

*A person-specific perspective on the dynamics of anxiety  
in foreign language learning:  
A dynamic P-technique factor analysis*

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Abstract

In the field of second and foreign language (L2) anxiety studies, which are predominantly group-based, the role of individual-level inner workings of L2 anxiety has been

neglected. Emerging evidence in L2 learning underscores that while aggregating data from a large number of learners reveals general trends, this approach often overlooks the distinct characteristics inherent in each individual's data. For this reason, specialists have emphasized the necessity of illuminating unique and individualized experiences of L2 anxiety, both in short- and long-term evaluations. The present study aimed to grasp person-specific variation in L2 anxiety in Sara, an adult female L2 learner. In a year-long ecological momentary assessment study design, Sara provided daily replies to an online questionnaire about L2 anxiety. Using the dynamic P-technique, this research explored how Sara's L2 anxiety ratings on a given day impacted or predicted her rating on the following day and the consistency of her evaluations over time. Results revealed that a four-factor structure best represented her daily L2 anxiety, comprising lack of self-confidence (LSC), fear of negative evaluation (FNE), performance anxiety (PA), and negative attitude toward language learning (NA). It was observed that on days when Sara experienced higher-than-usual LSC and FNE, her return to equilibrium was slower compared to days with heightened PA or NA. Additionally, despite daily fluctuations in the four subfactors, these factors appeared immune to fluctuations in predictor levels and did not immediately affect other subfactors. Moreover, LSC, FNE, PA, and NA exhibited positive feedback loops, where each subfactor could potentially predict another in subsequent states.

*Keywords:* L2 anxiety; individualized experience; person-specific perspective; dynamic P-technique factor analysis

## 1. Introduction

After more than 20 years of research in the field of second language acquisition (SLA) from a complex dynamic systems theory (CDST) perspective (Larsen-Freeman & Cameron, 2008), one clear conclusion emerges: Language development is not a pre-specified process but a unique and personalized one, arising from the interaction of various nested systems, a phenomenon known as “self-organization” (Verspoor et al., 2021). Lowie and Verspoor (2019) state that second and foreign language (L2) learners do not constitute ergodic ensembles and that language learning data lack stability. Ergodic theory posits that generalizing group statistics to individuals, and vice versa, is not possible unless the group is an ergodic ensemble (McManus et al., 2023; Molenaar, 2004). Hence, it is imperative to pursue an alternative line of inquiry in SLA, namely, the person-specific approach. Existing research suggests that including individual-level knowledge is an essential requirement for comprehensively understanding or rectifying our understanding of the underlying mechanisms and inner workings of L2 anxiety (MacIntyre & McGillivray, 2023). Achieving this goal, however, requires adopting a more focused approach to understanding the particular ways in which different anxieties are encountered by an individual language learner (MacIntyre & McGillivray, 2023).

The emergence of L2 anxiety exhibits significant complexity and heterogeneity (Elahi Shirvan & Talebzadeh, 2017; Gregersen, 2020; Gregersen et al., 2014; Kasbi & Elahi Shirvan, 2017; MacIntyre & Gregersen, 2022; MacIntyre & McGilivray, 2023). Traditionally, the examination of L2 anxiety has relied on models that analyze data at the group level. Accordingly, L2 emotion research typically considers L2 anxiety as homogeneous, relying on averages across individuals (Horwitz et al., 1986; MacIntyre, 1999; Papi & Khajavy, 2023). However, while summarizing data from a large number of learners captures overall patterns across multiple samples, it inevitably sacrifices the uniqueness of each individual data point. While group-level analyses reveal general patterns, anxiety levels fluctuate uniquely for each individual due to personal characteristics, motivation, emotions, and coping mechanisms (Piniel & Zólyomi, 2022; Teimouri et al., 2019; Zhang, 2019; Zhou et al., 2022, 2023). This underscores the importance of analyzing individual trajectories to fully understand the role of L2 anxiety. It is therefore crucial to expand the domain of the psychology of language learning by developing models that account for individual-level heterogeneity, thereby grasping the person-specific variation in L2 anxiety. Additionally, explicitly incorporating individual variations into the complexity of L2-related emotions is vital to recognize both their common (nomothetic) and personal (idiographic) characteristics (Gates et al., 2023).

An additional concern with prior investigations into L2 anxiety is the timescale at which it has been examined. Emotions, inherently dynamic, undergo changes over time. However, previous studies have either overlooked or only briefly examined this aspect of emotional change, often using idiodynamic methods. These methods have provided invaluable insights into the rapid fluctuations of L2 anxiety within short timespans, such as minutes or seconds (e.g., Elahi Shirvan & Talebzadeh, 2017; MacIntyre & Gregersen, 2022). Yet, the intricate nuances of how distinct emotions evolve within an individual over an extended period remain largely unexplored. While emotional reactions suggest adaptation and change over shorter periods, often measured in seconds or minutes (Fredrickson, 2013), studying the individual fluctuations of L2 anxiety over longer periods is essential to understand how it emerges from the dynamic interplay of its subfactors at the personal level. This underscores the need for models that account for individual differences.

This paper presents an instance of using a dynamic P-technique with a single-subject design to investigate L2 anxiety. The dynamic P-technique, a specific case of structural equation modeling (SEM; Howard & Hoffman, 2017), enables the examination of emerging latent variables and the associations between latent structures within a person, making it particularly suited for tracking the long-term dynamics of L2 anxiety (Kurz et al., 2019).

## 2. Literature review

### 2.1. L2 anxiety: From groups to individual learners

According to Horwitz et al. (1986), language anxiety can be defined as an individualized set of self-perceptions, beliefs, emotions, and actions that are associated with learning a second or foreign language in the classroom, resulting from the distinctive nature of the language learning process. MacIntyre (1999) characterizes L2 anxiety as a state of stress, nervousness, emotional response, and tension that is associated with the learning of an additional language. The study of L2 anxiety, along with other emotional constructs, can be approached from three perspectives: variable-centered, person-centered, and person-specific. These approaches encompass three prominent yet different types of methodologies. Instead of one approach being superior to the other, they can be applied to answer different sets of research questions (Howard & Hoffman, 2017).

Research on L2 anxiety utilizing the variable-centered approach, including techniques such as correlation and regression, has focused on understanding the relationships between L2 anxiety and other emotional or cognitive factors. This approach is widely established in the field of SLA. To investigate these associations, data are typically gathered from large samples of individuals on one or more occasions, with the aim of identifying commonalities within a representative group, thereby condensing a larger population into a generalized and homogeneous group.

The R-technique, where R typically stands for *relationships* among variables in a group, is the primary tool for examining the fundamental structure of L2 anxiety in variable-centered methods. This approach is typically associated with factor analysis, a statistical technique that reduces the number of factors by generating subfactors represented as linear combinations of the initial factors. When using the R-technique, researchers aim to identify subgroups of constructs with strong interrelationships to create distinct factors.

Utilizing the R-technique, Horwitz et al. (1986) developed the *Foreign Language Classroom Anxiety Scale* (FLCAS) to capture the range of anxiety-related thoughts, feelings, symptoms, and behaviors that students typically encounter in a foreign language classroom. This scale comprises thirty-three items and was specifically designed to assess foreign language anxiety as a unique phenomenon, independent of other forms of anxiety such as communication apprehension, fear of negative evaluation, and test anxiety. Subsequent research has explored the FLCAS's component structure, with varying results. In a factor analysis of the FLCAS, Aida (1994) identified four underlying factors: speech anxiety, fear of failure, comfort in speaking with native speakers, and negative attitudes toward the foreign language class. These findings indicate that foreign language

anxiety is a complex construct, with several factors impacting learners' anxiety experiences in various ways.

Elahi Shirvan et al. (2016) conducted a psychometric analysis of the Persian version of the FLCAS and found that the scale, which has 26 items, has a unidimensional structure. This result implies that, rather than being divided into several discrete components, FLCA may be best understood as a single construct in the context of Iran. The heterogeneity in the results among various studies highlights the significance of context in influencing the perception and quantification of foreign language anxiety. The present study acknowledges the ongoing discussion about the structure of the FLCAS and aims to enhance the understanding of FLCA from an individual-specific perspective.

Researching L2 anxiety from a variable-centered perspective has enhanced our understanding of this emotion in several areas, including: (a) how researchers conceptualize and measure the construct in the realm of second language acquisition (SLA) (e.g., Aida, 1994; Horwitz et al., 1986; MacIntyre & Gardner, 1994); (b) the influence of anxiety on various L2 outcomes (e.g., Dewaele & MacIntyre, 2014; Elahi Shirvan et al., 2018; Horwitz, 2017); and (c) potential sources of L2 anxiety (e.g., Botes et al., 2020; Jiang & Dewaele, 2020; Papi & Khajavy, 2023). An in-depth overview of variable-centered empirical investigations of L2 anxiety can be found in Papi and Khajavy (2023).

L2 anxiety variable-centered studies, whether employing cross-sectional or longitudinal methodologies, have primarily aimed to draw conclusions about the levels of L2 anxiety in groups of language learners sharing similar characteristics. However, applying these approaches to individual participants requires a significant shift in focus from analyzing between-person variations at the group level to within-person variations at the individual level. This methodological shift has been met with skepticism by some scholars, who question its validity and applicability across different levels of analysis (e.g., Gates et al., 2023; Lowie & Verspoor, 2019; McManus et al., 2023; Molenaar, 2004, 2007; Molenaar & Nesselroade, 2009; Verspoor et al., 2021). Molenaar (2004), for example, argues that this shift is only applicable under severe "ergodicity" conditions, which are often impractical in the field of SLA. Essentially, ergodicity is based on the assumption of homogeneity and stationarity, according to which all individuals are the same and remain unchanged over time. Violating these conditions leads to a failure of our frequently applied between-individual approaches at a group level to appropriately depict people over time.

These ideas have prompted a shift in research foci from a variable-centered approach to a more person-centered and person-specific approach. The need for these approaches arises from the heterogeneity and non-stationarity of the samples in the psychology of learning research (Gates et al., 2023; McManus et al., 2023; van der Gaag, 2023; Verspoor et al., 2021; Zhou et al., 2023). Additionally,

empirical evidence supporting non-ergodicity has also been accumulated in the field of SLA (Elahi Shirvan & Taherian, 2020; Elahi Shirvan, Taherian, et al., 2021; Elahi Shirvan, Yazdanmehr, et al., 2021; Kruk et al., 2021, 2022, 2023; Lowie & Verspoor, 2019; Taherian et al., 2023). For example, Elahi Shirvan, Taherian, et al. (2021) and Elahi Shirvan, Yazdanmehr, et al. (2021) supported non-ergodicity by employing latent growth curve modeling (LGCM), which allowed for the analysis of both intra-individual and inter-individual variations in L2 emotions. At Level 1, the studies examined changes in L2 emotions within each individual over time, highlighting how emotional experiences fluctuate uniquely for each learner. At Level 2, they analyzed between-individual differences in the trajectories of L2 emotions, revealing how these emotional patterns vary across learners. By capturing both levels of variability, these studies provided empirical evidence that group-level trends cannot fully explain individual-level emotional dynamics, supporting the non-ergodicity of L2 emotions.

The Q-technique, where Q typically stands for quantifying the subjective *qualities* of individual opinions, is the primary tool used in person-centered methods to evaluate the fundamental structure of a construct (Molenaar, 2004). The Q-technique considers variables as the primary focus of research but treats the subject as the dimension or mode to be factored (Irie, 2014). Similar to R-approaches, researchers seek to identify subsets of factors that exhibit strong correlations to form factors. In contrast to R-approaches, Q techniques are intended to specifically search for subsets of persons that display high relationships with form factors (Molenaar, 2007). For instance, individuals who exhibit identical patterns across assessed variables would manifest strong correlations. However, to the best of our knowledge, no studies have specifically employed the Q-technique to examine learners' L2 anxiety. In one relevant study, applying the Q approach, Fraschini and Park (2022) investigated undergraduate Korean language teaching students' perceptions of anxiety related to student-teacher interactions. The findings revealed four primary viewpoints: (1) participants expressing apprehension regarding their lack of experience, skills, and clarity in delivering their teaching; (2) participants expressing concern about a poor work-life balance and feeling underprepared for their classes; (3) participants expressing anxiety about their relationships with colleagues and supervisors, as well as issues related to managing the classroom; and (4) participants expressing concerns about being undervalued and lacking opportunities to demonstrate their creativity.

Additional techniques employed in person-centered approaches encompass latent profiles, mixture models, and cluster analysis. Wang et al. (2023), for instance, investigated the psychosocial qualities of university language learners' emotional adjustment, L2 anxiety, perceived support from their social environment, and self-efficacy beliefs during the COVID-19 pandemic in online settings.

They categorized the learners' profiles into three groups: strong adaptation, moderate adaptation, and low adaptation. The study revealed that learners in the strong adaptation group displayed more optimistic self-efficacy beliefs and lower levels of L2 anxiety. Conversely, students in the low adaptation group exhibited less optimistic self-efficacy beliefs and higher levels of L2 anxiety.

Nevertheless, when the research question or hypothesis is centered on an individual, analyses that aggregate data from a group to draw conclusions about subpopulations are inadequate. Therefore, in these instances, it is not appropriate to utilize the variable- and person-centered methods; instead, person-specific techniques are more suitable. Person-specific methods, such as state-space modeling, dynamic factor analysis, and P-technique factor analysis, are employed to examine influences that may be unique to individual learners (Howard & Hoffman, 2017). These methods typically involve data collection from a limited number of participants, sometimes as few as one, over multiple instances (Howard & Hoffman, 2017). This approach has been developed and implemented in response to the understanding that language learners should be viewed as non-ergodic, meaning that statistical tests must consider individuals as dynamically evolving rather than static entities (Lowie & Verspoor, 2019).

Currently, the person-specific method is not widely used in SLA research but is gaining popularity, especially among researchers who focus on change and development. Since the development of L2 anxiety is non-ergodic and highly individualized, traditional approaches like variable-centered and person-centered methods, which focus on between-group and individual-level analysis, often fall short of accurately assessing the daily L2 anxiety of individual students over time (MacIntyre & McGillivray, 2023). To address the limitations of conventional group-based methods in studying L2 anxiety, MacIntyre and McGillivray (2023) advocate reliance on an intrapersonal and dynamic approach. This approach allows a more comprehensive examination of various ways in which anxiety influences language on an individual level. MacIntyre and McGillivray (2023) discuss the potential of person-specific methodologies in the study of complex dynamic systems, highlighting their ability to generate novel insights pertaining to L2 anxiety. They also call for further research into L2 anxiety, emphasizing the importance of highly contextualized, individual-level studies.

## 2.2. P-technique: A person-specific approach of L2 anxiety

Based on the overview in the previous section, it can be concluded that L2 anxiety is not a one-size-fits-all experience. Adopting a person-specific approach enables researchers and practitioners to gain a deeper understanding of L2 anxiety,

allowing for the creation of tailored plans that address the specific needs of each individual, thereby leading to more effective and improved outcomes. By considering these individual differences, specialists can more accurately identify the underlying causes of L2 anxiety and develop targeted solutions that reveal each person's specific triggers and coping mechanisms. The challenge now lies in how researchers can measure and conceptualize the inner workings of L2 anxiety from a person-specific point of view. To this end, the study embarks on elucidating the underlying structure of L2 anxiety from a person-specific viewpoint. The P-technique, where "P" stands for *person-specific* analysis, is distinguished from the R-technique by its individual-centric analysis and emerges as a pivotal framework in this endeavor.

P-technique factor analysis is a statistical technique employed to examine data collected from a single case across several time periods in order to discover underlying factors that account for the variation among variables within that person (Gates et al., 2023). The model operates based on the common factor model, which represents the relationships between observed variables as being influenced by a collection of latent factors. The key assumption of the P-technique is the independence of observations, which implies that observations at each time point are not affected by observations at preceding points, and stationarity, which refers to the consistency of the covariance structure over time (Molenaar, 2004). Nevertheless, these assumptions impose specific constraints. Psychological processes frequently demonstrate temporal-structured variability, in which an individual's previous states or experiences impact their present and future states (Molenaar, 2004). For example, in our study, Sara's anxiety level observed on one day may carry over to the following day. The sequential dependency contradicts the assumption of independence, restricting the effectiveness of conventional P-technique factor analysis in representing these dynamic processes.

To address these limitations, dynamic P-technique factor analysis was developed. This methodology integrates time-series analysis, alleviating the assumption of independence by representing the sequential relationships in the data (Molenaar, 2004). The dynamic P-technique expands upon the conventional model by considering the impact of both concurrent variables and past states on an individual's present condition. This makes it especially useful for studying continuous psychological processes such as language anxiety, in which temporal dependencies play an important role. A key feature of the dynamic P-technique is the incorporation of autoregression and cross-regression parameters. The autoregression model incorporates carryover effects, which refer to the influence of an individual's past state on their present state. The cross-regression model considers spillover effects, which refer to one variable's potential to influence another over time (Molenaar, 2004). In the case of Sara in our study, for instance, the negative attitude toward language learning that she experienced on one day may have had an effect not only



on the level of negative attitudes that she experienced on the following day but also on the level of fear of negative evaluation that she experienced. Through the integration of these effects, the dynamic P-technique enables a more accurate and sophisticated comprehension of processes at the individual level (Ram et al., 2013).

A number of crucial data requirements must be met in order to conduct a dynamic P-technique analysis. Time-series data must be collected from a single individual across multiple occasions, typically with a minimum of 100 observations per person (Gorsuch, 1983). In order to guarantee adequate statistical power, it is often advised to use longer time series consisting of 300 or more observations for dynamic analyses (Wood & Brown, 1994). According to Molenaar (2004), the time scale should be in accordance with the phenomenon that is being investigated, and the intervals between the data collection points should be as evenly spaced as possible. In our study, data were gathered every day after English classes. This gave us a chance to model how anxiety changed from day to day. Determining a suitable time period is crucial, as it should be sufficiently extended to capture significant change without being too long so that crucial dynamics are not overlooked (Collins, 2006).

The P-technique is significant in measuring L2 anxiety for several reasons (Gates et al., 2023). First, it is possible that the same observed item may hold varying implications for L2 anxiety across different learners. Therefore, personalized estimates of how these items relate to the underlying concept are essential to accurately assess L2 anxiety for a particular learner at specific time points. Another reason for adopting person-specific models is the potential for different underlying structures of L2 anxiety among individual learners. As discussed in the previous section, it is recommended that measuring models be customized for each individual (Gates et al., 2023). The dynamic P-technique enables the assessment of the validity of group-level nomothetic approaches in a single-case, within-person, time-lagged framework, focusing on interactions among latent and measured constructs (Howard & Hoffman, 2017).

The primary goal of this study was to utilize the dynamic P-technique to gain a deeper understanding of the unique and personalized experience of L2 anxiety in an adult female language learner named Sara, as she navigated English learning in a foreign language setting. The secondary objective was to explore how Sara's L2 anxiety ratings on a particular occasion impacted or predicted her rating on the following day, as well as to assess the consistency of her evaluations from day to day. The research questions guiding this study were as follows:

- RQ1: What is the factor structure of Sara's daily L2 anxiety?
- RQ2: How stable are Sara's L2 anxiety ratings from day to day?
- RQ3: Are there serial dependencies inherent in time-series data for Sara's daily L2 anxiety subfactors?

### 3. Method

#### 3.1. Participant

The research project involved an intermediate-level English as a foreign language (EFL) student at a private institute in Iran. One challenge in the design of this study was the substantial time commitment required from the participant. Therefore, it was crucial to find volunteers who were not only willing to take part in the study but also perceived their participation as beneficial. In the first session of the course, we provided the learners in one class with a written summary that outlined the data gathering process, time involvement, and primary objectives of the study. One female student willingly offered to participate in the project. At the end of the session, she had a face-to-face meeting with one of the authors for a detailed verbal explanation of the project's requirements and expectations. To preserve her identity, we assigned the pseudonym Sara to a 22-year-old undergraduate student majoring in computer engineering. As a native Persian speaker, Sara had been learning English as a foreign language for about eighteen months and had reached an intermediate level of proficiency at the time of data collection. She registered for an intensive conversational English course requiring in-person attendance four times a week, with each session lasting two hours. This course aimed to enhance the proficiency of language learners in English conversation, with a special emphasis on the four essential language skills: speaking, listening, writing, and reading.

#### 3.2. Instrumentation

The FLCAS (Horwitz et al., 1986) was employed to measure the participant's daily L2 anxiety. The instrument consists of 33 items and is divided into three subscales: *communication apprehension*, *test anxiety*, and *fear of negative evaluation*. The internal consistency coefficient for the FLCAS is .94 (Horwitz et al., 1986). Items on the scale were evaluated using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). We decided to choose this scale over the short-form version (Botes et al., 2022) to preserve coherence with prior studies and guarantee comprehensive measurement of all aspects of foreign language anxiety. Although a shorter version may have been more practical considering the need to gather data daily throughout the year, the original version enabled a more thorough evaluation of the participant's anxiety, covering a wider spectrum of experiences and responses in the L2 classroom.

### 3.3. Data collection

Throughout the period of 12 months, from October 22, 2022, to October 22, 2023, Sara consistently provided daily responses to an online version of the FLCAS, which was utilized to assess her L2 anxiety levels. A personalized internet-based questionnaire was developed for her, which she accessed daily to record her L2 anxiety ratings for each session of the course. It is worth mentioning that Sara attended her English class four days a week and had a total of 62 days off throughout the data collection period. On days without English classes, she did not complete the questionnaire. To facilitate consistent participation, we sent Sara daily reminders twice to her cellphone: once in the evening, following her English lesson at 7 pm, and again at 10 pm. Over the course of the study, Sara provided a total of 264 responses. Most of her daily L2 anxiety ratings were recorded in the afternoon, subsequent to the completion of her English session.

The present study applied the episodic process model (Beal et al., 2005). Consistent with this model, emotional reactions are frequently associated with particular events or episodes. Following the episodic character of emotional processing, Sara's anxiety levels were documented on a daily basis subsequent to each class session. This method records emotional reactions associated with particular episodes, offering valuable insights into the progression of her anxiety throughout the day in reaction to classroom experiences.

### 3.4. Data analysis

The analyses were conducted using the Mplus 8.1 program (Muthén & Muthén, 2017). Sara submitted responses on 264 occasions, which represents 87.41% of the total data collection days. To address the missing data, we employed the complete information non-normal robust maximum likelihood estimator (MLR) (Zhong & Yuan, 2011). The analyses commenced with relatively simple models and progressively advanced to more complicated ones. First, we conducted P-technique exploratory factor analysis (EFA). Second, we performed P-technique confirmatory factor analysis (CFA, see Figure 1). Finally, we employed a dynamic P-technique CFA with serial dependencies (see Figure 2).

## 4. Results

### 4.1. P-technique EFA

Rather than applying nomothetic approaches to analyze Sara's daily L2 anxiety, we chose to perform a P-technique EFA following the guidelines provided by Gates

et al. (2023). To determine if there was sufficient correlation between variables to perform factor analysis, we computed the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-MSA) statistic (Kaiser, 1981). The overall KMO-MSA was .86, indicating that the sample correlation matrix had adequate intercorrelations among factors to warrant performing factor analysis. The analysis identified four factors with eigenvalues greater than 1.0: lack of self-confidence (LSC), fear of negative evaluation (FNE), performance anxiety (PA), and negative attitude toward language learning (NA). The method of maximum likelihood estimation was employed, utilizing bifactor rotation for extracting a multidimensional factor structure. Based on the results, we decided to extract four correlated factors to represent the factor structure of Sara's daily L2 anxiety (see Table 1).

Table 1 P-technique EFA solution for the daily FLCA scale

Items	LSC	FNE	PA	NA
1. I never feel quite sure of myself when I am speaking in my foreign language class.	.74	.11	.14	.02
4. It frightens me when I don't understand what the teacher is saying in the foreign language.	.68	.08	.17	.05
7. I keep thinking that the other students are better at languages than I am.	.56	.16	.13	.03
10. I worry about the consequences of failing my foreign language class.	.69	.14	.12	.04
12. In language class, I can get so nervous I forget things I know.	.70	.12	.16	.03
13. It embarrasses me to volunteer answers in my language class.	.72	.08	.09	.04
18. I feel confident when I speak in foreign language class.	.80	.09	.14	.07
22. I don't feel pressure to prepare very well for language class.	.74	.09	.18	.11
23. I always feel that the other students speak the foreign language better than I do.	.69	.11	.08	.06
2. I don't worry about making mistakes in language class.	.12	.63	.04	.16
15. I get upset when I don't understand what the teacher is correcting.	.16	.67	.08	.10
19. I am afraid that my language teacher is ready to correct every mistake I make.	.08	.72	.11	.08
24. I feel very self-conscious about speaking the foreign language in front of other students.	.11	.73	.05	.01
31. I am afraid that the other students will laugh at me when I speak the foreign language.	.07	.68	.06	.06
32. I would probably feel comfortable around native speakers of the foreign language.	.04	.71	.17	.11
3. I tremble when I know that I'm going to be called on in language class.	.16	.02	.58	.22
8. I am usually at ease during tests in my language class.	.04	.03	.67	.17
9. I start to panic when I have to speak without preparation in language class.	.14	.01	.59	.21
14. I would not be nervous speaking the foreign language with native speakers.	.18	.03	.70	.09
16. Even if I am well prepared for language class, I feel anxious about it.	.16	.05	.73	.10
20. I can feel my heart pounding when I'm going to be called on in language class.	.08	.06	.66	.15
27. I get nervous and confused when I am speaking in my language class.	.06	.02	.76	.10
28. When I'm on my way to language class, I feel very sure and relaxed.	.07	.01	.72	.11
29. I get nervous when I don't understand every word the language teacher says.	.14	.11	.74	.08
33. I get nervous when the language teacher asks questions which I haven't prepared in advance.	.06	.06	.66	.09
5. It wouldn't bother me at all to take more foreign language classes.	.08	.05	.11	.58
6. During language class, I find myself thinking about things that have nothing to do with the course.	.15	.12	.04	.61
11. I don't understand why some people get so upset over foreign language classes.	.04	.08	.02	.67
17. I often feel like not going to my language class.	.16	.08	.00	.61
21. The more I study for a language test, the more confused I get.	.16	.11	.02	.76
25. Language class moves so quickly I worry about getting left behind.	.06	.07	.05	.49
26. I feel more tense and nervous in my language class than in my other classes.	.08	.14	.09	.57
30. I feel overwhelmed by the number of rules you have to learn to speak a foreign language.	.05	.09	.02	.69

Note. LSC = lack of self-confidence; FNE = fear of negative evaluation; PA = performance anxiety; NA = negative attitude

## 4.2. P-technique CFA

We conducted an analysis of a four-factor CFA solution for Sara's daily L2 anxiety (see Figure 1). We employed the full-information non-normal robust maximum likelihood estimator to accurately estimate parameters and effectively manage missing data (MLR; Zhong & Yuan, 2011). Based on the recommendation of Lo et al. (2016), the acceleration factor (AF) approach was applied to the data. The AF method aligns with the location of a cut-off point in the scree plots (Lo et al., 2016). The selection of this approach was based on its superior performance in the simulation P-technique study conducted by Lo et al. (2016). The AF approach identified four factors for Sara's FLCA data. The overall fit indices for this correlated four-factor model were satisfactory ( $\chi^2$  (df = 106) = 307.33,  $p$  = .000; CFI = .94; TLI = .91; RMSEA = .03; SRMR = .06). Additionally, to explore the sequential dependencies present in time-series data (Little, 2023), we performed a dynamic P-technique CFA on Sara's daily L2 anxiety.

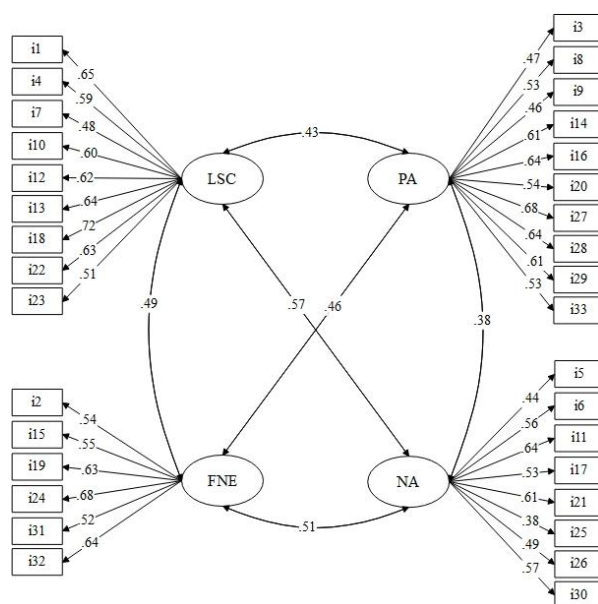


Figure 1 P-technique CFA for daily FLCA (LSC = lack of self-confidence; FNE = fear of negative evaluation; PA = performance anxiety; NA = negative attitude)

## 4.3. Dynamic P-technique CFA with serial dependencies

The previous CFA solution (see Figure 1) did not have the capability to represent the sequential relationships between assessment time points. Sequential dependencies

pertain to the associations between data acquired at closely related time intervals, such as between today and tomorrow. To incorporate these sequential relationships, it was necessary to modify the dataset to distinguish between different measurement instances. We implemented the procedures described in Kurz et al. (2019) to introduce a file to lag the data. After applying a lag to the data file, the subsequent task involved incorporating residual correlations between pairs of items at different time lags (e.g., Item 1 today and Item 1 tomorrow). Additionally, the solution included unidirectional autoregressive structures between latent variables, such as LSC today predicting LSC tomorrow. Overall, the fit indices outperformed the initially presented P-technique CFA solution ( $\chi^2$  (df = 106) = 294.51,  $p$  = .000; CFI = .96; TLI = .94; RMSEA = .03; SRMR = .05).

There were large and statistically significant autoregressive parameter estimates between LSC today and LSC tomorrow (.72, 90% CI [0.58-0.80]), between FNE today and FNE tomorrow (.61, 90% CI [0.48-0.70]), between PA today and PA tomorrow (.59, 90% CI [0.40-0.68]), and between NA today and NA tomorrow (.48, 90% CI [0.33-0.57]). These estimates did not include zero. These findings indicate that Sara's daily evaluations of LSC, FNE, PA, and NA exhibited a relatively consistent pattern from day to day. Consequently, an increase in one standardized unit in LSC today would correspond to an increase of 0.72 standardized units in LSC tomorrow. Similarly, a one-unit increase in FNE today was associated with a 0.61-unit increase in FNE tomorrow; a 0.59-unit increase in PA tomorrow followed a one-unit increase in PA today; and a one-unit increase in NA today led to a 0.48-unit increase in NA tomorrow. In longitudinal studies, such "carry-over effects," as described by Hamaker et al. (2023), refer to autoregressive parameters.

Addressing serial dependencies among subfactors, the findings indicated a positive association between an increase in LSC and increases in FNE, PA, or NA on the same day. Conversely, there was no matching association between an increase in FNE and increases in PA or NA. Similarly, there was no link between fluctuations in PA and NA observed on the same day. Moreover, in the analysis of lagged interactions on different days, significant correlations were observed: between LSC today and PA tomorrow (.32, 90% CI [0.25-0.43]), LSC today and FNE tomorrow (.37, 90% CI [0.28-0.49]), and LSC today and NA tomorrow (.19, 90% CI [0.11-0.30]). Additionally, significant associations were found between changes in FNE today and PA tomorrow (.24, 90% CI [0.16-0.35]), as well as between FNE today and NA tomorrow (.22, 90% CI [0.15-0.31]). Finally, changes in PA today were significantly related to NA tomorrow (.27, 90% CI [0.18-0.38]) (see Figure 2).

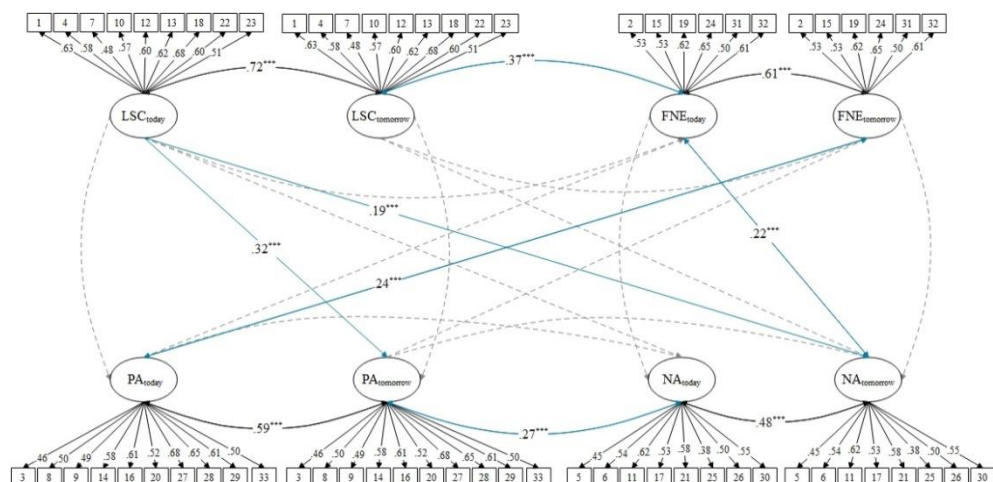


Figure 2 Dynamic P-technique CFA with serial dependencies between assessment time points (LSC = lack of self-confidence; FNE = fear of negative evaluation; PA = performance anxiety; NA = negative attitude)

## 5. Discussion

The aim of this research was to delineate the underlying structure of Sara's daily L2 anxiety ratings over a period of 264 days, employing the dynamic P-technique. This approach aligns with the calls by Lowie and Verspoor (2019) for the development and implementation of methodologies that are tailored to investigating individuals in the field of SLA. It also supports the recommendation of MacIntyre and McGillivray (2023) to investigate the inner workings of L2 anxiety as a distinctively individual and subjective experience and to shed light on how this emotion fluctuates over time for a specific learner. The second objective of this research was to investigate the impact of Sara's L2 anxiety ratings on a given day on her ratings the following day and to assess the consistency of these evaluations over time. We will discuss the findings of the study in three separate subsections, each addressing one research question: (1) the factor structures of Sara's daily L2 anxiety, (2) the day-to-day consistency of Sara's L2 anxiety subfactors, and (3) the serial dependencies in Sara's daily L2 anxiety subfactors.

### 5.1. The factor structure of Sara's daily L2 anxiety

To address RQ1, we conducted an analysis using the P-technique EFA and CFA to uncover the underlying structure of Sara's daily L2 anxiety. The results revealed

inconsistencies in the structure of Sara's anxiety compared to the three-factor structure established by Horwitz et al. (1986), indicating that a four-factor structure provided a more suitable representation of her daily L2 anxiety. The disparity emphasizes the idiographic attraction of the P-technique approach. Although the discrepancy may indicate the advantages of the P-technique in capturing subtleties of L2 anxiety, it is crucial to acknowledge that the potential to capture such variability is not unique to the P-technique method. Even when employing R-technique methods, various datasets can produce distinct factor structures. Nevertheless, the idiographic nature of the P-technique provides a more individualized perspective, allowing us to reveal nuanced patterns in Sara's anxiety that may otherwise be concealed in more general, group-oriented analyses.

A comparison with previous research in the same context (i.e., English language learners in Iran) provides further interesting insights. Elahi Shirvan et al. (2016), for example, conducted a psychometric analysis of the Persian adaptation of the FLCAS in Iran and confirmed the unidimensionality of the FLCAS with 26 items. In contrast, our P-technique analysis revealed a four-factor structure in Sara's daily anxiety, indicating significant within-person variability that contrasts with the unidimensional findings at the group level. Conversely, our analysis using the P-technique yielded a four-factor structure in Sara's daily anxiety, which suggests substantial variation within individuals and contradicts the one-dimensional results obtained through group analysis in the same context. While the R-technique approach in Elahi Shirvan et al.'s (2016) study identified a stable structure across individuals, our P-technique results highlight individual variability. This implies that drawing conclusions from group-level findings may not sufficiently represent the dynamic and changing experiences of individual learners. Such differences also provide evidence for the argument that language learners are non-ergodic and heterogeneous, and hence a shift from between-person to within-person methods may offer more accurate insights. This observation is consistent with a pattern found in other research utilizing P-technique methods since generalizations from group-level research generally fail to accurately apply to individual cases (Elahi Shirvan & Talebzadeh, 2017; Kruk, 2021; MacIntyre & McGillivray, 2023; Verspoor et al., 2021). For instance, Fisher (2015) uncovered variations in anxiety profiles and their daily fluctuations in a sample of 10 individuals in the United States diagnosed with generalized anxiety disorder, highlighting diversity in individual experience. Additionally, these results are in line with MacIntyre and McGillivray's (2023) study. The researchers argue that atypical results in previous studies, often regarded as outliers, can actually offer valuable insights into the underlying mechanisms of L2 anxiety.

These differences are crucial for tailoring interventions to individuals with specific characteristics, such as neurodivergent learners. In Sara's case, this suggests that



alternative measures may be necessary to address her L2 anxiety, characterized by four subfactors: lack of self-confidence, fear of negative evaluation, performance anxiety, and negative attitudes toward learning a language. Specifically, the factor loadings indicated that LSC and PA had a greater impact on her daily L2 anxiety changes compared to FNE and NA. Therefore, one strategy to alleviate Sara's anxiety could involve focusing on addressing her decreased self-confidence and discomfort when performing in front of her peers and the teacher. Although collecting such intensive data for every learner may not always be practical in larger studies, the P-technique is especially valuable in identifying specific needs for individual learners, particularly those with unique characteristics. For example, adults diagnosed with ADHD, autism, or social anxiety, who are prone to experience increased levels of language anxiety, could have their daily anxiety patterns tracked using this approach. This would enable researchers to precisely identify their particular difficulties and create customized interventions that cater to their unique needs. The insights from such an approach can help identify critical areas of concern that might be overlooked in traditional group-based studies.

## 5.2. Stability in Sara's subfactors of L2 anxiety ratings from day to day

To address RQ2, we employed the dynamic P-technique approach to assess the day-to-day stability of Sara's ratings across the four subfactors of FLCA. For all four subfactors, with the model's autoregressive parameter or carryover effect, we found that her ratings were relatively stable from day to day, exhibiting both trait- and state-like qualities. The carryover effect refers to the speed at which a person returns to equilibrium (i.e., a state at which an individual returns to a baseline or trait-level of emotional state) after a disturbance (Hamaker et al., 2023). The higher levels of autoregressive parameter for LSC and FNE suggest that when Sara experienced unusually high levels of LSC and FNE, she took longer to return to equilibrium compared to when she experienced elevated PA or NA. This finding implies that LSC and FNE were significant triggers for Sara's L2 anxiety, with potential longer-lasting effects on subsequent days. Awareness of these carryover effects and the implementation of strategies to regulate these specific anxiety sources could be beneficial in reducing L2 anxiety over time.

It should be mentioned at this juncture that while autoregressive parameters reflect temporal associations and imply consistency in emotional states from one day to the next, they do not provide conclusive evidence of causality. Autoregressive models emphasize the continuity of emotional and psychological states but do not explain the mechanisms that underpin these relationships. Therefore, these findings should be understood as a reflection of consistent trends over

time rather than as confirmation of one factor at occasion t-1 directly influencing changes in that factor at occasion t.

### 5.3. Serial dependencies in Sara's daily L2 anxiety subfactors

To address RQ3, we explored the spillover effect of one subfactor on the other subfactors of L2 anxiety over successive days using cross-lagged parameters. The dynamic P-technique enabled the examination of lagged correlations, namely, the regression paths between the subfactors at different time points. The spillover effect was analyzed at two levels. At Level 1, we assessed the immediate impact of changes in one subfactor on another within the same day (e.g., the influence of LSC today on FNE today). At Level 2, we investigated the delayed associations, examining how fluctuations in one subfactor (e.g., LSC today) influenced another on subsequent days (e.g., FNE tomorrow).

Addressing Level 1, which focuses on the immediate effect, the results showed that despite daily fluctuations in the four subfactors of Sara's daily L2 anxiety, they appeared to be immune to the daily fluctuations in predictor levels and unlikely to generate immediate fluctuations in other subfactors. Put differently, an increase in one subfactor did not necessarily result in immediate changes in another subfactor. This suggests that Sara might have been actively managing her L2 anxiety on a day-to-day basis. For instance, even if Sara experienced a drop in LSC within a single day, she seemed to employ strategies to effectively manage these decreases, preventing them from negatively impacting her L2 learning process and attitudes on the same day. However, in the analysis of the lagged interactions (Level 2), the results showed a different dynamic. While the fluctuations in each of the subfactors within a single day may not be mirrored by the other subfactors immediately, they could influence the other subfactors on the next day. Specifically, LSC, FNE, PA, and NA were found to exhibit positive feedback loops, meaning that a change in any one of these subfactors in the earlier state has the potential to predict changes in the other subfactors in the subsequent state. Taken together, the model suggests a predictable pattern where a current shift in any subfactor is likely to result in a delayed, rather than immediate, shift in all other subfactors on subsequent days.

According to the control-value theory (Pekrun, 2006), Sara's perception of her ability to control and influence her surroundings (self-confidence) might have greatly affected her day-to-day experience of L2 anxiety. When Sara's self-confidence diminished, it led to an increased likelihood of experiencing other sources of anxiety (i.e., FNE, PA, NA) as she felt less confident in handling challenging situations in her language class. Conversely, periods of elevated self-confidence

were marked by greater assurance in managing the challenges, resulting in a reduced likelihood of experiencing other sources of L2 anxiety. However, these effects for Sara were observed with a delay. Overall, the results demonstrate that Sara's self-confidence significantly impacted her susceptibility to other sources of L2 anxiety. This is because it affected her perceived control over her surroundings and her ability to manage anxiety-provoking situations. Thus, an effective approach to alleviating Sara's L2 anxiety would involve enhancing her beliefs in her capacity to regulate and impact her surroundings.

It is crucial to clarify the distinction between trait and state anxiety, as this has substantial consequences for the interpretation of the findings. Trait anxiety is a consistent and long-lasting characteristic of individuals, whereas state anxiety fluctuates based on situational factors and specific tasks. This study employed P-technique EFA and CFA to assess Sara's trait anxiety, which tends to be more consistent over time and indicates her general inclination towards language learning anxiety. From day to day, the results demonstrated consistent patterns in LSC, PA, FNE, and NA. This indicates that her underlying level of anxiety remained rather stable, consistent with the concept of trait anxiety. That said, the daily fluctuations of the subfactors of language anxiety were captured by the dynamic technique using autoregression and the cross-lagged regression analyses. The results obtained from the dynamic P-technique indicate the significant impact of state anxiety and demonstrate significant daily interactions within and between subfactors (i.e., LSC, PA, FNE, and NA). This suggests that although Sara may have exhibited a rather consistent level of trait anxiety, her emotional reactions may have differed considerably based on daily experiences or particular activities. These results highlight the significance of understanding that an individual's emotional reactions while learning a new language are influenced by both trait and state anxiety.

## 6. Conclusion

In alignment with trends across various fields of study, SLA researchers are currently reexamining traditionally accepted knowledge, particularly in recognizing the limitations of group-level studies in obscuring individual differences. This is because basic moderation and subgroup analyses often fall short of addressing the nuances of these differences. To achieve a more accurate understanding of and effectively address the episodic character of emotional experiences of language learners, researchers need comprehensive contextual frameworks that can smoothly transition from analyzing individual patterns to making broader generalizations. The statistical tools within the P-technique family are particularly suitable for analyzing intricate multivariate dynamics in individuals, small

groups, and large-scale investigations. SLA researchers may find this study helpful as an exemplar for seamlessly merging idiographic and nomothetic techniques, thus enhancing their understanding of the process of L2 learning.

From a pedagogical perspective, the results of the current study indicate that the P-technique provides valuable insights into within-individual variations in L2 anxiety by capturing daily fluctuations and unique patterns specific to each learner, addressing the non-ergodic nature of L2 affective experiences. By analyzing daily anxiety ratings, teachers can identify patterns and specific triggers that impact learners' anxiety levels. This understanding can then inform the development of personalized strategies and support mechanisms designed to address the unique needs of each student.

However, given that collecting intensive data for the P-technique is time-consuming and its analysis requires expertise, combining the P-technique with more practical tools, such as the idiodynamic method, offers a viable solution, particularly for learners with high levels of anxiety (MacIntyre & McGillivray, 2023). The idiodynamic method, which involves analyzing video recordings of learners during language tasks, allows teachers to identify specific anxiety patterns in a more accessible manner. When used alongside the P-technique, this approach provides a comprehensive understanding of anxiety, enabling teachers to tailor their support more effectively. For example, a teacher might use data from the P-technique to identify that a particular student, Alex, consistently experiences heightened anxiety before speaking activities. Using the idiodynamic method, the teacher could further analyze video recordings of Alex during these activities to pinpoint specific triggers, such as hesitations, self-corrections, or body language indicative of discomfort. Armed with this combined data, the teacher could then develop targeted strategies, such as offering Alex additional preparation time, providing positive feedback, or incorporating low-stakes speaking exercises to gradually build confidence. This approach would help reduce Alex's anxiety and enhance his overall language learning experience.

From a methodological standpoint, the use of the dynamic P-technique in this study enabled the identification and analysis of hidden patterns and relationships between the subfactors of L2 anxiety from a person-specific perspective. This approach affords researchers a more precise understanding of the underlying structure of the data, shedding light on important relationships that may be overlooked in group-based analyses. By effectively identifying and analyzing these hidden patterns of L2 anxiety, researchers can make more informed decisions with regard to targeted interventions and instructional strategies. Furthermore, this methodological approach facilitates the generation of more accurate predictions and forecasts, tailored to individual learning experiences and needs.

While providing valuable insights into the nuances of L2 anxiety using the dynamic P-technique, this study is subject to several limitations. Primarily, the

focus on a single individual, Sara, limits the generalizability of the findings. The unique experiences and responses of one person may not accurately represent the broader population of language learners, thereby constraining the applicability of the results. Additionally, the longitudinal nature of the study, spanning a year, demanded a substantial commitment from the participant. This extended period of engagement could have potentially influenced responses due to changing personal circumstances or even response fatigue. Lastly, while the dynamic P-technique offers significant insights, it may not fully capture the complex interplay of internal and external factors that influence L2 anxiety (e.g., personality, other emotions such as boredom, the teacher, activities used, and so on).

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