *9*(1), 14668. https://doi.org/10.1038/s41598-019-50280-3

Steffen, P. R., Fidalgo, L., Brown, T., Tsui, Y., & Schmuck, D. (2014). Psychotherapy participants show increased cardiovascular and cortisol reactivity to a laboratory stressor relative to matched controls. *Frontiers in Psychology: Psychology for Clinical Settings*, *5*, 1-7. https://doi.org/10.3389/fpsyg.2014.00795

Thayer, J. F., Åhs, F., Fredrikson, M., Sollers, J. J., & Wager, T. D. (2012). A meta-analysis of heart rate variability and neuroimaging studies: Implications for heart rate variability as a marker of stress and health. *Neuroscience & Biobehavioral Reviews, 36*(2), 747-756. https://doi.org/10.1016/j.neubiorev.2011.11.009

Thomas, B. L., & Viljoen, M. (2019). Heart rate variability and academic performance of first-year university students. *Neuropsychobiology*, *78*(4),175-181. https://doi.org/10.1159/000500613

Thompson, A. S., & Lee, J. (2014). The impact of experience abroad and language proficiency on language learning anxiety. *TESOL Quarterly*, *48*(2), 252-274. https://doi.org/10.1002/tesq.125

Tinello, D., Kliegel, M., & Zuber, S. (2022). Does heart rate variability biofeedback enhance executive functions across the lifespan? A systematic review. *Journal*

of Cognitive Enhancement, *6*(1), 126-142. https://doi.org/10.1007/s41465-021-00218-3

Tremblay, P. F., & Gardner, R. C. (1995). Expanding the motivation construct in language learning. *Modern Language Journal*, *79*(4), 505-518. https://doi.org/10.1111/j.1540-4781.1995.tb05451.x

Trotman, G. P., Veldhuijzen van Zanten, J. J., Davies, J., Möller, C., Ginty, A. T., & Williams, S. E. (2019). Associations between heart rate, perceived heart rate, and anxiety during acute psychological stress. *Anxiety, Stress, & Coping*, *32*(6), 711-727. https://doi.org/10.1080/10615806.2019.1648794

Vande Berg, M., Connor-Linton, J., & Paige, R. M. (2009). The Georgetown Consortium Project: Interventions for student learning abroad. *Frontiers: The Interdisciplinary Journal on Study Abroad 18*, 1-75. https://doi.org/10.36366/frontiers.v18i1.251

Wilkinson, S. (1998). On the nature of immersion during study abroad: Some participant perspectives. *Frontiers: The Interdisciplinary Journal of Study Abroad, 4*(1), 121-138. https://doi.org/10.36366/frontiers.v4i1.65

APPENDIX

Open-ended questions used in the interviews

Personal Interview A #	
Program	Overseas Arabic Program in Amman, Jordan/ [name of university]
Term and academic year	fall, 2019/2020
Day and date of the interview	
Time of the interview	
Name of the interviewee (learner)	
Age of the interviewee	
Sex of the interviewee	
Major of the interviewee	
A. Questions on the interviewee's interaction with local Jordanians outside the school	
A.1. Are you happy about your experience outside the school?	
A.2. What do you like most about Jordanian society?	
A.3. Do you have any bad experience outside the school? Explain! How have you dealt with that?	
A.4. Do you meet with local Jordanians outside the school?	
A.5. Do you do any activities outside the school? If so, what activities do you do? Do these activities allow you to interact with Jordanians?	
A.6. What fears or perhaps misconceptions do you have about interacting with locals?	
A.7. What strategies do you use to deal with your fears?	
A.8. Do you face any obstacles that prevent you from interacting with locals? If so, what obstacles do you face?	
A.9. What strategies do you use to get rid of these obstacles?	
A.10. Do you believe that interaction with locals outside the school helps you develop your language competences, mainly sociocultural competence or sociolinguistic competence?	
A.11. What inhibits you from making friends outside the school?	
A.12. How do you deal with that?	
A.13. Do you have any plan for enhancing your interaction with the host culture outside the school? Explain! If not, will you think of one?	
Notes	
Interviewer	