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研究成果の概要(和文)：このプロジェクトでは、自律神経系の覚醒度をオン・オフのタスクで生理学的に測定・追跡するSituation Specific Arousal Analyzer アプリケーションを作成しました。このアプリケーションは、OS XまたはWindowsのいずれかのプラットフォームで使用でき、主に心拍数(HR)、心拍変動(HRV)(時間領域法、周波数領域法、非線形領域法)、皮膚電気活動(EDA)の計算に重点を置いています。HRVの時間領域では、NNMeanは0.015625(1/64)秒に1回まで、EDAMeanは0.25(1/4)秒に1回までデータを取得することが可能です。

研究成果の学術的意義や社会的意義

Situation Specific Arousal Analyzer (SSAA)が実施したデータの定量化は、外国語教育不安の研究に適用できるアクセス可能な研究手法の重要な革新を示しています。このインターフェースは、L2スピーキング活動中の特定の時間セグメントにおける覚醒度のマイクロ分析、または授業時間全体といったより長いマクロ期間の分析に焦点を当てた、さまざまな実験条件に合わせて調整することが可能です。生成された生理学的データにより、他の変数との相関関係や感情関係を分析することができます。SSAAは、結果を集計したCSVファイルやビジュアライゼーションとして生成・出力します。

研究成果の概要(英文)：This project created the Situation Specific Arousal Analyzer (SSAA) application for the on-off task physiological measurement and tracking of autonomic nervous system arousal. The application can be used on either the OS X or Windows platform and primarily focuses on the calculation of heart rate (HR), heart rate variability (HRV) (time-domain methods, frequency-domain methods, non-linear domain methods), and electrodermal activity (EDA). The interface can be tailored to meet a range of experimental conditions focused on either the micro analysis of arousal in time specific segments during an L2 speaking activity, or relative to longer macro periods of analysis such as across an entire classroom period. For the HRV time-domain, the beat-to-beat interval (NNMean) can be calculated up to once per 0.015625 (1/64) second while for the EDAMean it is possible to capture data once per 0.25 (1/4) second. The SSAA generates and exports these results as tabulated CSV files and visualizations.

研究分野：Foreign Language Education

キーワード：Language Education Anxiety Physiological Data Wearable Technology Research Methods

1. 研究開始当初の背景

Recent shifts toward the greater inclusion of educational psychology within the remit of foreign language education and a rapid uptake in interest in positive psychology (Wang et al. 2021) have produced several studies examining the affective role of emotions (Botes et al. 2020; Chen et al. 2021; Dewaele and Li 2020; Dewaele and Pavelescu 2019). However, emotion research is partially constrained by the inherent imprecision of subjective descriptions of emotional experience. Methodological limitations have reinforced a perception that emotions are “poorly studied and poorly understood” (Swain 2013, p. 195). This reflects a wider trend in foreign language education research to emphasize the experiential component of emotion while neglecting the behavioural and, to a much greater extent, the physiological components. In over-emphasizing experiential self-report measures, foreign language education research has avoided giving due consideration to emotion as a multifaceted process inclusive of “components such as appraisal of the situation, action preparation, physiological responses, expressive behavior, and subjective feelings” (Scherer and Moors 2019, p. 721). Methodological innovation is required for the benefit of students, teachers, and the integrity of future research output.

For several decades research attention within foreign language education has fixated on the emotion of anxiety and its negative impact upon the language learner (Aida 1994; Dewaele et al. 2008; Gregersen and Horwitz 2002). As a response to environmental stimuli, anxiety is a particularly important emotion beyond its role in education due to its evolutionary function in survival and the avoidance of threat. Its prominent evolutionary function is further reflected in the fact that anxiety disorders now constitute a considerable worldwide burden having social and economic consequence (Robinson et al. 2013). It is believed that “conscious emotional experience is closely bound to changes in bodily sensations. Indeed, if one accepts the notion that consciousness is grounded in biological processes...emotional experience must, by its nature, be physiological” (Pace-Schott et al. 2019, p. 267). This project highlights advancements made in the health tracking provisions of wearable wristbands with a focus on the Empatica E4, a “medical-grade wearable device that offers real-time physiological data acquisition, enabling researchers to conduct in-depth analysis and visualization” (Empatica Inc. 2021). This project demonstrates how foreign language education anxiety researchers can use the device to objectively document autonomic nervous system arousal in real-time communication situations using high-integrity metrics such as heart rate variability (HRV) and electrodermal activity (EDA).

2. 研究の目的

Horwitz et al. (1986) define anxiety within the foreign language classroom as “ a distinct complex of self-perceptions, beliefs, feelings and behaviours related to classroom learning arising from the uniqueness of the language learning process ” (p. 128). This definition only concerns the experiential and behavioural components of anxiety. Since this time and despite anxiety being “ characterized by feelings of tension, worried thoughts and physical changes like increased blood pressure ” (American Psychological Association 2021), research into the physiological assessment of anxiety within foreign language education has been almost entirely absent, an omission made even more curious given that prominent foreign language educators have described how anxiety “ is influenced by internal physiological processes ” (MacInyre 2017, p. 28). With reference to the dominant methods used in service of the Horwitz et al. (1986) definition of anxiety in the foreign language classroom, while the behavioural component can be logged and studied by the researcher, the reliability and validity of data obtained through experiential self-report measures is dependent upon the subjectivities of the individual. Such methods do not consider the conceptual distinction between actual lived sensory experience and post-activity semantic recall (Robinson and Clore 2002). The extent to which language learners have sufficient awareness to link momentary changes in psychophysiology to external stimuli and accurately communicate these dynamics post-activity through generic self-report measures, all while managing the demands of communication in a foreign language, is questionable. Harmon-Jones et al. (2016) confirm such concerns in asserting that it is inappropriate “ to assume that a null effect on a self-report measure means that emotional processes were not involved in the psychological phenomena of interest. That is, the (often poor) measurement of emotion should not be conflated with emotion itself ” (p. 2).

Self-report measures can be considered problematic for a variety of reasons. In the context of communication between health professionals and non-proficient English speakers, Hunt and Bhopal (2004) detail how latent variables and constructs are not often shared across languages or cultures and that translation into other languages is problematic as words and concepts may be represented differently. Lim (2016) documents how emotions are influenced by the environment with clear differentiations in valence, arousal and preference across cultural boundaries. The author outlines how in “ individualist culture, high arousal emotions are valued and promoted more than low arousal emotions ” whereas in contrast within “ collectivist culture, low arousal emotions are valued more than high arousal emotions ” (p. 105). Cultural differentiations also exist in the avoidance of conflict and adherence to prescribed social roles and expectations which may give rise to the kind of social desirability bias identified in self-reports of negative emotional states (Paulhus and Reid 1991).

3 . 研究の方法

Anxiety is an ideal emotion for physiological measurement, especially as state anxiety can be experimentally induced giving the researcher a greater level of control. Moreover, physiological data would appear to provide a more reliable foundation for the attribution of cause and effect relations as it is “difficult for individuals to mask or control, which creates the possibility of more objectively gauging individuals’ arousal” (Roos et al. 2021, p. 583). In a meta-analysis of previous works using physiological measures of state specific test anxiety, the same author concludes that “physiological measures can provide objective information about test anxiety, particularly about the physiological component of test anxiety which is difficult to capture through self-reports” (p. 611). The necessity to accurately assess state specific anxiety is wide ranging (cf. Conley and Lehman 2012) and correlations have been drawn with important learning outcomes such as educational achievement (cf. Putwain 2008).

Two of the most prominent metrics used in the physiological assessment of anxiety are heart rate variability (HRV) and electrodermal activity (EDA) (Blom et al. 2010; Croft et al. 2004; Nikolic et al. 2018; Sebastiao 2020). As a reliable psychophysiological marker of health and well-being, HRV reflects an unobtrusive measure relating to the modulation of heart rate under instruction of the autonomic nervous system. HRV represents the the variance in duration between heart beats or fluctuations in heart beat over a period of time measured in milliseconds. Reduced resting-state HRV has been linked to depression, alcoholism, and pathological worry (Kemp et al. 2010; Quintana et al. 2013; Tully et al. 2013) while it has been reported that sufferers of anxiety are often characterized by a reduced HRV in comparison to non-anxiety sufferers (Chalmers et al. 2014). In contrast to HRV, EDA detects autonomic changes in the electrical properties of skin which allows researchers to remove the parasympathetic contamination found within the use of heart rate monitors (Braithwaite et al. 2013). As a correlate of sympathetic nervous system activity, EDA concerns the volume of sweat produced by eccrine sweat glands. It is believed that the greater the volume of sweat present, the more electrical conductivity can be measured (Figner and Murphy 2011). EDA has been used as a metric within studies of mathematics anxiety (Pizzie and Kraemer 2021) and as a predictor of public speaking anxiety (Egloff et al. 2006; Lee 2020; Sevinc 2018).

4 . 研究成果

State specific anxiety is dynamic rather than static and momentary fluctuations in arousal can be expected even within the context of exposure to specific stimuli. Given that state anxiety corresponds to a specific stimulus, it is incumbent upon researchers to establish a clear start and end to accurately connect the stimulus to the response and avoid the misattribution of emotions to uncontrolled factors. However, within foreign language education research fixed durations including fluctuations across the timespan have not been documented due to methodological

limitations and challenges in data processing. Recent advances in wearable health tracking devices have now created new opportunities for improvements to be made in terms of methodology and assessment. As one such device, the Empatica E4 wristband uses four sensors which allow data to be “unobtrusively and continuously acquired while participants are performing the cognitive task” (Shackman et al. 2006, p. 42). Within the Empatica eco-system data from the E4 wristband can be captured in real-time and uploaded to the E4 Connect repository where the data files can then be downloaded into specialized software for further analysis. For non-clinical researchers knowing how to process this data and how such data can then support the study of emotions in the classroom is challenging.

Informed by the challenges outlined, this project created the Situation Specific Arousal Analyzer (SSAA) application for the on-off task physiological measurement and tracking of autonomic nervous system arousal. The SSAA application can be used on either the OS X or Windows platform and primarily focuses on the calculation of heart rate (HR), heart rate variability (HRV) (time-domain methods, frequency-domain methods, non-linear domain methods), and electrodermal activity (EDA). The user friendly interface can be tailored to meet a range of experimental conditions focused on either the micro analysis of arousal in time specific segments such as every few seconds during an L2 spoken presentation, or relative to longer macro periods of analysis such as across an entire classroom period. For the HRV time-domain, the beat-to-beat interval (NNMean) can be calculated up to once per 0.015625 (1/64) second while for the EDAMean it is possible to capture data once per 0.25 (1/4) second. The SSAA generates and exports these results as tabulated CSV files and visualizations. The SSAA application also produces data outputs and visualizations for the HRV frequency-domain (low frequency (LF), high frequency (HF), and the ratio of LF and HF (LF/HF)) and for the HRV non-linear domain (SD1 and SD2 Poincaré Plots) although these outputs are not anticipated to be as useful within the context of foreign language education due to their complexity. The tabulated data for each student can then be plotted into more accessible line charts for the basis of analyzing the physiological flow of changes in arousal relative to each metric within and between students. The data quantification undertaken by the SSAA represents a significant innovation in accessible research methodology applicable to the study of foreign language education anxiety. The data generated through the SSAA permits correlations and affective relationships to be analyzed with other variables such as language acquisition and achievement and motivation. More importantly, the SSAA application provides greater access to a much-needed physiological component in the study of state specific anxiety and an overdue partner to the experiential self-report measures currently used.

5. 主な発表論文等

〔雑誌論文〕 計16件（うち査読付論文 16件／うち国際共著 16件／うちオープンアクセス 3件）

1. 著者名 Rivers Damian J.	4. 巻 7
2. 論文標題 Multimodal Gestalts and Post-pandemic Utopianism: Drum and Bass on the Bike	5. 発行年 2022年
3. 雑誌名 Frontiers in Communication	6. 最初と最後の頁 -
掲載論文のDOI（デジタルオブジェクト識別子） 10.3389/fcomm.2022.817332	査読の有無 有
オープンアクセス オープンアクセスとしている（また、その予定である）	国際共著 該当する
1. 著者名 Rivers Damian J.	4. 巻 2022
2. 論文標題 Stress Mediates the Relationship between Personality and the Affordance of Socially Distanced Online Education	5. 発行年 2022年
3. 雑誌名 Human Behavior and Emerging Technologies	6. 最初と最後の頁 1~12
掲載論文のDOI（デジタルオブジェクト識別子） 10.1155/2022/9719729	査読の有無 有
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1. 著者名 Rivers Damian J.	4. 巻 7
2. 論文標題 The Situation Specific Arousal Analyzer: Innovation in the Physiological Assessment of Foreign Language Education Anxiety	5. 発行年 2022年
3. 雑誌名 Frontiers in Education	6. 最初と最後の頁 -
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1. 著者名 Rivers Damian J., Nakamura Michiko, Vallance Michael	4. 巻 60
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3. 雑誌名 Journal of Educational Technology Systems	6. 最初と最後の頁 -
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2. 論文標題 Donald Trump, legitimisation and a new political rhetoric	5. 発行年 2020年
3. 雑誌名 World Englishes	6. 最初と最後の頁 623 ~ 637
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3. 雑誌名 Journal of Language and Politics	6. 最初と最後の頁 831 ~ 856
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1. 著者名 Ross Andrew S., Rivers Damian J.	4. 巻 35
2. 論文標題 Sport in the new media landscape: Community, participation and discourse	5. 発行年 2020年
3. 雑誌名 Discourse, Context & Media	6. 最初と最後の頁 100378 ~ 100378
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2. 論文標題 Internet Memes, Media Frames, and the Conflicting Logics of Climate Change Discourse	5. 発行年 2019年
3. 雑誌名 Environmental Communication	6. 最初と最後の頁 975-994
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2. 論文標題 Walking on Glass: Reconciling Experience and Expectation in Japan. Journal of Language, Identity and Education	5. 発行年 2019年
3. 雑誌名 Journal of Language, Identity and Education	6. 最初と最後の頁 377-388
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〔学会発表〕 計7件（うち招待講演 0件 / うち国際学会 7件）

1. 発表者名 Rivers Damian J.
2. 発表標題 Innovation in the physiological analysis of foreign language education anxiety: The Situation Specific Arousal Analyzer (SSAA)
3. 学会等名 15th International Conference on e-Learning & Innovative Pedagogies (国際学会)
4. 発表年 2022年

1. 発表者名 Rivers Damian J.
2. 発表標題 The physiological assessment of situation specific anxiety in education
3. 学会等名 16th annual International Technology, Education and Development Conference (INTED) (国際学会)
4. 発表年 2022年

1. 発表者名 Rivers Damian J., Vallance Michael
2. 発表標題 Unconscious incompetence and resistance to professional development in Japanese higher education
3. 学会等名 16th annual International Technology, Education and Development Conference (INTED) (国際学会)
4. 発表年 2022年

1. 発表者名 Damian J. Rivers
2. 発表標題 Cognitive and Social Antecedents of Academic Success
3. 学会等名 Twelfth International Conference on e-Learning & Innovative Pedagogies (国際学会)
4. 発表年 2019年

1. 発表者名 Damian J. Rivers
2. 発表標題 Motivational Affordances and ICT Design in an Online Social Fitness Network.
3. 学会等名 Tenth International Conference on Sport & Society (国際学会)
4. 発表年 2019年

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2. 発表標題 The Conflicting Logics of Climate Change Discourse: The Interplay of Internet Memes and Media Frames
3. 学会等名 Australian and New Zealand Communication Association (ANZCA) Conference (国際学会)
4. 発表年 2019年

1. 発表者名 Damian J. Rivers and Andrew S. Ross
2. 発表標題 Deflection as a Communication Strategy: A Corpus Analysis of President Trump 's Twitter Behaviour
3. 学会等名 Australian and New Zealand Communication Association (ANZCA) Conference (国際学会)
4. 発表年 2019年

〔図書〕 計2件

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2. 出版社 Routledge	5. 総ページ数 366
3. 書名 Discourses of (De)Legitimization: Participatory Cultures in Digital Contexts	

1. 著者名 Damian J. Rivers	4. 発行年 2019年
2. 出版社 Routledge	5. 総ページ数 33
3. 書名 Political Cartoons as Creative Insurgency: Delegitimization in the Culture of Convergence	

〔産業財産権〕

〔その他〕

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6. 研究組織

氏名 (ローマ字氏名) (研究者番号)	所属研究機関・部局・職 (機関番号)	備考
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7. 科研費を使用して開催した国際研究集会

〔国際研究集会〕 計0件

8. 本研究に関連して実施した国際共同研究の実施状況

共同研究相手国	相手方研究機関
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