Investigating State-Trait Distinction in Scales of Resilience: Application of Generalisability Theory

A thesis

submitted in fulfilment

of the requirements for the degree

of

Master of Psychology in Science

at

The University of Waikato

by

Lucy Child

2020

Abstract

Psychological resilience has been linked to a range of positive psychological outcomes, notably as a protective factor against the harmful effects of stress and symptoms of depression and anxiety. Resilience is also a proven asset for students, workers, and organisations. Despite a general academic consensus of resilience as both dynamic and developable, interventions to develop it have proven largely ineffective. Interventions designed to enhance resilience should be focused on aspects of resilience that are dynamic and thus amenable to change. Accordingly, accurate assessment of resilience, and formation of effective resilience training interventions necessitates clear delineation between stable and dynamic aspects of resilience. Without this distinction, changes in state and trait resilience are likely to be conflated, resulting in imprecise measurement of resilience and inadequate design of interventions. Generalisability Theory (G-theory) has been recommended as the most robust and appropriate statistical model to evaluate state-trait distinction, reliability, and sources of measurement errors.

This study investigated five major psychometric scales of resilience and the individual items within these scales to ascertain whether they were reliable measures of either stable or dynamic features of resilience. G-theory methodology was implemented to discriminate between state and trait features of resilience, and to assess the reliability of five scales of resilience measurement over a period of several weeks. Longitudinal measurement design was applied to an adequate sample of 94 participants, assessed at 3 time points with one-week intervals on five resilience scales.

All analysed scales demonstrated a high generalisability of scores across occasions and the sample population ($G > 0.90$), consistent with expectations for a trait measure. Eleven state-items were identified in four resilience scales and consolidated into eight dynamic aspects of resilience. These dynamic aspects of resilience include adaptation to change, perseverance, self-confidence in the face of adversity, self-efficacy, trust in instincts, ability to follow plans, ability to plan, and non-reactivity. These resilience facets are the most modifiable and therefore should be the primary target of interventions to enhance resilience in people. This research established the overall reliability of all five psychometric scales for the assessment of trait resilience. Therefore, these validated scales are useful to assess long-lasting changes in resilience but lack the sensitivity required to detect temporal changes, warranting the development of a state-resilience scale.

Acknowledgements

A very special thanks to my supervisor, Oleg Medvedev, for always being kind, supportive, and teaching me the joy of statistics.

I am grateful for my family and friends who have all contributed in unique ways to form a comprehensive support network.

Thank you very much to Jess Leov, for your patience and wisdom while helping me to create my survey.

Finally, thank you to everyone who participated in this study and made its findings possible.

Academic Collaborations

I have written a journal article reporting the findings of this study, co-authored by my supervisor Oleg N. Medvedev who advised on study design, statistical analyses, and editing. The manuscript was submitted to a peer reviewed journal in June 2020. The original submission is included in this thesis and can be found in Appendix A1.

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Chapter 1 Context and Application of Resilience

Background

The word 'resilience' derives from the Latin verb *resilire* meaning 'to leap back' (Oxford Dictionary, 1989). Resilience its-self is a broad term which refers to a dynamic system's capacity to maintain or return to equilibrium following a disruption (Masten, 2007). In this way, resilience can be applied to systems such as economy, organisation, and ecology. In physics, resilient materials can return to their original shape following impact or compression (Campbell, 2008), and in biology, resilience is the capacity for an organism to withstand stressors that threaten physiological homeostasis (Schorr et al., 2017).

Psychological resilience has been a prevalent construct in child and developmental psychology for over fifty years (Anthony, 1974; Werner & Smith, 1982). Interest in the concept was initially sparked by a 1950's longitudinal cohort study of Hawaiian children born into significantly adverse circumstances. The unexpectedly positive trajectories of adaptation or recovery exhibited by some participants led to an interest in factors contributing to individual differences in adaptation (Masten, 2007). More recently, there has been a steady increase in research pertaining to resilience in adult populations, due to its frequent correlations with positive and protective psychological effects, particularly against the deleterious effects of stress (Vanhove et al., 2016). A review of PubMed citations showed that psychological resilience was referred to 11 times between 1977 and 1987, and in the two following decades was referenced 92 and 508 times, respectively, demonstrating a rapid increase of research in this area (Wagnild, 2009).

Definitions

Despite the high level of conceptual interest, the definition of psychological resilience has been subject to debate (Meredith et al., 2011). It has been suggested that the recency and rapid growth of adult resilience studies may contribute to the spread of theoretical inaccuracies, if theories disseminated without sufficient validation (Vanhove et al., 2016). Systematic review has highlighted the inconsistencies between studies of resilience and the disparate interpretations of this construct (Bryan et al., 2017). A literature review of over 270 publications conducted by the US Military found the common factors with the most empirical support to be positive thinking, coping, and affect; realism; behavioural control; familial support; community belonging; positive command climate (Meredith et al., 2011). Definitional commonalities from over 50 resilience studies were compiled and synthesised as: “a dynamic process encompassing the capacity to maintain regular functioning through diverse challenges or to rebound through the use of facilitative resources” (Bryan et al., 2017, p. 77). Based on the literature review within this study, resilience can be defined as a dynamic interaction of personality (traits) and environment that facilitates positive adaptation through adversity.

State and Trait Resilience

A key distinction in the classification of resilience is whether it is a personal trait or a dynamic process. Trait resilience is a collection of an individual’s resilient characteristics that is stable over time (Spielberger, 1983). State resilience is dynamic and changeable. resulting from interactions of trait resilience features, and environmental, occasion-specific factors (Medvedev et al., 2017a). Early conceptualisations of resilience examined ‘ego resilience’, typified by characteristics that are stable from childhood (Block & Block, 1980). Empirical support for resilience as a trait includes its correlation with ‘Big five’ personality traits (Riolli et al., 2002; Oshio et al., 2018); stability over time (Silk et al., 2007); and correspondence with genetic and neurobiological markers (Curtis & Cichetti, 2003). Further, most psychometric scales designed to assess resilience are designed to detect trait aspects of resilience (Salisu & Hashim, 2017). While there is a strong empirical base for a trait-resilience model, modern resilience theory has moved towards a dynamic process model (Stainton et al., 2018). Within this model, trait resilience is considered in terms of its interaction with both stable and dynamic environmental factors, including the nature and severity of stressors. Some enduring personality features (e.g. openness, conscientiousness) will increase the likelihood of resilient outcomes; however, these traits will not be advantageous in all contexts (Rutter, 2006). The lack of distinction between state and trait within trait-centric resilience assessment tools is ill fitting with the current dynamic resilience model.

Resilience and Wellbeing

The myriad of associated positive physical and mental health outcomes emphasises the importance of fostering and building resilience. Growing evidence identifies resilience as a protective factor against symptoms of anxiety and depression, suicidal ideation, internet and online gaming addiction, and burnout (Sheerin et al., 2018; Stewart & Yuen, 2011; McCraty & Atkinson, 2012; Kim et al., 2020; Robertson et al., 2018; Lee et al., 2019). Resilient individuals demonstrate greater levels of happiness and interest under stressful conditions (Tugade & Fredrickson, 2004), and the relationship between positive emotions and higher life satisfaction is mediated by resilience (Cohn et al., 2009). In terms of physical health, resilience is negatively correlated with cardiovascular reactivity, pain catastrophising, and blood glucose instability in diabetes patients (Cohn et al., 2009; Tugade & Fredrickson, 2004; Ong, et al., 2010; Yi, et al., 2008). It has also been shown to protect against the deleterious effects of stress on physical health and immunity (Dantzer et al., 2018).

Academic and Organisational Applications

Effective stress management tools and psychological resources such as resilience are vital to enhance students' health and academic outcomes. Academically, resilience demonstrates a positive predictive effect upon the enjoyment of school, class participation and self-esteem (Martin & Marsh, 2006) High levels of resilience are associated with higher levels of academic achievement, significantly contributing to students being top-scorers amongst their peers (Allan et al., 2014). Systematic review indicates that university students experience substantially greater rates of depression than the general population (Ibrahim et al., 2013) with one in three students reporting significant anxiety or depression to the extent that their daily functioning is impacted (Akeman et al., 2020). Rapidly increasing suicide rates in full time tertiary students emphasise the importance of building protective psychological resources, such as resilience, in student populations (Cheng & Catling, 2015). Resilience training of university students led to reductions in both perceived stress and depression levels (Akeman et al., 2020). However, in this study, participants in the resilience training condition showed no improvement in resilience scores at the end of the study. The researchers postulated that this may have been due to the assessment tool used (the Connor-Davidson Resilience Scale) assessing stable beliefs, rather than the dynamic skills targeted by the training intervention (Akeman et al., 2020).

Resilience is increasingly studied in organisational contexts due to its potential as a buffer against the universal nature of work-related stress and the negative physical and mental health outcomes associated with this (Rees, et al., 2015). In addition to negative psychological outcomes, workplace stress is linked to a range of undesirable organisational outcomes such as impairments in work performance, patient care, attention, decision making skills, and increases in absenteeism and staff turnover (Bridger et al., 2013; Mealer et al., 2012; Tan et al., 2014; Skosnik et al., 2000; Starcke & Brand, 2012). Resilience has been shown to enable employees to more effectively manage their stress responses, protect themselves against stress-related depletion of self, and decrease vulnerability to future stressors (Grafton et al., 2010).

Distinguishing state from trait resilience is critical to inform effective training interventions, which will aid to negate the impact of organisational stress. Employee selection processes will also benefit from clear distinction between state and trait resilience by ensuring that resilience levels captured at the time of assessment are indicative of candidates' enduring resilient tendencies. If state and trait resilience factors contribute to the same score, which is interpreted as reflecting a trait, scores are liable to be impacted by temporary fluctuations in resilience factors and thus not accurately represent trait resilience. This is particularly salient when selecting for high-pressure and high-stakes roles in which resilience is both sought by employers and will negate stress-related harm for successful candidates.

Building Personal Resilience

With a strong case for both the value of resilience and its developable nature, existing data on the efficacy of resilience training interventions is troubling. Meta-analysis of 42 samples from workplace-based interventions found a small overall effect size (d = 0.21), with significantly reduction in effect within one month of intervention (d = 0.27), to at least one-month post-intervention (d = 0.07) (Vanhove et al., 2016). Another meta-analytic review yielded small to moderate effect sizes and found only four of the eleven identified studies that had control conditions to have statistically significant results (Joyce et al., 2018).

It is likely that the dearth of information regarding state and trait resilience factors contributes to the apparent lack of interventional success. A resilience training program that targets stable factors, such as those common to major resilience assessment tools, will be less effective than one designed to target resilience factors that are known to be dynamic and thus, more amenable to change than trait factors. Evaluation of interventional efficacy is also hindered by a lack of state-trait distinction, particularly when comparing effect sizes at time points both proximal and distal to the intervention its-self. A successful intervention will create changes in dynamic resilience features closer to the time of intervention. The broaden-and-build theory of positive psychological adaptation indicates that an uptake in positive emotional states will assist the development of enduring positive resources (e.g. positive traits) (Fredrickson, 2001). Therefore, effective interventions should also yield an increase in trait resilience after some time has elapsed post-intervention. Greater assessment sensitivity to state and trait resilience factors will assist in capturing this effect.

Conclusion

Resilience is a relatively recent and emerging subset of adult psychology. Its importance in facilitating a range of positive academic, organisational, and health-related outcomes has strong empirical foundations. In part due to its recency, conceptualisations of resilience lack consensus and there is a risk of inaccurate or incomplete data being used to inform resilience practices and research. Therefore, it is crucial at this stage to obtain useful information via statistically robust methods to enhance the understanding of resilience within the field of psychology. Specifically, distinguishing between state and trait resilience factors will assist in creating resilience-building interventions with greater efficacy, by targeting changeable features that enhance resilience. This distinction will also aid determination of the effects of intervention by increasing sensitivity to temporal changes in stable and dynamic forms of resilience. Organisations and workers will benefit from greater ability to enhance psychological resilience, thus, protecting themselves from potential harm caused by universal workplace stress. Selection for stressful and high-stakes roles will also benefit from the knowledge that obtained resilience scores are indicative of trait resilience, and not skewed by dynamic factors present at the time of assessment.

Chapter 2 Resilience Assessment

Table 1 shows a list of self-report scales of resilience assessment utilised in this study. The inclusion criteria for scales within this study ensured that the scales investigated are both major, validated, and appropriate to inform findings generalisable to an adult population. Each scale also needed to contribute unique factors for assessment, in order to reduce redundancy. This is reflected in the citation data and list of assessed factors within each scale as displayed in Table 1. Scales that were considered for this study but did not meet the inclusion criteria are briefly outlined within this chapter.

Table 1 includes reported reliability estimates in the form of Cronbach's alpha, which represents the internal consistency, or similarity of item scores within each scale. This similarity is often used to indicate that items within a scale assess the same latent construct. Test-retest reliability is also shown; a reliability estimation based on the closeness of scores between two assessment occasions. These values reflect reliability of trait measures, as score consensus shows a low amount of variance between assessment occasions. Test-retest reliability estimates had not been previously reported for the scale of protective factors (SPF) at the time of writing this report.

Table 1. *Test-retest reliability, Cronbach's alpha values and factor structures of the five major resilience scales ordered by number of google scholar citations.*

	Test-Retest Reliability	Cronbach's Alpha	Citations Scholar	Number of Items	Number of Factors	Factors Assessed
CD-RISC (2003)	0.87	0.89-0.96	6642	25	5	Personal competence, high standards & tenacity; trust in instincts, tolerance of negative affect, and strengthening effects of stress; positive acceptance of change and secure relationships; control; spiritual influences
TRS (1993)	0.89-0.94	0.90	4339	25	4	Perseverance, self-confidence, serenity, meaning, existential loneliness
ER89(1996)	0.87	0.73-0.81	2902	14	2	Emotional regulation, Openness to life experience
BRS (2008)	0.62-0.69	0.80-0.91	2012	6	1	Ability to bounce back/recover from stress
SPF (2015)	Not reported	0.91	34	24	4	Social support, social skill, self-efficacy, planning and prioritizing

Connor-Davidson Resilience Scale (CD-RISC)

CD-RISC is a 25-item, unidimensional self-report scale for the assessment of psychological resilience It is arguably the best known, and most widely used and validated resilience assessment tool (González et al., 2015). The development paper for CD-RISC cites Sir Ernest Shackleton, an explorer who led several expeditions to the Antarctic in the early 20th century, as an inspiration for the creation of the scale, and for the content of some of its items (Connor & Davidson, 2003). The authors of this paper regard Shackleton as exemplifying many resilient qualities, contributing to the survival of himself and his crew through perilous conditions. CD-RISC item 3, which assesses belief in a higher power, is based on Shackleton's essays describing his expedition (Connor & Davidson, 2003). Other influences upon the formation of this scale include Rutter's (1985) paper on adaptive coping, and Kobasa's (1979) study of psychological hardiness.

Dimension reduction of CD-RISC scale items identified a five-factor structure. The first factor pertains to personal competence, high standards, and tenacity. The second encompasses trust in intuition, tolerance of negative affect, and the strengthening effects of stress. Factor three involves positive acceptance of change and secure relationships. The fourth factor reflects control, and the fifth represents spirituality (Connor & Davidson, 2003). However, subsequent factor analyses have supported a unidimensional structure for this scale. The scale uses a five-point Likert scale response format from 'not true at all'= 0 to 'true nearly all the time'= 4 with higher scores corresponding to higher levels of psychological resilience. The total score is calculated as the sum of individual item responses. CD-RISC has good internal consistency with a reported Cronbach's alpha of 0.89-0.96, and test-retest reliability of 0.87 (Connor & Davidson, 2003; Ponce-Garcia et al., 2015). Despite the widespread use of CD-RISC, it has been criticised as having an inconsistent theoretical basis, and as emphasising resilience as trait-like despite current conceptualisations indicating otherwise (Windle et al., 2011).

The Resilience Scale (TRS)

Developed in 1993, TRS is the earliest published instrument of resilience assessment (Wagnild, 1999) and is the second most highly cited scale within in this study. While originally developed and tested on a sample of elderly Swedish participants, TRS has demonstrated validity across Nigerian, Dutch, Italian, Spanish, and American population samples and a wide range of age groups (Abiola & Udofia, 2011; Portzky et al., 2010; Girtler et al., 2010: Heilemann et al., 2003; Resnick & Inguito, 2011; Wagnild, 1999). Identified factors within TRS are equanimity, perseverance, self-reliance, meaningfulness, and existential aloneness. TRS is a 25-item unidimensional self-report scale. Responses range from 'strongly disagree'=1 to 'strongly agree'= 7. The total score for this scale is calculated as the sum of individual item responses and higher scores are indicative of higher resilience level. Reported Cronbach's alpha for TRS is 0.89-0.94 (Wagnild & Young, 1993). Reported test-retest reliability from a Dutch adaptation of this scale is 0.90 (Wagnild & Young, 1993;

Ponce-Garcia et al., 2015) and test-retest reliability data for the English version of this scale was not available.

Scale of Protective Factors (SPF)

SPF is the least cited assessment tool investigated in this study, likely in part due to the recency of its creation in 2015, however it still meets the minimum citation requirements for inclusion in this study. The factors identified within this assessment tool are social skills, social support, goal efficacy, and planning and prioritizing behaviour. The unique content and existing validation data for the SPF further warrants its inclusion within the present study. A comparison study of SPF, CD-RISC and TRS on a young adult sample found that CD-RISC and TRS assessed only individual/cognitive factors, while SPF assessed both individual/cognitive and social protective factors. SPF was also found to have the best model fit of all three scales (Madewell & Ponce-Garcia, 2016). In this way, the uncommon assessment of social factors within SPF combined with the lack of existing research inclusion justifies its examination within this study. SPF is a 24-item unidimensional self-report scale. Responses range from 'disagree completely'=1 to 'agree completely'= 7 with higher scores representing higher resilience levels. Reported Cronbach's alpha for the SPF is 0.91(Ponce-Garcia et al., 2015). No reported test-retest reliability values were available for this scale.

Ego Resiliency Scale (ER89)

ER89 is a 14-item unidimensional self-report scale used to assess a stable form of resilience known as ego-resiliency. Ego-resiliency is individual capacity to adapt levels of emotional control as appropriate across various situational contexts (Block & Block, 1980). A revised version of the scale reduced the number of items to 10. In the revised version items 3, 4, 6, and 13 were removed due to their weak psychometric properties. The revised version revealed a two-factor structure of optimal emotional regulation and openness to life experience which match the factors identified by exploratory factor analysis of the original ER89 (Alessandri et al., 2007; Fonzi & Menesini, 2005). The present study utilised the original 14 item scale to maximise the number of scale items investigated for state and trait properties. Responses range from; 'does not apply to me at all'= 1 to 'applies to me completely'=4. Reported Cronbach's alpha for ER-89 range from 0.73-0.81 and test-retest reliability is 0.87 (Block & Kremen, 1996) (Farkas & Orosz, 2015).

Brief Resilience Scale (BRS)

BRS was designed as a short questionnaire, used to assess ability to 'bounce back' or recover from stress. The developers of this scale promote it as the only assessment tool to reliably assess the original and most basic definition of resilience (Smith et al., 2008). Factor analysis has confirmed a single-factor structure related to resilience resources and health outcomes (Smith et al., 2008). The BRS is a short, 6-item unidimensional self-report scale. Responses for the BRS range from 'strongly disagree'=1 to 'strongly agree' 5. Reported Cronbach's alpha values for this scale range from 0.80-0.91, and test-retest reliability values range from 0.62-0.69 (Smith et al., 2008).

Other Resilience Scales

The five by five resilience scale (5X5RS) was developed in 2017. Like SPF, it differs from other assessment tools due to its emphasis on social support. The subscales of 5X5RS are adaptability, emotion regulation, optimism, self-efficacy, and social support (DeSimone et al., 2017). The 5X5RS is a relatively new scale, and therefore there is not yet enough robust validation to support its reliability and validity. The factors assessed by 5X5RS (adaptability, emotion regulation, optimism, self-efficacy, and social support) are represented in other scales included in this study (see Table 1) therefore it was not included due to a likelihood of factor redundancy, and it's lack of existing validation.

The Resilience Research Centre Adult Resilience Measure (RRC-ARM) was adapted for use in an adult population, from the Child and Youth resilience measure (CYRM) (Liebenberg & Moore, 2018). While CYRM has demonstrated internal and structure validity, RRCRM has not been subject to robust validation research. In fact, there were no existing validation data available for this scale, even within its own development paper. Google scholar citations = 15, thus this scale was not included. The Academic resilience scale (ARS-30) is designed to assess resilience in an academic context and achieves this by measuring participant responses to hypothetical case vignettes of academic adversity (Cassidy, 2016). The limited scope of this assessment tool was not fitting with the level of generalisability sought for the purposes of the present study; therefore, it was not utilised as part of the survey questionnaire. The Predictive 6-factor resilience scale (PR6) was of interest due to its unique factor structure. Particularly, a 'health-hygiene' factor comprised of exercise, nutrition, and sleep assessment

(Rossouw & Rossouw, 2016). However, this assessment tool also lacks external validation data (google scholar citations = 16) and was accordingly excluded from this research.

State and Trait Distinction in Resilience Assessment

At a basic level, clear distinction between state and trait resilience will enable the accurate assessment of changes in both forms of resilience over time and will enhance the methodology used in future resilience research (Paterson et al., 2018). The traditional method to distinguish states from traits is test-retest reliability coefficients, which are based on the correlation of total scores at two separate measurement points. A test-retest reliability coefficient of <0.60 indicates a valid state measure and >0.70 indicates a valid trait measure (Ramanaiah et al., 1983; Spielberger et al., 1970) as the scoring for a trait is not expected to change greatly across occasions, while state scores will be less stable. While this method is useful to give a general trend of temporal reliability, it is limited to provide surface-level data only. Problems with the validity of test-retest reliability in state-trait distinction were identified in a reliability investigation of the State-Trait Anxiety Inventory (STAI; Gaudry et al., 1975) (Barnes et al., 2002) which found test-retest correlations ranging from 0.82-0.94 for trait anxiety, and 0.34-0.96 for state anxiety. The higher upper range for state anxiety contradicts the prescribed criteria for state and trait distinction. Thus, more psychometric work is needed to distinguish between state and trait in resilience and to identify sources of the measurement error using appropriate methodology (Medvedev et al., 2017a).

While CD-RISC is the most widely used and validated assessment tool in this study, neither it, nor any of the other scales used in this research have undergone statistically robust assessment of their temporal reliability. None of the scales included in or considered for the present study have the capability to distinguish state from trait resilience. Currently, test-retest reliability is the psychometric criteria most commonly used to make distinctions between state and trait facets of assessment tools (Arterberry et al., 2014). Except for the more recent SPF for which reported test-retest reliability values were not available, Table 1 shows reported test reliability scores above 0.70 for all included scales, and table 2 shows obtained test-retest reliability values within the present study for all scales as above 0.70. These test-retest correlations indicate that all investigated scales are reliable measures of trait resilience (Spielberger, 1999; Spielberger et al., 1970). While this fits with data supporting the existence of trait-like aspects of resilience (Silk et al., 2007; Curtis & Cichetti 2003; Oshio et al., 2018; Riolli et al., 2002), these resilient traits are generally understood as part of an interactive system of resilience that is influenced by both stable and dynamic factors (de Terte et al., 2014; Liu et al., 2017; Stainton et al., 2019).

Resilient traits are stable tendencies possessed by an individual (Spielberger, 1983). Resilient states are only demonstrated in certain situations and are the result of interaction between the person (trait) and occasion (present moment environment) (Spielberger, 1983; Medvedev et al, 2017a). Take for example, the adverse situation of unexpected unemployment. An individual who demonstrates a generally resilient disposition in the face of everyday stressors, but who lacks self-efficacy regarding employment seeking is likely to be less resilient in this context. Self-efficacy is an identified antecedent of resilient outcomes (Bender & Ingram, 2018; Keye & Pidgeon, 2013). Therefore, in this situation a trait-resilient individual with low self-efficacy specific to job-seeking, may have less favourable outcomes than their peers.

To understand the differences and relationships between state and trait features of resilience, in a robust and systematic manner, it is necessary to understand the contribution of factors such as the scale and its items, the individual (the object of assessment), and the occasion. Until recently, structural equation modelling (SEM) has been the only method available to explore the relationship of state and trait factors, however this method is also unable to ascertain the contribution of different factors to measurement error attributed to state and trait variability. Knowledge of the variability caused by the interaction of person and occasion is imperative to understanding of fluctuations in state (Buss, 1989; Chaplin et al., 1988). Therefore, the ability to identify and compare the variance in resilience scoring, as contributed by person (trait), occasion (state), and their interaction (person x occasion), will increase both the accuracy and comprehensiveness of resilience assessment. G-theory has been described as the most robust and appropriate method to distinguish state from trait as it can determine and compare the variance caused by person, item, and occasion, as well as the interactions of these factors (Bloch & Norman 2012). G-theory has been successfully applied to distinguish between state and trait features in the assessment of mindfulness (Medvedev et al., 2017a; Truong et al., 2020) but does not appear to have been applied to the assessment of resilience.

Conclusion

The previous description of resilience theories as broad and incohesive is echoed by the range of resilience factors identified within the widely-used scales of resilience assessment selected for this study. This may be indicative of the fact that the antecedents of positive adaptation through adversity are many and varied. While these assessment tools are underpinned by a range of resilience theories and encompass many distinct factors, none can distinguish between state and trait features of resilience. This is a clear limitation in the assessment of resilience. This limitation is particularly salient when considering resilience is generally held as an interaction of both stable and dynamic factors (de Terte et al., 2014; Liu et al., 2017; Stainton et al., 2019). Previously used methodologies such as test-retest reliability and SEM are useful as indicators of state and trait factors but have been surpassed by G-theory in terms of statistical robustness, and by the wealth of information that can be gleaned from G-theory analysis.

Chapter 3 Methods to Establish Reliability and Validity

Psychometric tests are structured, standardised tools designed to assess factors such as cognition, behaviour, and emotions (NZ Psychologists Board, 2015). Psychometric testing has become increasingly common and the information gained from these tests guides many important healthcare, education, and career-related decisions (Bichi, 2016). Consequently, enhancement of psychometric assessment tools is a critical aspect of psychological research. Classical Test Theory (CTT) is a prominent statistical framework used to investigate and enhance psychometric measurement (Bichi, 2016). Modern CTT has developed from a 'true score' model (Spearman, 1904). The true score model states that an observed score is comprised of a true assessment score and an error (random variance). Through a series of refinements in framework, formulae, and systematism the true score model evolved into CTT. In 1963 G-theory was established, its creators describing it as a liberalisation of CTT (Cronbach et al.,1963). G theory is like CTT in that is concerned with observed scores and appraises assessment tools by estimation of reliability coefficients and standard errors (Suen & Lei, 2007). However, G-theory extends CTT in several meaningful ways (Shavelson et al., 1989). This chapter will review the structure and methodology of both CTT and G-theory and examine their capacity to accurately distinguish state and trait factors within psychometric assessment tools.

Classical Test Theory

For decades, CTT has been the predominant statistical approach to establish reliability and make assertions about the nature of psychometric assessment tools (Bishi, 2016). CTT analyses are based on the concept of observed score (X) = true score (T) + error (E). This can be expressed as the equation:

$$X = T + E \#(1)$$

In this model, all sources of error fall within E, therefore, specific sources of error and levels of attribution to E are unknown. If true (T) and error (E) scores are assumed to be independent, then CTT can be represented as:

$$\sigma_x^2 = \sigma_T^2 + \sigma_E^2 \#(2)$$

Where σ_x^2 is total score variance, σ_T^2 is true score variance, and σ_E^2 is error variance.

Reliability coefficients are a way to quantify the reliability of a measure by estimating the amount of true variance within an observed variance score and are a central feature of CTT. Values generally range from zero to one, one indicating that observed scores are free of measurement error, and zero indicating only noise, and no reliability of scores. Traditionally, the definition of reliability is the squared correlation between observed and true scores, (P_2) (Lord, 1955). The reliability coefficient can be expressed as:

$$P_2 = \frac{\sigma_T^2}{\sigma_X^2} = \frac{\sigma_T^2}{\sigma_T^2 + \sigma_E^2} \#(3)$$

Or simply:

$$\frac{True\ score\ variance}{True\ score\ variance + Total\ error\ variance} \#(4)$$

Ways to quantify and interpret correlation coefficients vary contingent on the source of measurement error that is being sought. In cases where multiple sources of random error are likely to influence observed scores, it is common for multiple reliability coefficients to be reported (Allen & Yen, 1979). The most common coefficients used are test-retest reliability, which estimates the temporal stability of observed scores; internal consistency, an estimate of heterogeneity of scale items; inter-rater reliability, consistency of values across raters; and equivalent forms, a calculation of heterogeneity among different forms of the same test. The coefficients above are calculated based on parallel trend assumptions. Parallel trend assumption applies to between-group comparisons and requires that in the absence of manipulation (e.g. training intervention or treatment) differences between group scores will not change over time. The conditions required for this to be strictly met are stringent to the point of impracticality. For example, all items must have equal covariance with true scores, and all items must contribute an equal amount of error to total score variance (DeVellis, 2006).

The tau or τ-equivalent model employs a less stringent set of assumptions to reach similar conclusions as parallel trends. The constraints of these models are that the magnitude of the true score effect (τ) must be equivalent for each item, but that such equivalence is not required for the error effect magnitude (Vispoel et al., 2018). One of the most used τ-equivalent methods to establish reliability is Cronbach's coefficient alpha (Cronbach's α). Cronbach's α is often cited as a measure of reliability, however it is important to note that α only represents one aspect of reliability: the internal consistency of items within a measure. It was initially proposed as a test of equivalence, designed to show how likely different sets of items from within the same scale were to produce the same score (Taber, 2018). While internal consistency may impact the temporal stability of a test, it does not directly represent this. Furthermore, even the internal consistency of a scale may vary across time due to the impact of factors such as participants and assessment occasions. The formula to calculate Cronbach's α can be expressed as:

$$\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum_{i=1}^{k} \sigma_i^2}{\sigma_y^2}\right) \#(5)$$

In which y is a scale with multiple items, k is the number of items within that scale, $\sum_{i=1}^{k} \sigma_i^2$ is the sum of variances for the individual items, and σ_y^2 is total score variance.

CTT has many advantages that contribute to its dominance in the field of psychometric validation. The assumptions for its framework are conveniently aligned with traditional assessment methods, allowing for constraints to be met with ease (Kline, 2013). Software to conduct CTT analyses is readily available and relatively easy to use. IBM SPSS statistics, and even Microsoft Excel have a bevy of resources available to assist in CTT analysis via their software (George & Mallery, 2019; Abbott, 2016). Finally, and possibly the greatest strength of CTT is the simplicity and elegance of its framework, allowing for uncomplicated estimation of measurement error. The same simplicity that makes CTT so accessible is also one of its main limitations. In particular, the ambiguous conceptualisation of true score variance, and causes of error variance have been subject to criticism (Hoyt & Melby, 1999). CTT allows for the estimation of different types of reliability, such as internal consistency (α), temporal reliability (e.g. test-retest), and inter-rater reliability. These measures of reliability are related and can influence each other, for example a scale with low internal consistency should not be expected to yield high test-retest reliability coefficients, as items within the scale are not likely to produce similar scores. Similarly, low inter-rater agreement will impact test-retest correlations, even if the scale in question is reliable due to rater-effects. However, there is no reliability estimate within the CTT framework that allows for these sources of error to be estimated together and separated from true score variance.

CTT-based reliability assessment does not only suffer from methodological limitations, erroneous interpretation of the nature of reliability values is a pervasive issue within this framework. Many misconceive reliability to be a stable property of the instrument for which is has been calculated (Henson, 2001; Vacha-Haase et al., 2000). Reliability is a property of the scores obtained by an assessment tool for the specific participant sample from which reliability data are obtained (Vacha-Haase et al., 2000; Vacha-Haase et al., 1999). An instrument which demonstrates reliability one day may not demonstrate reliability the next, due to the myriad potential sources of influence on reliability scores, such as the person being assessed, or features of the assessment occasion (e.g., before an exam, or during a holiday). Therefore, a statistical framework which can identify sources of random error may be used to enhance psychometric reliability, knowledge of error sources, and challenge misconceptions about the nature of reliability coefficients.

Generalisability Theory

G-theory has been proposed as a robust alternative to CTT for the assessment of instrument reliability, and error attribution (Lawson, 2006; Medvedev et al., 2017a; Arterberry et al., 2014; Paterson et al., 2018). Established by Cronbach et al. (1963), G-theory shifts CTT's emphasis on reliability to a more flexible and comprehensive *generalisability*. Score generalisability is a true estimation of reliability that accounts for both internal (e.g., items) and external (e.g., occasions) error sources which impact assessment accuracy. G-theory advances CTT in many ways and has greater robustness against a range of probability distributions, including non-normality (Suen & Lei, 2007). G-theory can identify and estimate the level of contribution for differing sources of measurement error, making it a richer source of information than CTT, in which the composition of error is unknowable.

The complexity of natural environments means that there are a multitude of potential error sources, which may obscure the true score reflecting a latent variable. Accordingly, G-theory accounts for all potential sources of error variance and seeks to estimate their contribution to the observed score (Bloch & Norman, 2012). Commonly investigated sources of error variance, or *facets*, include scale items and occasions, which may impact score outcomes either directly, or by interacting with other facets (Brennan, 1992). Facets are homologous to factors within ANOVA studies. G-theory is an enhancement of CTT in that it accurately estimates all potential sources of error variance, including interactive effects. Comparatively, CTT is only capable of assessing one aspect of reliability at a time, and all possible assessment methods group error as a one factor, providing limited insight. Therefore, G-theory is more effective than CTT in informing enhanced methodology and more precise psychometric assessment tools (Medvedev et al., 2017a; Bloch & Norman, 2012).

Within G-theory, assessment scores are viewed as having been sampled from an observational universe comprised of facets contributing to variance within an assessment condition. These facets characterise the universe across which scores for the object of measurement (e.g. persons), can then be generalised (Vispoel et al., 2018). Instances in which only one possible error source is present means that Generalisability analysis (G-analysis) is concerned with a single facet, and thus employs a single-facet design. If a scale item (*i*) is the only source of error variance for a score X, a single-factorial ANOVA model can be used to express the separation of an observed score for a person (*p*) within condition (*i*) into a universe score, or grand mean (μ), an effect for each person ($\mu_{\tilde{p}}$), an effect for each item ($\mu_{\tilde{i}}$), and the effect of residual random error ($\mu_{\tilde{pi}}$) (Vispoel et al., 2018; Suen & Lei, 2007):

$$X = \mu + \mu_{\tilde{p}} + \mu_{\tilde{i}} + \mu_{\tilde{pi}} \#(6)$$

In (7), the grand mean (μ) is a constant value, signifying the mean aggregate score across all persons and items. The person effect ($\mu_{\tilde{p}}$) represents the divergence of a person's universe score from the grand mean ($\mu_p - \mu$). The item effect ($\mu_{\tilde{i}}$) represents the deviation of an item's difficulty from the average item difficulty ($\mu_i - \mu$). The residual effect ($\mu_{\tilde{pi}}$) is the collective effect of the interaction between person and item, and any other sources of error (Vispoel et al., 2018):

$$(X - \mu_p - \mu_i + \mu) \#(7)$$

Therefore, assuming all deviation scores and the universe score are independent, observed score variance (X) can be represented as:

$$\sigma_x^2 = \sigma_p^2 + \sigma_i^2 + \sigma_{pi}^2 \#(8)$$

The CTT method of indirectly estimating reliability coefficients under parallel trend or τ-equivalent assumptions has been surpassed by G-theory, which employs direct estimation of variances from observed data. Direct estimation is achieved by utilising common analysis of variance. The estimated variances are then used as components to form appropriate estimates of reliability coefficients (Suen & Lei, 2007).

G-theory partitions what would otherwise be known as homogenous 'random error' into sources of its variance and estimates the relative contribution of each source to the error, which can also be known as an intra-class coefficient (ICC). Like reliability coefficients in CTT, ICC values range from zero to one ICC may be used to reflect the ability of a resilience assessment tool to differentiate between participants by between-score variance, which can be expressed by the formula:

$$ICC = \frac{\sigma_T^2}{\sigma_X^2} = \frac{\sigma_T^2}{\sigma_T^2 + \sigma_E^2} \#(9)$$

In this context, the obtained ICC value is based on the ability of the assessment tool to distinguish between participants (true variance), and the amount of variance caused by other factors (random error or noise). ICC represents the ratio of variance contributed by the true score (caused by the variable being measured), and the overall variance observed (Brennan, 2001; Bloch & Norman, 2012). For example, in the evaluation of a resilience assessment tool, the amount of variance between scores caused by between-participant differences can be represented by an ICC, indicating the discriminative accuracy of that tool (Bloch & Norman, 2012). Therefore, the ICC for such a measure would be determined by:

$$\frac{variance\ (participants)}{variance\ (participants) + variance\ (error)} \#(10)$$

ICC is widely used within CTT as an indicator of the quality of an assessment tool and calculated by employing the concept of 'signal-to-noise ratio' (SNR) (Fisher, 1925). SNR is equal to effect size (ES), squared. Effect size is the proportion of change in X variable (ΔX) relative to overall observed variance (σ) (Bloch & Norman, 2012). Therefore, ES can be represented as:

$$\frac{\Delta x}{\sigma} \#(11)$$

And SNR as:

$$\frac{\Delta x^2}{\sigma^2} \#(12)$$

Therefore, the calculation of ICC using SNR is expressed as:

$$\frac{SNR}{1 + SNR} \#(13)$$

Within this model, the greater the amount of variance related to a variable of interest (signal) relative to noise, the greater the likelihood of reliably detecting changes of interest. ICC values closer to 1 signify a relatively low level of noise, and a substantial amount of difference produced by the signal. Conversely, the more closely an ICC value approaches zero, the greater the indication of a large amount of noise, or of systematic error.

In G-theory ICC values are equivalent to the G-coefficient, which is also a measure of true variance caused by the object of measurement (σ_p^2) relative to total variance of universe scores which includes both true variance and error variance (σ_{error}^2). G-coefficient is related by the formula:

$$G_p = \frac{\sigma_p^2}{\sigma_p^2 + \sigma_{error}^2} \#(14)$$

In this equation, *p* signifies the variance due to person effect, as person is a common discrimination facet, and is usually the object of measurement in psychometric assessment tools. G-coefficient is usually calculated for the variable of interest (such as resilience) but can be calculated for every contributing facet of error variance that can be captured within the study design (Bloch & Norman, 2012). In this, the G-coefficient shows how generalisable a given factor's variance contribution is across all possible circumstances.

G-theory analysis is conducted at two levels. Both levels involve estimation of variance contribution and score generalisability but differ in terms of scope. The first level of analysis is a Generalisability-study, or G-study, which samples from as broad a universe as possible in order to maximise identification of error variance sources. The second level of analysis is a Decision-study, or D-study, which usually selects fewer facets of investigation, thus narrowing the universe to which its results can be generalised. For example, G-analysis of a psychometric scale may involve a G-study of the entire scale, and D-study analyses of individual scale items.

There are two types of G-coefficients used to estimate score reliability: relative (G_r).and absolute (G_a). G_r is norm-referenced, or relative to other participant scores while G_a is based on established criteria. Within G-analysis, both relative and absolute G-coefficients are calculated for the object of measurement (person). When score values are norm-referenced they are compared to other participant scores. Norm-referencing is useful for ascertaining where an individual's score lies relative to their peers, for example, rank-ordering of anxiety scores to determine which individuals within a group most require intervention. This type of referencing falls within a relative assessment model, and therefore, is the basis for calculation of a relative G-coefficient (G_r). (Vispoel et al., 2018; Suen & Lei, 2007). The G_r for a single-facet design of person x item can be computed using the following:

$$G_r = \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\delta^2} \#(15)$$

In which σ_δ^2 is the relative error variance, calculated using n_i (number of items):

$$\sigma_\delta^2 = \sigma_p^2 + \frac{\sigma_{pi}^2}{n_i} \#(16)$$

Assessment can also be made using criterion-referencing within an absolute model. Criterion-referencing makes decisions contingent on absolute set score criteria. For example, resilience assessment scores during an employment selection process for the military may have an agreed absolute score reference point required for successful application. The reliability coefficient within the absolute model is an absolute G-coefficient (G_a). This is equivalent to a phi-coefficient (Φ), which is calculated by applying Whimbey's correction: $\frac{K-1}{K}$ in which K represents the magnitude of the facet universe (e.g. person or item) within the G-theory model (Whimbey et al., 1967). G_a is absolute in its encompassment of all error variance, including facets that may impact the score within an absolute model (Cardinet et al., 2011). G_a within a single-facet design can be expressed as:

$$G_a \cong \Phi = \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\Delta^2} \#(17)$$

In which σ_{Δ}^2 is the absolute error variance and is calculated as follows:

$$\sigma_p^2 + \frac{\sigma_{pi}^2}{n_i} + \frac{\sigma_i^2}{n_i} \#(18)$$

If assessing for two possible facets of error contribution, such as scale items and assessment occasions, a two-facet study design is employed. In G-theory, the two-facet design to investigate item and occasion variance contribution is:

$$X = \mu + \mu_{\tilde{p}} + \mu_{\tilde{i}} + \mu_{\tilde{o}} + \mu_{\tilde{pi}} + \mu_{\tilde{po}} + \mu_{\tilde{io}} + \mu_{\tilde{pio}} \#(19)$$

In this equation X represents the observed score for a person on one item, across occasions of assessment; $\mu_{\tilde{o}}$ is the effect of the occasion; $\mu_{\tilde{io}}$ is the effect caused by the interaction of person and occasion; $\mu_{\tilde{pio}}$ is the effect caused by the interaction of person, item, and occasion.

The variance of X (observed score) can be expressed as:

$$\sigma_X^2 = \sigma_p^2 + \sigma_i^2 + \sigma_o^2 + \sigma_{pi}^2 + \sigma_{po}^2 + \sigma_{io}^2 + \sigma_{pio}^2 \#(20)$$

Therefore, within a two-facet design, G_r is:

$$\frac{\sigma_p^2}{\sigma_p^2 + \sigma_\delta^2} \#(21)$$

In this equation, σ_p^2 represents the relative error variance and is calculated using n_o (number of occasions):

$$\frac{\sigma_{pi}^2}{n_i} + \frac{\sigma_{po}^2}{n_o} + \frac{\sigma_{pio}^2}{n_i n_o} \#(22)$$

G_a in a two-facet study design is again equivalent to Φ, which is calculated as:

$$\frac{\sigma_p^2}{\sigma_p^2 + \sigma_\Delta^2} \#(23)$$

In this equation, σ_Δ^2 absolute error variance:

$$\sigma_\Delta^2 = \frac{\sigma_o^2}{n_o} + \frac{\sigma_i^2}{n_i} + \frac{\sigma_{pi}^2}{n_i} + \frac{\sigma_{po}^2}{n_o} + \frac{\sigma_{io}^2}{n_i n_o} + \frac{\sigma_{pio}^2}{n_i n_o} \#(24)$$

Provided the object of assessment within a study is the person, G_r and G_a both signify the reliability of trait assessment. A coefficient value of 0.80 and above indicates good reliability (Cardinet et al., 2010), but in some cases a lower reliability threshold of 0.70 has been accepted for G_a values (Arterberry et al., 2014). While G-theory can estimate a greater number of error variance sources with higher accurately compared to CTT, the increase of error estimates necessitates far greater complexity of formulae and computations. This is exemplified when comparing single to two-facets design equations (see figures 18, 20), and when comparing G-study and CTT reliability calculations (see figures 3, 18, 20). It is likely that this is a key contributor to the underapplication of G-theory, despite its superior statistical properties such as robustness and discriminative potential (Bloch & Norman, 2012). Therefore, G-theory should be applied more widely, to demystify its process and to allow for more effective examination of assessment tools.

State and Trait Distinction using Generalisability theory

The ability to accurately assess the temporal stability of a measure is important to vital enhancements of psychometric assessment, and evaluation of psychological interventions. Without the sensitivity to distinguish between state and trait features of an assessed variable, psychometric assessment may be compromised in terms of both reliability and validity (Medvedev et al., 2017a). The transient effect of factors such as mood, hormones, or recent social interactions may influence scores which are presumed to reflect stable patterns. The perceived efficacy of interventions is marred by such insensitivity in at least two ways. If treatment decisions are made based on erroneous conflation of state and trait, the most appropriate intervention plan may be overlooked, thus reducing treatment efficacy. For example, if an individual was to undergo psychometric assessment of depressive symptoms to determine whether they were a suitable candidate for therapy, it would be critical that fluctuations in state and trait features of depression were discernible from one-another. Environmental factors, such as a positive chance interaction with a stranger or receiving good news shortly before the assessment could cause temporary improvements in affect. Without a psychometric instrument that distinguishes between state and trait depressive features, these state fluctuations could be construed as reflecting a general improvement in the participant's depression levels. Accordingly, the severity of the individual's depression could be underestimated, and could result in clinical intervention not occurring, despite a clinical need existing.

Further, a lack of state-trait distinction may cause specious evaluation of interventional success. For example, an effective resilience-building program should bring about state changes soon after the intervention condition, and changes in trait some time afterwards. The dynamic nature of state features means they are more easily amended, while traits change more slowly. However, traits can be built over time by reinforcement and repetition of states (Fredrickson, 2001). If state changes are brought about shortly following a training condition but assessed using a trait measure, they may not be detected, and the immediate benefits of the intervention may be overlooked. Conversely, training may enact changes in state that do not eventuate into meaningful trait changes. If state changes are detected, then the intervention may be deemed a success. However, this would overlook the limited ability of the training condition to cause long-term changes. In this example, the flawed intervention may continue to be used without providing true, lasting benefits to those who take part in training.

Comprehensive assessment of the interventional effect therefore requires accurate detection of both state changes proximal to the time of intervention, and trait changes after some time has passed. The inherent problems with application of temporally ambiguous assessment tools is exemplified in a recent study wherein resilience training brought about positive change in perceived stress and depression, but resilience scores did not improve (Akeman et al., 2020). This effect can also be inferred from the small effect sizes computed in a meta-analysis of workplace resilience training, which notably diminish at one-month post-intervention to d = 0.07, where d = 0.2 is the accepted lower limit for a 'small' effect size (Cohen, 1992; 2013). Therefore, attention to, and detection of error contribution by different facets has vital implications for many aspects of psychological research, assessment, and treatment. Accordingly, this information should be obtained by using appropriate statistical methods, which can be found within the G-theory framework (Medvedev et al., 2017; Bloch & Norman, 2012).

The most common method of distinguishing between state and trait utilises test-retest reliability analysis, and question wording (Gaudry et al., 1975). Conceptually, items and instructions should be worded to refer to the present in order to assess state features, and towards overall tendencies to assess trait features. In psychometric terms, a test-retest reliability coefficient of <0.60 indicates a state measure and >0.70 indicates a trait measure (Ramanaiah et al., 1983; Spielberger et al., 1970). The rationale for this method is straightforward; scoring for a trait is not expected to change greatly across occasions, while state scores will be less stable, impacting test-retest reliability accordingly. While this method is useful to give a general idea of temporal reliability, it provides no insight into variability at the level of single scale items. Test-retest reliability is also unable to estimate the unique variance contributed by specific factors such as person, item, occasion, or the interactions of these factors, and therefore is not a robust method of reliability estimation.

The use of ICC to capture temporal reliability has similar limitations to test-retest reliability. ICC is also unable to capture variability attributed to specific scale items or to various factors affecting measurement including their interactions (Medvedev et al., 2017a; Bloch & Norman, 2012). In an instance where psychometric assessment is used to evaluate the effect of a resilience-building intervention, application of ICC may lack the sensitivity to accurately determine if resilience levels have changed. For example, if a participant was assessed using TRS prior to intervention and scored 5 on item 8 (*I am friends with myself*), and 1 on item 21 (*My life has meaning)*, then was assessed again using TRS one month after the training condition and scored 1 on item 8 and 5 on item 21; the total assessment scores would not reflect that any change had taken place. The ICC value obtained for these assessments would imply that intervention did not influence resilience levels. Such a result would obscure the changes in specific resilience factors that occurred in this example. Consequently, meaningful changes in resilience may be overlooked, affecting the accuracy of assessment, and concealing the effects of the intervention. This example clearly demonstrates that comparison of two total scores at different time-points is not an accurate representation of temporal reliability. ICC is also not adequately sensitive to detect changes in specific state and trait aspects of resilience, or item-level changes. Furthermore, ICC is unable to account for error variance caused by factors such as item and occasion, or the interaction of these factors with the object of measurement (person) (Medvedev et al., 2017a; Bloch & Norman, 2012).

The State Trait Anxiety Inventory (STAI; Spielberger et al., 1970) is the most widely used state-trait anxiety assessment tool. A validation study of the STAI by Barnes et al. (2002)

demonstrated the limitations of CTT-based reliability assessment. The STAI is a self-report scale comprised of two 20-item subscales, one assessing trait anxiety, and the other state anxiety. Items within the trait subscale are worded to assess perception of a generally threatening environment, while items within the state subscale are worded to assess feelings of anxiety at the time of assessment. Item wording that directs participants to express their feelings in the present moment to measure state, and to indicate their general feelings in order to measure trait, has been employed in other state-trait scales such as the Positive and Negative Affect Scale (Watson et al., 1988) and the State Trait Anger Expression Inventory-2 (Spielberger, 1999). In the Spielberger (1979) study, correlation values for the two STAI subscales fit with anticipated values for a state-trait relationship (r = 0.70–0.80) (Ramanaiah et al., 1983; Spielberger, 1999).

As stated previously, Barnes et al. (2002) highlighted the limited value of CTT reliability assessment methods. This was revealed by test-retest reliability analysis of individual STAI subscales. Test-retest correlation for the trait subscale showed good temporal reliability (r = 0.78-0.94), while a wide range of test-retest values was obtained for the state subscale (r = 0.16 – 0.96)(Barnes et al., 2002; Spielberger 1999), which did not clearly indicate whether the subscale measured state or trait anxiety. These findings present an issue with the reliability of test-retest methods, as the maximum test-retest value for the state subscale (0.96) was higher than that of the trait subscale (0.94), contradicting the CTT based psychometric criteria for state and trait distinction. When assessing state and trait factors, scores reflecting a trait are expected to show little variation between occasions, while the variance caused by an interaction of person and occasion is regarded as indicative of a state (Epstein, 1984; Chaplin et al., 1988). The CTT methods used in this study demonstrated crucial shortcomings when differentiating between the state and trait subscales of the STAI. The influence of factors such as individual items, assessment occasions, and interactive effects of these and the person were not accounted for, leading to conflicting results reported in the Barnes et al. (2002) and Spielberger (1999) studies.

Structural equation modelling (SEM) is a form of multivariate analysis within the CTT framework that has also been used to assess the variability of state and trait (Hamaker et al., 2007; Geiser et al., 2015). SEM combines multiple regression and factor analysis in a way that allows for the modelling of correlations between observations across a variety of sources, (e.g., causal relationships, longitudinal and repeated measure designs). Specifically, SEM can be applied to investigate the relationship between latent and directly measured variables and was proposed to make distinctions between state and trait changes (Kaplan, 2008; Kline, 2011). However, like other CTT methods, SEM is limited by its inability to distinguish between error variance caused by different factors (e.g., person, item, occasion, and their interactions), a distinction which has now been clearly established as essential to accurately estimate state and trait variance. SEM also does not allow for temporal reliability analysis of individual scale items. (Medvedev 2017a). It should be noted that very few studies have applied SEM to distinguish between state and trait, likely due to its lack of suitability for this purpose. For reliability findings to be generalisable to conditions outside of the specific conditions in which they were obtained, the variance contributions of different facets, the object of measurement, and of interaction effects must be accounted for. This knowledge informs the accurate prediction of state and trait fluctuations in more natural environments (Medvedev 2017a).

As detailed throughout this chapter, G-theory can be applied to detect and compare variance uniquely contributed by facets, such as person, item, and occasion, as well as their interactions (Brennan, 2001; Bloch & Norman, 2012). Estimated person variance is indicative of a trait-like latent variable presence, while the person x occasion interaction value indicates state-changes (Buss; 1989; Chaplin et al., 1988; Epstein, 1994). G-theory based variance estimation can be applied in this way to entire scales, subscales, and individual scale items. Therefore, G-theory can determine which items within a scale are sensitive to state, and which reliably measure traits. A generalisability study, or G-study, is a form of G-theory analysis used to evaluate the reliability of assessment scores by identifying and estimating the unique error variance contribution of as many facets as are relevant and possible to establish. In terms of psychometric assessment, the contribution of facets such as items and occasion, and of the object of measurement (e.g. the person) can be estimated within a G-study.

Variance components are calculated from observed scores which are obtained from the universe of all possible scores based on the variance components within that universe (Medvedev et al., 2017a). A scale or item that accurately assesses state factors is expected to demonstrate a higher level of variance caused by the interaction of person and occasion, and have low cross-occasion generalisability, e.g., G-coefficient (G) < 0.70, while reliable assessment of trait features should demonstrate greater generalisability ($G > 0.80$) (Arterberry et al. 2014; Cardinet et al. 20 11). By nature, states are partially determined by traits, through their interaction with situational factors. Consequently, discrimination between state and trait can be achieved by estimating variance components for the interaction of traits and environmental factors (e.g. occasion) (Medvedev et al., 2017a; Paterson et al., 2017).

A more rigorous investigation of state and trait factors within an assessment tool can be made within a decision study (D-study). D-studies are conducted based on the results of a G-study and experiment with different measurement designs, such as fixed and variable, in order to lessen the effect of measurement error (Brennan, 2001; Shavelson et al., 1989). The results of a D-study can be used to determine the temporal reliability of specific scale items. In doing so, assessment tools can be enhanced by identifying and removing items which are a poor temporal fit (e.g., stable items within a state assessment tool), or by modifying the scale to reflect item temporality.

Previous investigations of psychometric assessment tools using G-theory include a study of the Big Five Personality Inventory (BFI; John et al., 1991; Arterberry et al., 2014). Arterberry et al.'s (2014) study involved an American university student sample (*N* = 264) assessed using the BFI at three separate measurement points. Participants completed a baseline BFI reading, and again at one and six-months post-baseline. G-study results indicated that all five BFI subscales reliably assessed their respective personality traits (G-coefficients 0.81 – 0.89). In this study, BFI was proven, using robust statistical methods, to be reliable in its assessment of stable personality traits (Arterberry et al., 2014). While this study has successfully applied G-theory to obtain new and useful information, both it and other G-theory investigations have cited a lack of explicit criteria to apportion state and trait variance contribution as a methodological shortcoming.

Medvedev et al. (2017a) sought to remedy this limitation by devising a formula for the calculation of state component index (SCI) and trait component index (TCI) values. These values represent the proportion of variance within a score contributed by state and trait factors. The formula to calculate SCI is:

$$SCI = \frac{\sigma_s^2}{\sigma_s^2 + \sigma_t^2} \#(25)$$

Within this calculation, the state variance component ($\sigma_2^s = \sigma_{po}^2$) is the error variance or noise within trait scores, as caused by the interaction of person and occasion. This calculation elicits the ratio of state to trait, including noise components of both. The noise component is assumed to be equal for both state and trait as the trait component (person effect), because as previously described, state variance is partially determined by trait variance ($\sigma_t^2 + \sigma_p^2$). SCI values are calculated using the absolute variance value for person x occasion obtained in G and D-studies. Using absolute person x occasion values ensures that state variance is estimated accurately, as all discernible sources of error variance are included in its calculation. SCI calculation and interpretation is congruent with previously established G-theory logic. For example, an SCI value of 1.00 is indicative of a purely-state measure, without any trait influence. Obtaining such a value for SCI is unlikely based on what is already known about the determining influence of states upon traits (Buss, 1989; Epstein, 1984). An SCI value of 0.50 indicates that state and trait variance is equal, and therefore the scale, item, or subscale being investigated can neither be classed as a state nor a trait measure. An SCI value of 0.60 and above can be interpreted as reflecting state assessment, with higher scores indicating greater sensitivity to state changes. TCI calculation can be applied in a similar way to validate the assessment of states, using the formula:

$$TCI = \frac{\sigma_t^2}{\sigma_s^2 + \sigma_t^2} \#(26)$$

Like SCI values, a TCI of 0.60 and above indicates that a trait is being assessed, with the closeness of SCI to 1.00 predicting a greater stability of scores across occasions, and a value of 0.50 showing an equal ratio of state-to-trait variance.

Medvedev et al. (2017a) applied these novel formulae in the investigation of the Toronto Mindfulness Scale (TMS; Lau et al., 2006), a scale designed to assess state-changes during mindfulness practice. In this study, 55 participants from a New Zealand university sample responded to the TMS at three separate occasions, the timing of which was designed to capture maximum variability in state-mindfulness. The three occasions were: “after a holiday”, “after a mindfulness exercise”, and “before a stressful event”, and were assessed as a baseline, 1-week, and 1-month post-baseline, respectively (Medvedev et al., 2017a, p. 4). Overall, TMS was shown to largely assess state-mindfulness, while only capturing a small amount of trait-variance; thus, validating TMS’ status as a state-sensitive assessment tool (Medvedev et al., 2017a). D-studies of TMS’ two subscales resulted in G-coefficients below the accepted threshold for a state measure (<0.70), with SCI values of 0.70 and 0.75. Thus, this study substantiated the dynamic nature of the TMS and its subscales. Beyond the findings relating to TMS, the study also introduced a revolutionary new process to accurately estimate state-trait variance contribution. Prior to this, methodology did not exist for the evaluation of state-scales using G-theory.

Studies have since utilised the formulae and interpretation criteria outlined in Medvedev et al.’s (2017a) paper to make assertions regarding state and trait variance ratios within psychometric assessment tools. This includes a study by Paterson et al. (2017) investigating the 10-item Children's Depression Inventory (CDI-10; Kovacs, 1985). The CD-10 is a widely used scale in the assessment of depressive symptoms in young people (ages 7-17). The study used the CD-10 to assess a sample of 668 children of Pacific Island descent, living in New Zealand, on three occasions. Assessment occasions in this study were years apart, with the baseline assessment taken when participants were 9 years of age, the second assessment taken at age 11, and the third assessment at age 14. An acceptable level of generalisability was demonstrated across assessment occasions (G = 0.79). CDI-10 was also shown to assess both state and trait features of depression, with an SCI of 0.33 and TCI of 0.67 showing it to be a valid state-scale (Paterson et al., 2017).

Lyndon et al. (2019) applied G-theory to the Academic Motivation Scale (AMS; Vallerand et al., 1992), a scale designed to assess state and trait aspects of academic motivation. New Zealand-based medical students ($N = 130$) completed a medicine-specific adapted version of the AMS, on three occasions, with 10-11 months between each assessment. The study determined that the entire scale showed high generalisability, but most individual items were shown to have SCI values of 0.60 and above. Furthermore, three AMS subscales (extrinsic, intrinsic, and amotivation) were shown to assess dynamic features of motivation. These findings were a revelatory insight into the nature of motivation, indicating that while the overall construct is stable across time, individuals are not generally more or less motivated than others in a specific direction. Rather, the results point to frequent shifts in motivational priorities contributing to overall stable levels of individual motivation.

Truong et al. (2020) also applied the novel SCI and TCI criteria to the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The FFMQ and its shortened version (FFMQ-18) both assess trait aspects of mindfulness. The 2020 study assessed 83 New Zealand university students, three times, at two-week intervals. Both FFMQ and FFMQ-18 obtained TCI values of 0.90, but more than half of their individual items had SCI values of 0.60 and above. The apparent conflict of reliable trait assessment tools being comprised of many dynamic items highlights the role of item combination in error reduction. In these examples, the findings indicate that specific state aspects of motivation and mindfulness may be mutually exclusive or cancel out each other's effects when combined, thus allowing their contribution to reliable trait assessment.

Recently, a study by Ye et al. (2020) calculated SCI and TCI values for a short version of the Resilience Scale Specific to Cancer (RS-SC-10; Ye et al., 2019) and its subscales. A group of 317 Chinese breast cancer patients completed the RS-CS-10 on four occasions, at six-month intervals. One subscale was found to reliably assess trait resilience (G = 0.81) while the other showed good sensitivity to state resilience (SCI = 0.84), indicating RS-SC-10 can be used to assess both state and trait resilience changes in cancer patients.

Within this chapter, G-theory has been repeatedly demonstrated as a powerful tool to evaluate and hone methods of psychometric assessment, particularly in the accurate estimation of state and trait influences. Despite this, G-theory continues to be underutilised in psychometric validation studies. There are many possible contributing factors to this, including the requirement of longitudinal data and difficulty in collecting these, a lack of user-friendly software and related resources in comparison to CTT analysis, and the relatively complex statistics employed. At present, the Ye (2020) study is the only validation study of resilience assessment tools using G-theory identifiable within existing academic publications. Decades of resilience research has culminated in an understanding of the construct as being influenced by both stable and dynamic factors, and emphasis has been placed on the contribution of interactive effects to positive adaptation. When considering the preeminent strength of G-theory in identifying stable and dynamic construct facets, application of this model in the investigation of resilience is logical. Hence, it is vital that future studies of resilience make use of this robust statistical method to validate and enhance resilience assessment, and to enhance understanding of resilience as a dynamic process.

Summary and Research Goals

In order to accurately track changes in state and trait features of a construct, stable and dynamic features must be clearly identifiable within that construct's assessment. Tracking changes in state and trait can be applied to inform and optimise interventions. This knowledge is critical for enhancing understanding of resilience as a dynamic process. Currently, the field of temporal reliability research into psychometric tools is dominated by CTT methods. Traditional CTT uses test-retest reliability correlation to determine temporal reliability of assessments and to make distinctions between state and trait. Application of CTT does not allow for estimation of contributions to error variance, as all error is grouped into a sole factor (E). In this way, CTT is limited in its ability to accurately distinguish between state and trait factors. Conversely, G-theory can account for all possible sources of error variance, including interactions between variance components. The effect of the person being assessed, items within a scale, and the context of assessment occasions may contribute both uniquely, and interactively to assessment error variance. Consequently, G-theory is the most appropriate and robust framework for the investigation of reliability, and state and trait features in psychometrics. The present study applies G-theory to five major scales of resilience assessment to examine their temporal reliability, and to differentiate between state and trait features of resilience.

Chapter 4 Generalisability Analysis – Methods and Results

Study Aims

The goal of this study is to apply G-theory to investigate the temporal reliability of five scales of resilience assessment (CD-RISC; TRS; SPF; ER89; BRS) and identify state and trait features of resilience by examining the stability of scale items. The study design is longitudinal, with repeated measures. Participants were assessed on three separate occasions, with one-week intervals between assessments. The G-theory component of this research involved both a G-study and D-study. The G-study estimated the generalisability of each scale and investigated sources of error variance within the scales. Following this, a D-study was performed with analysis at a scale item level. D-study goals were to evaluate the temporal reliability of individual items and improve measurement design (Cardinet et al., 2011). This study received ethics approval from the ALPSS Human Research Ethics Committee of the University of Waikato, approval reference FS2018-29 (see Appendix A2).

Participants.

The study included 94 New Zealand university students who received course credit for completion of an online survey on three occasions. In order to achieve statistical power of $\beta=0.90$, $p=.05$ with ICC $\geq.40$ and repeated measures over three time points, the minimum required sample size is $n=50$. Therefore, the sample size in this study is greater than adequate for this type of reliability research. This has been demonstrated in similar studies (Shoukri et al. 2004; Truong et al., 2020). The sample included 75 (80%) females and 19 (20%) males with a mean age of 27 years (SD = 9.47). The ethnic composition of the sample is as follows: New Zealand European 57 (60%), New Zealand Maori 13 (14%), Pacific Peoples 2 (2%), Asian 13 (14%), and Other 9 (10%).

Data Collection

Creation and administration of the online survey was conducted using Qualtrics XM Version 2019 of the Qualtrics Research Suite. Copyright © 2019 Qualtrics. Participants were given the opportunity to complete the first survey during a lecture. Completion of the first and second surveys triggered an automated email to be sent one-week post-completion, containing a link to the following survey. Email addresses were supplied by students as part of the survey. Data were stored online with encryption and password protection. Demographic information such as the age, sex, and ethnicity of participants was obtained. At the end of the assessment conditions, data were depersonalised, downloaded, and stored on the researcher's computer with password protection. Participants were verbally informed about the nature of the survey before participating in the first assessment. Text explaining the nature of the content was also included at the start of each survey condition. Participants gave their consent by submitting their completed survey and were able to withdraw consent at any time prior to this by exiting the assessment. There were some concerns that emotional harm that could occur due to the self-reflection required to answer some questions. To mitigate potential harm, survey completion prompted navigation to a summary page. The summary page encouraged participants to seek assistance if they felt that their mental health had been negatively impacted, and included contact information for student health services, and online depression and anxiety services provided by the New Zealand government.

Assessment Instruments

CD-RISC is a 25-item unidimensional self-report scale. Information regarding items and scoring for this scale is presented in Appendix B1. The scale uses a five-point Likert scale response format from 'not true at all'= 0 to 'true nearly all the time'= 4. Total score for CD-RISC is calculated as the sum of individual item responses with the higher scores corresponding to higher levels of psychological resilience. Reported Cronbach's alpha for this scale is 0.89 – 0.93 (see Table 4).

TRS is also a 25-item unidimensional self-report scale designed to measure psychological resilience. Information on items and scoring for this scale are presented in Appendix B2. The scale uses a seven-point Likert scale response format with responses ranging from 'strongly disagree'=1 to 'strongly agree'= 7. Total TRS scores are calculated as the sum of individual item responses with higher scores reflecting higher levels of psychological resilience. Reported Cronbach's alpha for this scale is 0.89 – 0.94 (see Table 4).

SPF is a 24-item unidimensional self-report scale. SPF items and scoring are shown in appendix B3. The scale uses a seven-point Likert scale response format with responses ranging from 'disagree completely'=1 to 'agree completely'= 7. SPF scoring is calculated as the sum of individual item responses. Higher scores indicate higher levels of psychological resilience. Reported Cronbach's alpha for this scale is 0.94 – 0.95 (see Table 4).

ER89 is a 14-item unidimensional self-report scale designed to measure trait resilience. The scale uses a 4-point Likert scale response format. Responses range from 'does not apply to me at all'= 1 to 'applies to me completely'=4 (Block & Kremen, 1996). Scores are calculated as the sum of individual item responses with higher scores showing higher levels of psychological resilience. Reported Cronbach's alpha for this scale is 0.73 – 0.81 (see Table 4).

BRS is a 6-item unidimensional self-report scale. The scale uses a 5-point Likert response format. Responses for the BRS range from 'strongly disagree'=1 to 'strongly agree' 5. BRS items 2, 4, and 6 were negatively worded, and thus reverse-coded. The total score for BRS is calculated as the sum of individual item responses, with higher scores representing higher psychological resilience. Reported Cronbach's alpha for this scale is 0.80 – 0.91 (see Table 4).

The survey used in this study was comprised of all scale items from the five scales investigated, totalling 94 items. Scoring for all scales was changed to a five-point Likert scale as used by the most validated CD-RISC, to ensure consistency and coherence across scales. This is supported by Rasch analysis indicating that scales with four to five response categories are psychometrically superior to scales with six or more categories (Medvedev et al., 2016; 2017b).

Data Analyses

IBM SPSS Statistics version 25 was used to calculate descriptive statistics, such as means, standard deviation (SD), Cronbach's Alpha, and ICC for all scales. Generalizability analysis (see Appendices C1-16) was conducted according to the guidelines described by Cardinet et al (2011) and Medvedev et al. (2017a), and analysis was carried out using EduG 6.1e software (Swiss Society for Research in Education Working Group, 2006).

Random effect measurement design was employed for both G and D studies, with two crossed facets for both studies: persons (P), by item (I), by occasion (O), expressed as P × I× O, in which facets P and O are infinite and facet I is fixed because the study was limited to the items specific to the included scales. The facets were operationalized with person as the object of measurement or differentiation facet, which is not a source of error (Cardinet et al., 2010; Vispoel et al., 2018). Instrumentation factors were items and occasions Both G and D-study estimates were computed using the equations detailed in Chapter 3 as formulated by

Brennan (1992), and Whimbey's correction was applied. Calculations included grand mean, mean facet effects, facet variance components, facet interaction variance components, relative (G_r) and absolute (G_a) G-coefficients.

State and trait component index values were calculated using the formulae detailed in Chapter 3, as developed by Medvedev et al. (2017a). SCI and TCI values were calculated for scoring on entire scales, and individual items; indicating the proportion of score variance contributed by state and trait factors. The D-study estimated variance components for each individual item from all original resilience scales. G-analysis was also performed on various combinations of dynamic items identified within the G-study, to determine whether these items could form a valid scale of state-resilience assessment.

Results

Descriptive statistics were calculated for five major resilience scales on three assessment occasions using ICC methods, as displayed in Table 2. All scales demonstrated good internal consistency across occasions, as indicated by Cronbach's alpha values above 0.70 (Nunnaly, 1978). SPF showed the highest internal consistency (α = 0.94-0.95). Test-retest reliability values were calculated for Occasions 2 and 3, in reference to Occasion 1, and were strong for all scales, ranging from 0.82-0.92. Reliability was also estimated using ICC, a more robust method to determine temporal reliability. An ICC value of 0.80 and above indicates near-perfect reliability of a valid trait measure (Landis & Koch, 1977); scale values ranged from 0.81 (TRS) to 0.92 (CD-RISC). The scales which obtained the highest reliability values were SPF (test-retest = 0.95, 0.94; ICC = 0.91) and CD-RISC (test-retest = 0.88, 0.86; ICC = 0.92). Mean scores for all scales did not differ significantly across assessment occasions, indicated by p-values <0.05 in the paired samples t-tests. All scales demonstrated adequate levels of internal consistency, and temporal reliability values support all scales as valid tools for the assessment of trait resilience.

Table 2. *Cronbach's alpha, test-retest bivariate correlation and ICC for all scales.*

Scale/Assessment	Occasion 1	Occasion 2	Occasion 3	ICC (95%CI)
CD-RISC				
Mean (SD)	3.64 (0.48)	3.62 (0.54)	3.63 (0.50)	
Cronbach's alpha	0.89	0.93	0.92	
Test-retest *(r)*[a]	--	0.88**	0.86**	0.92(0.83-0.91)
TRS				
Mean (SD)	3.67 (.48)	3.63 (0.53)	3.69 (0.51)	
Cronbach's alpha	0.89	0.92	0.91	
Test-retest *(r)*[a]	--	0.85**	0.82**	0.81(0.70-0.87)
SPF				
Mean (SD)	3.61(0.62)	3.62 (0.65)	3.63 (0.61)	
Cronbach's alpha	0.94	0.95	0.94	
Test-retest *(r)*[a]	--	0.92**	0.88**	0.91(0.88-0.94)
ER89				
Mean (SD)	3.46 (0.53)	3.46 (0.53)	3.52 (0.55)	
Cronbach's alpha	0.81	0.84	0.86	
Test-retest *(r)*[a]	--	0.83**	0.84**	0.84(0.78-0.88)
BRS				
Mean (SD)	3.32 (0.72)	3.35 (0.76)	3.38 (0.74)	
Cronbach's alpha	0.87	0.89	0.89	
Test-retest *(r)*[a]	--	0.84**	0.84**	0.86(0.81-0.90)

Note. ** = $p < 0.05$; a Test-retest bivariate correlation between Occasion 1 and Occasions 2 and 3; CI = Confidence interval.

Test-retest reliability values from this study are shown alongside those reported in previous studies in Table 3. This comparison is shown for all scales except SPF, for which prior test-retest data could not be obtained. Test-retest coefficients across studies showed that the scales assessed trait resilience (r >0.70). BRS was the exception to this, as previously reported values did not meet the lower limits for a trait measure (r = 0.62-0.69). However. this study found acceptable reliability (r = 0.84) for both paired t-tests of this scale.

Table 3. *Previously reported and current estimations of test-retest reliability for five major resilience scales.*

Scale/Assessment	Previous study results	Occasion 2	Occasion 3
CD-RISC			
Test-retest *(r)*	0.87	0.86	0.88
TRS			
Test-retest *(r)*	0.90*	0.82	0.85
SPF			
Test-retest *(r)*	Not reported	0.88	0.92
ER89			
Test-retest *(r)*	0.87	0.84	0.83
BRS			
Test-retest *(r)*	0.62-0.69	0.84	0.84

Note. Occasions 2 and 3 in comparison to occasion 1, *from a Dutch adaptation of TRS.

Table 4 shows the previously reported internal consistency values for the five scales, alongside those estimated in this study, represented by Cronbach's alpha. All scales showed good internal consistency across studies, an expected result for widely used and validated assessment tools.

Table 4. *Previously reported, and currently estimated Cronbach's alpha for five major resilience scales.*

Scale/Assessment	Reported Values	Present Study
CD-RISC		
Cronbach's alpha	0.89-0.96	0.89-0.93
TRS		
Cronbach's alpha	0.89-0.94	0.89-0.92
SPF		
Cronbach's alpha	0.91	0.94-0.95
ER89		
Cronbach's alpha	0.73-0.81	0.81-0.86
BRS		
Cronbach's alpha	0.80-0.91	0.87-0.89

G-Study

Table 5 shows variance component attributions of person (P), item (I), occasion (O) and interaction effects (PxI, PxO, IxO, PxIxO), as well as state and trait component indices, and generalisability coefficients for all scales. Computational outputs from EduG including study design, ANOVA, and full G-study data are included in Appendices C1-5.

Relative and absolute generalizability coefficient values ranged from 0.88 to 0.97; therefore, all included scales show reliability in assessment of trait resilience, with scores generalizable across occasions and the sample population. Consistent with the high G-coefficients obtained, negligible SCI values ranging between 0.00 - 0.01 for all scales showed a lack of sensitivity to dynamic aspects of resilience. TCI values of 0.99 - 1.00 suggest that these scales are ideal for assessing trait resilience, due to their temporal stability. SPF was found to have the highest generalisability (G_r = 0.97; G_a = 0.96) and reliability (TCI = 1.00) across persons and occasions. The main sources of error variance in SPF were PxIxO and PxI interactions, together comprising 84.80% of total SPF score error. PxIxO interactions were the main source of error variance across all scales, accounting for between 52.50% and 76.60% of total score error, indicating that while all scales reliably assess state-resilience, measurement error has a considerable impact on score outcomes.

Table 5. *G-study estimates for five major resilience scales including Coefficient G relative (Gr), Coefficient G absolute (Ga), Trait Component Index (TCI), State Component Index (SCI), and variance components (σ2) for the Person (P) × Occasion (O) × Item (I) design including interactions in % (n = 94). Three decimal points used for variance components to distinguish small values.*

	CD-RISC		TRS		SPF		ER89		BRS	
Facets	σ^2	%	σ^2	%	σ^2	%	σ^2	%	σ^2	%
P	0.21		0.17		0.25		0.25		0.27	
I	0.000	1.70	0.000	0.30	0.001	6.60	0.000	0.00	0.003	9.60
O	0.000	1.90	0.000	0.70	0.000	0.00	0.000	0.00	0.001	4.10
PxI	0.002	16.90	0.003	31.80	0.002	23.20	0.006	25.50	0.005	13.70
PxO	0.002	15.60	0.001	6.60	0.000	3.80	0.003	13.10	0.000	0.00
IxO	0.001	7.80	0.001	8.00	0.000	4.80	0.002	8.80	0.001	2.00
PxIxO	0.006	56.00	0.005	52.50	0.006	61.60	0.012	52.50	0.026	70.60
Gr	**0.96**		**0.95**		**0.97**		**0.93**		**0.90**	
Ga	**0.95**		**0.94**		**0.96**		**0.92**		**0.88**	
TCI	0.99		1.00		1.00		0.99		1.00	
SCI	0.01		0.00		0.00		0.01		0.00	

Note. Bolded numbers denote acceptable generalisability coefficients.

D Study

Analysis of facets was conducted to estimate variance components for individual items of each scale by excluding all other scale items. All EduG outputs pertaining to these analyses are shown in Appendices C6-16. Estimated SCI values and variance components for person (P) and person-occasion interactions (PxO) are included in all D-study tables. The original spelling and punctuation for all scales which item wording has been included, has been maintained from their original publications.

Overall, eleven items with SCI values above 0.60 indicating sensitivity to state resilience were identified within the scales studied. Items with SCI values between 0.40 and 0.60 were identified within all scales, with 52 out of 94 items obtaining such scores, meaning that these items cannot be said to definitively assess state or trait, as they assess both features. Items that reliably assess trait resilience were also identified within all scales, 31 items obtained

SCI values of 0.30 and below indicating that scores for these items are stable across assessment occasions. All but one scale (BRS) contained items shown to assess dynamic aspects of resilience, and all scales contained items that did not clearly assess state or trait, the contribution of these items to validated assessment tools of trait resilience is noteworthy.

D-study results for CD-RISC are shown in Table 6. EduG outputs for this D-study are presented in Appendix C6. Due to copyright constraints, exact item wording for CD-RISC cannot be published in this study. Consequently, the resilience features assessed by each CD-RISC item have been included in lieu of their specific wording. SCI values obtained for this scale indicate that five CD-RISC items are sensitive to state changes, eleven items reliably assess trait resilience, and nine items do not clearly assess either. Item 13 (SCI = 0.94) had the highest calculated SCI out of all items from all scales and is therefore the most dynamic item identified in this study. This item pertains to confidence of resources in times of trouble. Other items in this scale with high SCI values include item 1 'ability to adapt to changes' (SCI = 0.77) and item 20 'trust in one's own instincts' (SCI = 0.75). The item shown as least sensitive to state resilience, and thus most reliable in the assessment of trait resilience was item 23 'enjoyment of challenges' (SCI = 0.23). In G-theory, state and trait variance components for one measure necessarily add together to 1.00, therefore TCI for item 23 = 0.77 (Medvedev et al., 2017a).

Table 6. *D-Study Results for items in CD-RISC, including person variance, person x occasion variance, and state component index (N = 94 x 3).*

CD-RISC	*P*	*PxO*	*SCI*
1. Ability to adapt to changes	0.10	0.33	0.77
2. Close and secure relationships.	0.23	0.14	0.38
3. Belief in a higher power.	0.37	0.24	0.40
4. Self-belief to deal with any challenge.	0.21	0.14	0.40
5. Confidence from past successes	0.37	0.16	0.30
6. Effort to see humour in the face of problems.	0.19	0.17	0.48
7. Belief in strengthening effects of stress.	0.24	0.22	0.48
8. Tendency to bounce back after illness, injury or other hardships.	0.37	0.14	0.28
9. Belief that most things happen for a reason.	0.25	0.12	0.33
10. Concerted effort despite challenges.	0.08	0.21	0.72
11. Belief in ability to achieve goals, despite obstacles.	0.48	0.18	0.27
12. Perseverance in the face of hopelessness.	0.18	0.26	0.59
13. Confidence of resources in times of trouble.	0.02	0.29	0.94
14. Focus and clear-headedness under pressure.	0.44	0.14	0.24
15. Leadership in problem-solving.	0.19	0.16	0.46
16. Lack of discouragement by failure.	0.46	0.17	0.27
17. Self-perception as strong when dealing with challenges and difficulties.	0.16	0.27	0.63
18. Ability to make unpopular or difficult decisions.	0.27	0.19	0.42
19. Ability to regulate negative emotions.	0.37	0.28	0.44
20. Trust in one's own instincts.	0.08	0.23	0.75
21. Strong sense of purpose in life.	0.25	0.20	0.43
22. Feelings of control.	0.39	0.17	0.30
23. Enjoyment of challenges.	0.44	0.13	0.23
24. Effort towards goal obtainment.	0.30	0.25	0.46
25. Sense of pride in achievements.	0.33	0.24	0.42

Table 7 shows D-study results for TRS. Appendix C7 shows the EduG outputs for TRS D-study calculations. SCI values indicate that four TRS items were sensitive to state changes, twelve were largely stable across assessment occasions, and nine were neither state-sensitive nor temporally stable. The highest SCI value was attributed to item 7 "I usually take things in stride" (SCI = 0.74). The second and third highest scoring TRS items were item 23 "When I'm in a difficult situation, I can usually find my way out of it" (SCI = 0.72) and item 1 "When I make plans I follow through with them" (SCI = 0.67). In contrast, item 2 "I usually manage one way or another" represents the most stable aspect of resilience assessed by SPF (TCI = 0.79).

Table 7. *D-Study Results for items in TRS, including person variance, person x occasion variance, and state component index (N = 94 x 3).*

TRS	*P*	*PxO*	*SCI*
1. When I make plans I follow through with them	0.12	0.24	0.67
2. I usually manage one way or another	0.37	0.10	0.21
3. I am able to depend on myself more than anyone else	0.46	0.18	0.28
4. Keeping interested in things is important to me	0.59	0.18	0.23
5. I can be on my own if I need to	0.24	0.16	0.40
6. I feel proud that I have accomplished things in life	0.38	0.18	0.31
7. I usually take things in stride	0.07	0.21	0.74
8. I am friends with myself	0.27	0.26	0.50
9. I feel that I can handle many things at a time	0.36	0.11	0.24
10. I am determined	0.22	0.22	0.49
11. I seldom wonder what the point of it all is	0.30	0.16	0.35
12. I take things one day at a time	0.27	0.14	0.33
13. I can get through difficult times because I've experienced difficulty before.	0.20	0.19	0.50
14. I have self-discipline	0.43	0.14	0.24
15. I keep interested in things	0.32	0.12	0.28
16. I can usually find something to laugh about.	0.14	0.13	0.47
17. My belief in myself gets me through hard times.	0.14	0.22	0.61
18. In an emergency, I'm someone people can generally rely on.	0.44	0.13	0.23
19. I can usually look at a situation in a number of ways.	0.21	0.24	0.54
20. Sometimes I make myself do things whether I want to or not.	0.27	0.18	0.39
21. My life has meaning.	0.23	0.17	0.41
22. I do not dwell on things that I can't do anything about.	0.25	0.22	0.46
23. When I'm in a difficult situation, I can usually find my way out of it.	0.10	0.25	0.72
24. I have enough energy to do what I have to do.	0.21	0.20	0.48
25. It's okay if there are people who don't like me.	0.30	0.25	0.45

SPF D-study results are shown in Table 8, all EduG outputs for this study component are included in Appendix C8. Only one SPF item had a calculated SCI reflecting state-sensitivity. There were thirteen trait-items, and ten temporally ambiguous items identified within this scale. The single dynamic SPF item was item 18 “When working on something I plan things out” (SCI = 0.63). Item 15 “I organise my time well” (TCI = 0.84) was the most stable of all items from all scales. Item 17 “I am good at being with other people” was also highly stable (TCI = 81). These results are consistent with D-study findings, in which SPF obtained the highest G-coefficients, indicating that SPF is the most temporally reliable of all the included scales, and CTT investigation in which SPF had the highest test-retest reliability coefficients, and second-highest ICC value.

Table 8. *D-Study Results for items in SPF including person variance, person x occasion variance, and state component index (N = 94 x 3)*

SPF	*P*	*PxO*	*SCI*
1. I am good at starting new conversations	0.27	0.14	0.34
2. My friends and/or family, keep me up to speed on important events	0.14	0.14	0.49
3. I am good at making new friendships	0.17	0.19	0.53
4. My friends and/or family, are supportive of one another	0.39	0.15	0.27
5. When working on something, I make a list of things to do in order of importance	0.30	0.23	0.43
6. I am confident in my ability to solve problems	0.20	0.18	0.48
7. My friends and/or family, spend free time together	0.39	0.15	0.28
8. When working on something, I set priorities before I start	0.28	0.20	0.42
9. I am confident in my ability to succeed	0.36	0.18	0.33
10. I am confident in my ability to think out and plan	0.16	0.22	0.58
11. I am confident in my ability to think on my feet	0.31	0.21	0.40
12. I am good at working with others as part of a team	0.33	0.28	0.46
13. I am good at socializing with new people	0.16	0.19	0.55
14. I am confident in my ability to achieve goals	0.25	0.22	0.47
15 - When working on something, I organize my time well	0.54	0.11	0.16
16. I am good at interacting with others	0.43	0.14	0.24
17. I am good at being with other people	0.68	0.16	0.19
18. When working on something, I plan things out	0.14	0.24	0.63
19. I am confident in my ability to make good decisions/choices	0.25	0.22	0.47
20. My friends and/or family see things the same way as I do	0.36	0.14	0.27
21. My friends and/or family are seen as united	0.45	0.19	0.29
22. When working on something, I do better if I set a goal	0.52	0.15	0.23
23. My friends and/or family are optimistic	0.38	0.15	0.29
24. When working on something, I can see the order in which to do things	0.23	0.15	0.39

D-study findings for ER89 are shown in the top section of Table 9. Computational outputs from EduG for this D-study are presented in Appendix C9. Only item 14 "I get over my anger at someone reasonably quickly" (SCI = 0.82) was detected as sensitive to a dynamic feature of resilience. Seven of the fourteen ER89 items had SCI values reflecting assessment of trait resilience, and six did not clearly assess state or trait. Item 9 "Most of the people I meet are likeable" (SCI = 0.17) was the best representation of state resilience in this scale, and the second most stable of all items from all scales studied. This highly stable item and the existence of only one ER89 item are fitting with its theoretical underpinnings of ego-resiliency. Interestingly, item 14 was the second most state-sensitive item identified in this study, challenging the notions of stability surrounding this facet of resilience. The middle section of Table 9 shows D-study results for BRS. EduG outputs for this analysis can be found in Appendix C10. All BRS items were shown to reliably assess trait resilience (TCI 0.60 – 0.71). The most stable items were 5 "I usually come through difficult times with little trouble" and 4 "It is hard for me to snap back when something bad happens", TCI for both = 0.71.

Finally, the eleven state items identified in the previous D-studies underwent generalisability analysis in various combinations. The items with the highest SCI's were combined in an endeavour to create a tool which reliably assessed state-resilience. Computational outputs from EduG for these analyses are shown in Appendices C11-16. The results of this D-study are presented in the bottom section of Table 9. The first attempt combined all items with SCI ≥ 0.60, which yielded an SCI of 0.00. The following calculations successively removed items with the lowest SCI values in order to enhance the state-sensitivity of the item combinations. Six different item sets were investigated, with 0.10 the highest obtained SCI which falls substantially short of the criteria for a valid state measure (0.60 and above). Therefore, no tested combinations of dynamic items found within this study demonstrated sensitivity in state-resilience assessment, and removal of less dynamic items did not correlate with improved sensitivity.

Table 9. *D-Study Results for items in ER89, BRS, and state items above 0.6 SCI including person variance, person x occasion variance, and state component index (N = 94 x 3)*

ER89	*P*	*PxO*	*SCI*
1. I am generous with my friends.	0.26	0.22	0.46
2. I quickly get over and recover from being startled.	0.18	0.20	0.52
3. I enjoy dealing with new and unusual situations.	0.26	0.22	0.46
4. I usually succeed in making a favorable impression on people.	0.60	0.14	0.19
5. I enjoy trying new foods I have never tasted before.	0.29	0.22	0.43
6. I am regarded as a very energetic person.	0.48	0.17	0.26
7. I like to take different paths to familiar places.	0.29	0.20	0.41
8. I am more curious than most people	0.42	0.12	0.23
9. Most of the people I meet are likable	0.62	0.13	0.17
10. I usually think carefully about something before acting	0.45	0.18	0.28
11. I like to do new and different things.	0.37	0.16	0.30
12. My daily life is full of things that keep me interested.	0.38	0.21	0.35
13. I would be willing to describe myself as a pretty “strong” personality.	0.14	0.18	0.57
14. I get over my anger at someone reasonably quickly.	0.07	0.30	0.82
BRS	*P*	*PxO*	*SCI*
1. I tend to bounce back quickly after hard times	0.26	0.13	0.33
2. I have a hard time making it through stressful events	0.29	0.20	0.40
3. It does not take me long to recover from a stressful event	0.20	0.14	0.40
4. It is hard for me to snap back when something bad happens	0.37	0.15	0.29
5. I usually come through difficult times with little trouble	0.34	0.14	0.29
6. I tend to take a long time to get over set-backs in my life	0.32	0.18	0.36
State Items above 0.60 SCI	*P*	*PxO*	*SCI*
11 items above 0.60	0.06	0.00	0.00
10 items above 0.62	0.06	0.00	0.02
8 items above 0.66	0.05	0.01	0.10
7 items above 0.71	0.05	0.00	0.06
5 items above 0.73	0.06	0.00	0.00

4 items above 0.74	0.06	0.00	0.00

Chapter 5 Discussion

This study sought to apply G-theory in order to assess the generalisability and temporal reliability of five major resilience assessment scales. A further aim was to determine which items within these scales assessed state and trait features of resilience, and what sources of measurement error affecting their scoring. G-coefficients ranging from 0.88 to 0.97 show that all five scales reliably assess trait resilience, with G-coefficient ≥ 0.70 the accepted criteria for a valid trait measure (Arterberry et al., 2014). This is supported by very high TCIs estimated for all scales (0.99-1.00) wherein TCI ≥ 0.60 is held as reflecting state assessment (Medvedev et al., 2017a). The results of the G-study in this paper demonstrate the reliability and generalisability of scores for all five scales across persons and assessment occasions. This study has also successfully identified stable and dynamic aspects of resilience with a level of statistical robustness not previously applied to this construct. The details of this application of G-theory will be discussed more definitively in the following sections of this chapter.

G-Study Findings

The present research demonstrates the utility of proposed SCI and TCI estimation criteria (Medvedev et al., 2017a) in identifying state and trait features of assessment tools and evaluating the strength of state and trait evaluation. In this calculation, person is the facet of differentiation and is not a direct source of error. The interaction of person x occasion, however, is a considered source of error, and in this model represents the presence of a state facet. A G-coefficient of 0.70 and above and an TCI of 0.60 and above indicates reliability of trait assessment; while a G-coefficient below 0.70 and SCI of 0.60 or greater denotes reliable trait assessment (Medvedev et al., 2017a). As previously outlined, estimated SCI, TCI, and G-coefficients for all five major scales support their reliability in the assessment of trait-resilience. Therefore, all five scales are useful to assess long-lasting changes but may lack sensitivity to detect temporal changes in resilience caused by interactions of person and environment.

While G-study results demonstrated a high level of reliability across the scales, they also revealed the presence of measurement error, most critically, the interaction of person, item, and occasion. The contribution of PxIxO to error variance of scores ranged from 52.50% (TRS, ER89) to 70.60% (BRS) and was the most highly attributed error facet for all scales. However, the presence of this and other error sources had a negligible effect on reliability, as demonstrated by the high G-coefficients obtained. G-coefficients ranging from 0.88 to 0.97 mean that the effect of person, which is equivalent to trait, contributed between 88% and 97%

of total score variance across scales. This study also further establishes G-theory's value as a tool to determine the state and trait variance contributed by scales and their facets. The original paper in which Medvedev et al. (2017a) proposed their novel method of state and trait component index calculation applied this method to TMS, a scale assessing state-mindfulness. Due to TMS' assessment of state, the study sought to confirm low G-coefficients and high SCIs. G-analysis within this study verified TMS and its subscales as valid in the assessment of state-mindfulness, as subscale G-coefficients were below 0.80, showing low temporal reliability, and SCI values were 0.70 and 0.75, reflecting state-sensitivity.

Subsequent studies include that of Lyndon et al. (2019) who used G-theory to examine the AMS, in its assessment of both state and trait features of academic motivation. Overall, the AMS was shown to assess stable academic motivation ($G_a = 0.93$), but three of the seven AMS subscales (intrinsic, extrinsic, and amotivation) obtained low G_a values (0.20-0.56) indicating a high degree of error variance contribution by non-trait facets, and thus low temporal reliability. D-study of individual AMS items found that 16 of 28 items were sensitive to state changes (SCI 0.70-0.99) and only six shown to clearly assess trait academic motivation (TCI = 0.16-0.27).Truong et al. (2020) applied G-theory to evaluate the FFMQ trait-mindfulness scale. The G-study showed strong temporal reliability for the total FFMQ ($G_a = 0.89$, TCI = 0.90) and FFMQ-18 ($G_a = 0.75$, TCI = 0.90). Subsequent D-studies of all five FFMQ subscales found TCI values above 0.60 and G-coefficients below 0.45, indicating the subscales are reliable state measures.

The present research has yielded comparable results to that of Lyndon et al. (2019) and Truong et al (2020), as G-study data support all five scales as reliably assessing stable features of resilience overall, with acceptable generalisability. However, like these two studies, D-study in the present research has uncovered several dynamic components partially comprising scales of reliable trait assessment. These data, and those of Truong et al. (2020) and Lyndon et al. (2019), provide insight into composition of stable, unidimensional constructs within psychometric measures. It can be inferred that trait assessment may often involve a degree of state influence at levels of greater specificity, but that these state features do not impact the reliability of state assessment in a meaningful way. All the studies outlined in this section clearly show the importance of G-theory as a 'liberation' of CTT, allowing for more robust and accurate quantification of states and traits within psychometrics. Determination of state and trait in CTT is limited to test-retest reliability coefficients which only reflects trends of reliability. In contrast, G-theory involves direct estimation of state and trait variance and provides a far richer wealth of data which can be used to understand the nature of states and traits.

G-study and CTT Comparison

Before the proposal of G-theory, CTT was the sole method used to evaluate the temporal reliability of psychometric assessment scores, and to date, is still the predominant framework for conducting such research. While G-analysis has proven to be a more appropriate method for reliability estimation, CTT data were calculated in order to compare reliability estimates between the two models and determine whether the findings are consistent. CTT data indicated that all scales assessed trait resilience, represented by ICC values ranging from 0.81 (TRS) to 0.92 (CD-RISC). Test-retest reliability coefficients ranging from 0.82 (TRS) to 0.92 (SPF) also supported trait assessment by all scales. G-coefficients between 0.88 and 0.97 for all scales within this study are consistent with CTT results as all support the scales in question as reliable in trait assessment.

Comparison of CTT and G-theory reliability estimates showed consensus between findings. The largest cross-study discrepancy was found in test-retest reliability coefficients for BRS. The development paper for BRS reported $r = 0.62$-0.69 for paired tests at three- and one-month intervals, respectively (Smith et al., 2008) indicating unreliability of trait assessment. Contrastingly, test-retest coefficients from the present study ($r = 0.84$) support BRS as a stable trait measure. The difference in interval lengths between test and retesting may be a contributing factor to this discrepancy. The true cause of this divergence in reliability cannot be ascertained due to the lack of context provided by CTT methods. Test-retest and ICC calculations can be used to evaluate error contribution of different factors by manipulation of assessment conditions; however only one source of score variance can be assessed at one time using these methods. In contrast, the present study has applied G-theory to directly and accurately all measurable facets that may impact reliability. Sources of error variance such as item, occasion, and interactions of person, item and occasion have been measured concurrently, allowing for more precise assessment of reliability for five major resilience scales. G-coefficients also denote the generalisability of scores across different assessment occasions and participant groups, further justifying G-theory as the superior means of reliability and generalisability evaluation for psychometric assessment tools.

D-Study Findings

Each individual item from all scales underwent G-study analysis to determine the extent to which items assessed state or trait resilience factors. The main goal of this portion of the study was to detect item sensitivity to changes in state-resilience. In doing so, the content of identified state-items could then be inferred as showing dynamic features of resilience, thus providing novel information about the nature of the resilience construct. State-items could also be combined to form a novel scale of state-resilience assessment. The content of this scale would be based on more robust statistical methods than existing state-resilience scales, which rely on item wording of current feelings to assess state, and overall tendencies to assess trait.

The results of the D-study show that while all scales show high levels of stability when their items are combined to assess a unidimensional construct, all scales except BRS contained items that were sensitive to dynamic aspects of resilience ($SCI \geq 0.60$). Overall, eleven dynamic items were identified from four of the scales. Five were found within CD-RISC: ability to adapt to changes; concerted effort despite challenges; confidence of resources in times of trouble; self-perception as strong when dealing with challenges and difficulties; trust in one's own instincts. TRS contained four state items: "When I make plans I follow through with them"; "I usually take things in stride"; "My belief in myself gets me through hard times"; "When I'm in a difficult situation, I can usually find my way out of it". One dynamic item apiece was found in SPF "When working on something, I plan things out" and ER89 "I get over my anger at someone reasonably quickly". Thematic analysis of state-items resulted in the identification of eight dynamic aspects of resilience. These include adaptation to change (CD-RISC, item 1); perseverance (CD-RISC, item 10); self-confidence while facing adversity (CD-RISC, item 13; TRS, item 17, 23); self-efficacy (CD-RISC, item 17); trust in instincts (CD-RISC, item 20); ability to follow plans (TRS, item 1); non-reactivity (TRS, item 7; ER-89, item 14); ability to plan (SPF, item 18).

The eight dynamic resilience facets listed above are well represented across studies in association with resilience, and resilience-related outcomes such as optimal mental and physical health, and protection effects against mental illness. Self-confidence is the aspect most represented across measures and has been proven as inversely related to symptoms of anxiety and depression (Lun et al., 2018). Self-efficacy has been shown to mediate, and strongly predict resilience (Bender & Ingram, 2018; Keye & Pidgeon, 2013); therefore, targeted efforts to enhance this quality may be particularly effective for resilience-enhancement. Adaptation to change is negatively associated with stress and depressive symptoms (Dyson & Renk, 2006). Non-reactivity, represented in two resilience scales is also one of the five facets of mindfulness (Baer et al., 2006) and has been consistently determined as a protective factor against depression and stress (Medvedev et al., 2018). Persistence has been implicated as a protective factor against depression, anxiety, and panic disorder (Zainal & Newman, 2019). Trust in instincts, or an intuitive decision-making style has a strong positive correlation with global happiness and wellbeing (Stevenson & Hicks, 2016). Planning and following plans are key features of behavioural activation, an effective means to reduce depressive symptoms (Soucy et al., 2017). These features of resilience are empirically supported as being the most amenable to change, therefore, design of future resilience-building interventions will be enhanced by targeted efforts to cultivate them.

The final component of this study involved G-analysis of various combinations of the state-items identified in the previous G-studies (Table 7). The aim of this analysis was to find a combination of dynamic items with an estimated SCI ≥ 0.60. Such an item set could then be used to form a unique scale for the assessment of state-resilience. All tested combinations of dynamic items had very low associated SCI values (0.00-0.10), and therefore did not demonstrate sensitivity to state-resilience. This result echoes low SCIs found for combinations of state items in studies by Medvedev et al. (2018) and Truong et al. (2020). A reasonable explanation for this effect is that while the features assessed by dynamic items have a propensity for frequent change, these changes do not tend to occur in unison. An increase in some item scores may predict a decrease in others. Take for example, CD-RSC item 1 'ability to adapt to changes, and TRS item 1 "when I make plans I follow through with them" assess features that contribute to resilience. Closely following plans is not consistent with adaptation to change; therefore, while both features contribute to resilience, they do not do so simultaneously.

While this level of analysis was unable to assist in the creation of a new state-resilience scale, some meaningful inferences can be made from its results. First, that the presence of some dynamic resilience variances will necessarily predict the absence of others. Considering this, and the fact that all changes in state-resilience are partially determined by traits, it can be reasoned that this cancelling effect on state variance causes trait variance to be predominantly captured when the items are combined as a total scale. This is likely to explain the lack of impact caused by state features upon the reliability of trait scales as demonstrated in this research, and other G-studies of a similar nature. This phenomenon is also consistent with research indicating that combining items into super-items leads to a reduction in measurement error (Medvedev et al., 2018; Taylor et al., 2017). Furthermore, the cancelling effects between some dynamic items, and the explanation as to why this occurs indicates that all items within the studied scales are complimentary and valid contributors to the assessment of a trait resilience construct.

Practical Implications of Findings

The main finding from a G-study examining five major resilience scales was that all scales provided stable assessment of the latent construct of trait-resilience. This means that all scales included in this research can be applied by researchers and care providers to assess long-term changes in resilience. However, the associated lack of sensitivity to state changes means that these scales are not suitable for the detection of short-term fluctuations. In this way, these scales are suboptimal tools to evaluate the efficacy of resilience-building interventions, as an effective training program will influence the most changeable features of resilience. While these stable scales are appropriate to appraise long-term changes caused by training, it is vital that a reliable state-resilience scale is developed and used to accurately assess the direct impact of intervention on state-resilience levels.

The limitations of trait-resilience scale application in assessment of training outcomes were by raised within a study by Akeman et al. (2020), in which resilience training caused reductions in perceived stress and depression but did not lead to an increase in CD-RISC scores. The fact that outcomes associated with increased resilience (improved mental health) were detected indicates that the intervention was likely successful in enhancing resilience, but that this could not be identified due to the sensitivity of the scale used. This research has included the most widely used resilience assessment scales, therefore, it can be reasoned that many resilience interventions have been inaccurately appraised based on their ability to effect trait changes. This may explain in part the negligible improvements in resilience levels identified in meta-analyses of resilience training outcomes (Vanhove et al., 2016; Joyce et al., 2018).

Underestimation of training effects via inappropriate methods of evaluation has the potential to negatively impact the perceived value of intervention. This may have repercussions for who stand to benefit most from resilience training, as interventions viewed as ineffective are unlikely to be widely used, thus reducing accessibility. Furthermore, treatment expectations have been demonstrated as contributing to the success of psychological intervention (Noble et al., 2001). Therefore, undervaluation of training efficacy could in part be self-fulfilling. The effectiveness of resilience-building interventions can also be optimised by applying the D-study findings in this study. The eight dynamic resilience features identified are proven to be highly amenable to change, thus, resilience training should focus on enhancing these factors in order to optimise outcomes.

Limitations

The limitations of the present research must be considered. Data for this study were obtained from a predominantly European and female sample of university students. Future replications of this research would benefit from a more diverse sample population to increase the generalisability of findings. The recency of the TCI and SCI calculation methods means that this technique has not yet been applied to a wide range of studies. Accordingly, more research will need to occur in this area to clearly establish the criteria by which state and trait are determined, and the present research is potentially limited by this.

Finally, while all participants were free to choose whether they took part in this study, they were incentivised with course credit for doing so. As a result, it is possible that some participants were simply ‘going through the motions’ when responding to the surveys, particularly as they had to answer the same questions multiple times. Consequently, the data may not truly capture the changes in resilience for all participants. Despite this, participants were given the opportunity to obtain course credit by completing a short, written assignment which may have deterred some disinterested parties from participating. Furthermore, the sample size was well above that required for adequate statistical power, and the robust nature of G-theory means that the findings can be generalised to similar populations.

Future Research Directions

One of the most salient issues identified in this study was the lack of an existing state-resilience assessment tool based in robust methodology such as G-theory. Development of a reliable state-resilience assessment tool will allow for more accurate and detailed assessment of resilience. This would also enhance evaluation of training outcomes, and potentially improve perceptions, accessibility, and effectiveness of resilience training. Combining state items from this study did not successfully inform the creation of such a scale. There are a great many existing resilience scales not examined in this research. Future studies would do well to investigate item content from a wider range of scales, to increase the item-pool from which a dynamic scale can be created.

The similarity of the SPF item with the highest SCI value "when working on something I plan things out" (SCI = 0.63) and SPF item with the highest TCI value "when working on something I organize my time well" (TCI = 0.84) raises some questions. Further investigation could be useful to determine whether the distinction between planning and time organisation is critical in this context, or if other factors such as question wording have shaped this result.

Finally, the trait-specific nature of the leading resilience assessment tools, and their inability to distinguish between state and trait is a poor fit with the conceptual understanding of resilience as a dynamic process involving both states and traits. G-theory has been established as a highly appropriate tool in the assessment of state and trait, but its application in resilience research is very low. It is logical for future studies of resilience, and other constructs to apply this theory due to its usefulness and superior accuracy in comparison to CTT methods.

Conclusions

Resilience has been an increasingly popular topic of psychological research. It can enhance people's lives by acting as a protective factor against the effects of stress, and mental illness. It is also related to the optimisation of health, educational, personal, and athletic outcomes. The current body of research supports resilience as a multidimensional construct composed of states and traits that interact to facilitate positive adaptation. Accurate distinction between stable and dynamic features of resilience is critical to enhance understanding, psychometric assessment, and development of resilience. This research has applied G-theory, the most apt and robust method to make such distinctions, to five major scales of resilience assessment. The results indicate that all five scales are reliable in assessing trait-resilience, and that their scores are generalisable across assessment occasions and participant samples. SPF and CD-RISC were shown to have the greatest temporal reliability and therefore are the most appropriate scales to ensure the assessment of trait-resilience.

All but one of the scales studied were shown to contain items that were sensitive to state-resilience changes. The combination of these dynamic items resulted in item-packets reflecting a high level of temporal reliability. These findings are indicative of a nullifying effect between state-item scores due to their assessment of facets that do not change concurrently. This, and the presence of trait influence in all state score variance supports the reliability of the trait-scales despite their containment of state-items. Moreover, it shows that despite their dynamic nature, the state-items are complimentary in the context of their respective scales and contribute to the reliable assessment of a stable resilience construct.

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Appendix A1

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Identifying Stable and Dynamic Features of Resilience Using Generalizability Theory

Journal:	*Depression and Anxiety*
Manuscript ID	DA-20-500
Wiley - Manuscript type:	Research Article
Date Submitted by the Author:	16-Jun-2020
Complete List of Authors:	Child, Lucy; University of Waikato, School of Psychology Medvedev, Oleg; University of Waikato, School of Psychology
Keywords:	Resilience, Assessment/Diagnosis, measurement/psychometrics, Anxiety/Anxiety disorders, Depression

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Identifying Stable and Dynamic Features of Resilience Using Generalizability Theory

Lucy E. Child[1] and Oleg N. Medvedev[1*]

[1]University of Waikato, School of Psychology, Hamilton, New Zealand

*Corresponding Author:

Medvedev, Oleg N., Email: oleg.medvedev@waikato.ac.nz

School of Psychology, Faculty of Arts & Social Sciences, University of Waikato

Private Bag 3105, Hamilton 3240, New Zealand

Phone: + 64 7 837 9212

Lucy E. Child, Email: lc189@students.waikato.ac.nz

Declaration of Interest: The Authors declare that they don't have a conflict of interest regarding this paper.

Acknowledgements: The authors express their gratitude to Jess Leov at the University of Waikato for her patience and for imparting a wealth of expertise regarding the use of Qualtrics survey software. Further acknowledgement to the participants without whom this research would not have been possible.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Compliance with Ethical Standards: All participants in this study provided their informed consent. This study has received ethics approval from the ALPSS Human Research Ethics Committee of the University of Waikato based on internationally accepted ethical standards.

Author Contributions: LC contributed to study design, data collection, literature review, writing and revision of the report and creation of figures. OM contributed to study design, data collection, writing and revision of the report and creation of figures.

Abstract

Objectives: Challenges of modern living such as burden of disease, a global COVID-19 pandemic and workplace stress leading to anxiety and depression raise the importance of psychological resilience. Psychological interventions aimed to enhance resilience should focus on amendable, dynamic aspects of resilience to be effective, which requires a clear distinction between dynamic and stable aspects of resilience using appropriate methodology. Generalizability Theory (G-theory) is the most robust method increasingly used to distinguish between state and trait and to establish reliability of psychological assessment.

Materials and Methods: G-theory was applied to evaluate the five major resilience scales using repeated-measures data that possess adequate statistical power for such analyses.

Results: Eight dynamic aspects of resilience were identified from all five resilience scales including adaptation to change; perseverance; self-confidence while facing adversity; self-efficacy; trust in instincts; ability to follow plans; non-reactivity; ability to plan. All five resilience scales demonstrated high generalizability of scores across occasions and sample population (G>0.90) as expected for a trait measure.

Conclusions: Dynamic aspects of resilience identified in this study are the most amendable and should be the primary target of resilience-building interventions to ensure their efficacy. All five measures of resilience are useful to assess long-lasting changes but may lack sensitivity to detect temporal changes in resilience. Development of a state resilience scale is warranted.

Key words: Resilience, State and Trait, Generalizability Theory, Reliability, Assessment.

Introduction

Challenges of living in the modern world such as burden of disease (e.g. COVID-19 pandemic) workplace stress, burnout, and negative environmental effects leading to anxiety and depression raising the importance of resilience concept across many areas of psychology (Heinz et al., 2018). Psychological resilience is indicated as an effective tool to ameliorate the negative effects of stressors leading to anxiety and depression (Dantzer et al., 2018; Sheerin et al., 2017; Stewart & Yuen, 2011; McCraty & Atkinson, 2012). Resilience has been proven to act as a protective 'buffer' against the role of adverse childhood experiences (ACEs) resulting in adult depression (Poole et al., 2017), and is negatively associated with suicidal ideation (Kim et al., 2020).

A recent study found 1/3 of university students experienced anxiety or depression that affected their daily functioning, and that students who underwent a short resilience-building program showed improvements in depression and perceived stress. However, the program yielded a negligible improvement in resilience levels and a decrease in resilience scores from pre to post-training (Akeman et al., 2019). This may in part be due to CD-RISC (the assessment tool used) lacking the sensitivity required to pick up dynamic changes in resilience. Meta-analysis of workplace-based resilience building programs found an overall modest effect size which decreased markedly over a one-month period post-intervention (Vanhove et al., 2016). Another meta-analysis yielded small to moderate effect sizes and found only four of eleven identified studies with control conditions with statistically significant results (Joyce et al., 2018). Further issues in resilience research lie in the current conceptualizations of measuring trait and state resilience. Trait resilience refers to a relatively stable resilient nature over time (Spielberger, 1983). It could also be described as a resilient personality type. State resilience is a dynamic and changing form of resilience. It results from the interaction of individual trait resilience features with occasion-specific factors (Medvedev et al. 2017a).

The most common method of distinguishing between state and trait features utilizes test-retest reliability and question wording (STAI; Gaudry et al., 1975). Conceptually, items and instructions should be worded to refer to the present in order to assess state features, and towards overall tendencies to assess trait features. In psychometric terms, a correlation between two test scores at separate intervals of less than 0.6 indicates a state item, while a correlation of 0.70 and above indicates a trait scale or item (Medvedev et al., 2017a). Problems with this style of assessment are shown in the 2002 reliability investigation of the State-Trait Anxiety Inventory (STAI; Gaudry et al., 1975) (Barnes et al., 2002) which found a test-retest correlation ranging from 0.82 to 0.94 for trait anxiety, and 0.34 to 0.96 for state anxiety. The higher upper range for state anxiety contradicts the prescribed criteria for state and trait distinction. Thus, more psychometric work is needed to distinguish between state and trait in resilience and to identify sources of the measurement error using appropriate methodology such as G-theory (Bloch & Norman 2012, Medvedev et al., 2017a)

G-theory is a robust statistical method developed by Cronbach et al. (1963) that can be used to determine the overall reliability of a measure and identify specific sources of error that may impact on measurement. G-theory expands on Classical Test Theory (CTT) by using ANOVA to precisely determine sources of error that in CTT would be classified as unknown. The CTT model of $X = T + E$ states that the observed score (X) is comprised of a true score (T) + error (E) (Brennan, 2010). In this model all sources of error fall within E therefore, specific sources of error and levels of attribution to E remain unknown. In G-theory levels of contribution for differing sources of error are calculated using a model which can be shown as:

$$X = T + E_P + E_I + E_O + E_{(P \times I)} + E_{(P \times O)} + E_{(P \times I \times O)}$$

where: E_p = Error attributed to person; E_I = error attributed to item; E_O = error attributed to occasion; $E_{(P \times I)}$ = error attributed to interaction of person and item; $E_{(P \times O)}$ = error attributed to interaction of person and occasion; $E_{(P \times I \times O)}$ = error attributed to interaction of person, item, and occasion (Medvedev et al., 2017).

Application of G-theory first involved a Generalizability (G)-study: examining reliability at a scale-level without modifications. G-study assesses the amount of variance attributed to the factors being assessed within the scale such as person, item, and occasion and interactions between them. G-study yields a G-coefficient that is calculated as a ratio of true variance to observed score variance including true variance and total error variance (Bloch & Norman, 2012). G-coefficients of 0.80 and above indicate high generalizability of assessment scores, which is characteristic of a trait measure (Medvedev et al., 2018). In this case the G-study examines the extent to which each scale measures trait resilience. A decision (D)-study is informed by G-study and experiments with measurement design aiming to optimize the overall assessment based on measurement properties that may compromise reliability. D-study can be conducted at the individual item level and inform which items measure trait or state resilience. A state component index (SCI) and trait component index (TCI) were also calculated using values from the G study (Medvedev et al., 2017a). The SCI and TCI indicate how strongly each scale/item measures state or trait resilience, with a SCI of 0.6 and above indicating a state item, and a TCI of 0.6 and above indicating a trait item (Medvedev et al., 2017a). To date, G-theory is increasingly used across discipline such as medicine, psychology and education to examine the overall reliability and generalizability of assessment scores, sources of the measurement error (Bloch & Norman, 2012; Medvedev et al., 2018) and to distinguish between state and trait (Lyndon et al., 2019; Truong et al., 2020).

This study aims to distinguish between state and trait resilience, identify sources of measurement error and the overall generalizability of assessment scores in the five widely used resilience measures by applying G-theory. Identifying stable and dynamic aspects of the resilience construct may add valuable knowledge to conceptualizations of resilience. While many studies have assessed both proximal and distal effects of resilience training, the scales used do not distinguish between state and trait in their assessment (Salisu & Hashim, 2017). Moreover, at the time of this research we were unable to identify any measurement tools that exclusively measure state resilience. If sensitivity to distinguish between state and trait resilience is achieved, proximal and distal effects of resilience training can be more accurately assessed. By identifying dynamic features of resilience, we will also be able to identify the factors which are most changeable. This can then be applied to form resilience building interventions that target amendable features of resilience thus increasing their efficacy. Overall, this study aims to contribute to more accurate assessment of resilience in a wider context including psychological interventions to enhance resilience in people.

Materials and Methods

Study Population

This study included 94 university students that completed an online questionnaire at three separate time points, with one-week intervals. To achieve statistical power of β=0.90, p=.05 with ICC $\geq$.40 and the repeated measures over three time points the minimum required sample size is n=50. Our sample size is greater and adequate for this type of reliability research as demonstrated by similar studies (Shoukri et al. 2004; Truong et al., 2020). The sample included 75 (80%) females and 19 (20%) males with a mean age of 27 years (SD = 9.47). The ethnic composition of the sample is as follows: New Zealand European 57 (60%), New Zealand Maori 13 (14%), Pacific Peoples 2 (2%), Asian 13 (14%), and Other 9 (10%). Student participants received course credit for research participation.

Instrumentation

Connor-Davidson Resilience Scale (CD-RISC).

CD-RISC is a 25-item unidimensional self-report scale, that is designed to measure psychological resilience. The scale uses a five-point Likert scale response format from 'not true at all'= 0 to 'true nearly all the time'= 4 with the higher scores corresponding to higher levels of psychological resilience. The total score is calculated as the sum of individual item responses. The CD-RISC has a reported Cronbach's alpha of 0.89-0.96, and test-retest reliability of 0.87 (Connor & Davidson, 2003) (Ponce-Garcia et al., 2015).

The Resilience Scale (TRS)

TRS is also a 25-item unidimensional self-report scale designed to measure psychological resilience. Responses range from 'strongly disagree'=1 to 'strongly agree'= 7. Total score for this scale is calculated as the sum of individual item responses. Reported Cronbach's alpha for TRS is 0.89-0.94 (Wagnild & Young, 1993). Reported test-retest reliability from a Dutch adaptation of this scale is 0.90 (Wagnild & Young, 1993; Ponce-Garcia et al., 2015). Test-retest reliability data was not available for the English version of this scale.

Scale of Protective Factors (SPF)

SPF is a 24-item unidimensional self-report scale. Responses range from 'disagree completely'=1 to 'agree completely'= 7. This scale measures the following facets of resilience: social skills, social support, goal efficacy, and planning and prioritizing behavior.

Reported Cronbach's alpha for the SPF is 0.91. No test-retest reliability values were available for this scale (Ponce-Garcia et al., 2015).

Ego Resilience Scale (ER89)

The ER89 is a 14-item unidimensional self-report scale designed to measure trait resilience. Responses range from 'does not apply to me at all'= 1 to 'applies to me completely'=4. Reported Cronbach's alpha= 0.73-0.81 and test-retest reliability =0.87 (Block & Kremen, 1996) (Farkas & Orosz, 2015).

Brief Resilience Scale (BRS)

The BRS is a short, 6-item unidimensional self-report scale. Responses for the BRS range from 'strongly disagree'=1 to 'strongly agree' 5. Reported Cronbach's alpha values for this scale range from 0.80-0.91, and test-retest reliability values range from 0.62-0.69 (Smith et al., 2008).

<INSERT TABLE 1. >

Qualtrics XM was used to create and administer an online survey. The survey was comprised of the five resilience scales described above and included demographic information such as age, sex, and ethnicity. The scoring for all items was changed to a five-point Likert scale used by the most validated CD-RISC to ensure consistency and coherence across scales. This is supported by Rasch analysis indicating that scales with four to five response categories are psychometrically superior to scales with six or more categories (Medvedev et al., 2016; 2017b).

Procedure

This study was approved by the authors' institutional ethics committee. Participants who wished to take part in the study completed online surveys at three time points in their own time. Informed consent was obtained from all participants as a part of completing the questionnaire. A one-week period between completion of one survey and distribution of the next was selected based on Spielberger's 1983 findings that this timeframe is optimal for assessment of temporal reliability and to minimize learning effect.

Data Analysis

Descriptive statistics were computed using IBM SPSS Statistics version 25. Generalizability analysis was conducted according to the guidelines described by Cardinet et al (2011) and Medvedev et al. (2017a), and analysis was carried out using EduG 6.1e software (Swiss Society for Research in Education Working Group, 2006).

Random effect measurement design was employed for both G and D studies, with two crossed facets for both studies: persons (P), by item (I), by occasion (O), expressed as P × I× O, in which facets P and O are infinite and facet I is fixed because the study was limited to the items specific to the included validated measures.

The facets were operationalized with person as the object of measurement or differentiation facet, which is not a source of error. Instrumentation factors were items and occasions (Cardinet et al., 2011). Individual states by nature, should vary across occasions as reflected by person-item interaction. Therefore, the error variance attributed to person x occasion interaction is reflective of a state component (Medvedev et al., 2017a). The relative value of this interaction is also indicative a scale's sensitivity to measure individual states (Paterson et al 2017). Both G and D-study estimates were computed using formulas developed by (Brennan, 1992) that are based on repeated measures ANOVA. Whimbey's correction was utilized for ANOVA estimates using formula ((N(f) − 1)/N(f)), where N(f) refers to the "f" facet size and has no influence on facets sampled from an infinite universe (e.g., persons). G-study estimates relative and absolute generalizability coefficients (G-coefficients) and variance components for individual facets after controlling for true variance associated with the object of measurement (persons).

The absolute G (Ga) (expressed as Phi or Φ) involves using Whimbey's correction and controls for all sources of error variance that may impact reliability of measurement both directly and indirectly (e.g., item; Cardinet et al., 2011). The relative G (Gr) (expressed as ρ2, ϖ2) also applies Whimbey's correction but only considers error variances directly related to the object of measurement (e.g., person-item interaction). The TCI and SCI measure the extent to which a measure reflects stable and dynamic aspects of a construct and were computed using variance components of person and person-occasion interaction and formulae developed by Medvedev et al., (2017a). The D-study examined individual items from each original resilience scale to determine the degree to which individual items reflected state or trait resilience. In this study we also experimented with measurement design in an attempt to create a state-resilience scale by combining individual items reflecting a higher degree of state resilience.

Results

Table 2 shows temporal reliability estimates computed using CTT methodology. All scales showed strong temporal reliability with test-retest correlations ranging from 0.82 to 0.92 across measures. ICC, a more robust CTT method of reliability estimation has also been used. An ICC value of 0.80 and above indicates near-perfect reliability of a valid trait measure (Landis & Koch, 1977), scale values ranged from 0.81 (SPF) to 0.92 (CD-RISC).

<INSERT TABLE 2 HERE>

G-Study

Table 3 shows G-study results for person (P), item (I), occasion (O) and interaction effects for the resilience measures. Relative and absolute generalizability coefficient values ranged from 0.88 to 0.97 therefore all included scales are reliable measures of trait resilience, with scores generalizable across occasions and the sample population. Consistent with high G-coefficient, negligible SCI values ranging between 0.00 - 0.01 for all scales showed lack of sensitivity to dynamic aspects of resilience, and TCI values of 0.99 - 1.00 indicate an ideal characteristics of a trait resilience measure.

<INSERT TABLE 3 HERE>

D Study

Analysis of facets was conducted for individual items of each scale by excluding all other scale items. Overall, eleven items with SCI values (> 0.60) indicating sensitivity to state resilience were identified within the scales studied. Table 4 shows five items within the CD-RISC with sensitivity to dynamic resilience (SCI 0.63 – 0.94). Item 13 with the highest SCI value in this scale relates to confidence of resources in times of trouble. The most trait-sensitive CD-RISC item related to enjoyment of challenges (TCI = 0.77).

<INSERT TABLE 4 HERE>

Table 5 shows that three TRS items are sensitive to state resilience with (SCI 0.61 – 0.74). The highest SCI scored was obtained for item is item 7 – “I usually take things in stride”suggesting that this item reflects very dynamic aspect of resilience. In contrast, item 2 “I usually manage one way or another” represents very stable aspect of resilience (TCI = 0.79).

<INSERT TABLE 5 HERE>

Table 6 shows item 18 (SCI = 0.63) within SPF is sensitive to dynamic aspects of resilience with wording ‘when working on something I plan things out’. SPF item 15 - ‘when working on something I organize my time well’ had the greatest trait-sensitivity (TCI = 0.84).

<INSERT TABLE 6 HERE>

Table 7 shows that only ER89 item 14 “I get over my anger at someone reasonably quickly” (SCI = 0.82) was reflecting state resilience to a higher degree. On the other hand, item 9 – “most of the people I meet are likeable” is the best representation of trait resilience in this scale (TCI = 0.83). No state-sensitive items were found in the BRS. All other scale items were clearly measuring trait resilience (TCI 0.60 – 0.71) with the highest value attributed to item 5 – “I usually come through difficult times with little trouble”.

D-study was also conducted on combinations of all state items identified in the five scales studied in an attempt to develop a state-only scale. However, no tested combinations of state items showed sensitivity to state resilience (SCI 0.02 – 0.10) as shown in the bottom section of table 7.

<INSERT TABLE 7 HERE>

Conclusions

Resilience can act as a protective factor against stress, anxiety, and depression and is frequently the focus of studies relating to these disorders and challenges of modern living. Issues such as workplace stress, burden of disease, and the global COVID-19 pandemic highlight the importance of psychological resilience. Evaluation of the efficacy of interventions to develop resilience requires knowledge of stable and dynamic aspects of resilience as well as sources of error in its measurement. The aim of this study was to apply, G-theory to evaluate the five major resilience measures and to elucidate differences in state and trait resilience, sources of error, and generalizability of assessments scores. Eight dynamic aspects of resilience were identified from all five resilience scales including adaptation to change (CD-RISC, item 1); perseverance (CD-RISC, item 10); self-confidence while facing adversity (CD-RISC, item 13; TRS, item 17, 23); self-efficacy (CD-RISC, item 17); trust in instincts (CD-RISC, item 20); ability to follow plans (TRS, item 1); non-reactivity (TRS, item 7; ER-89, item 14); ability to plan (SPF, item 18).

Self-confidence is the aspect most represented across measures and has an inverse relationship to symptoms of anxiety and depression (Lun et al., 2018). Adaptation to change is negatively associated with stress and depressive symptoms (Dyson & Renk, 2006). Self-efficacy has been shown as a strong predictor of resilience (Martinez-Marti & Ruch), therefore, targeted efforts to enhance this quality may be particularly effective in resilience building. Non-reactivity, represented by two out of five resilience measures is also one of the five facets of mindfulness (Baer et al., 2006) and was consistently found as a protective factor against depression and stress (Medvedev et al., 2018). Persistence was implicated as a protective factor against depression, anxiety, and panic disorder (Zainal & Newman, 2019). Trust in instincts, or an intuitive decision-making style has a strong positive correlation with global happiness and wellbeing (Stevenson & Hicks, 2016). Planning and following plans are key features of behavioural activation, an effective means to reduce depressive symptoms (Soucy et al., 2017). These dynamic aspects of resilience are the most amenable to change, therefore interventions designed to increase resilience should primarily target these aspects for greater interventional efficacy.

All five resilience scales demonstrated high generalizability of scores across occasions and sample population (G>0.90) as expected for a trait measure. Therefore, all five measures of resilience are useful to assess long-lasting changes but may lack sensitivity to detect temporal changes in resilience caused by person-environment interaction. Similar generalizability research has been conducted on other psychological scales. Truong et al.

(2020) found that the Five Factor Mindfulness questionnaire and its shortened 18 item version are both reliable measures of stable mindfulness, and at the item level similarly identified several items reflecting dynamic aspects of mindfulness.

A D-study was conducted on all eleven identified state-items in an attempt to form a scale of state-resilience measurement (see table 6). However, combining these items did not yield a valid state measure with SCI values from 0.00 – 0.10 obtained. This is similar to the findings of Medvedev et al (2018); Truong et al., (2020) demonstrating that state variances are likely to cancel each other when items are combined. For example, one state item measures ability to adapt to changes, while another measures tendency to make and stick to plans. Closely following plans may negatively impact an individual's tendency to adapt to changes, reducing their combined effect.

Limitations and Directions for Future Research

This study has shown that the evaluated scales measure trait and have low sensitivity to state-resilience, while also highlighting the existence of state-resilience facets. This lack of state-sensitivity may explain some inconsistencies found in resilience research. For example, successful resilience training is likely to yield dynamic changes proximal to intervention, and more stable changes over time. Therefore, more effective measurement of resilience training effects may be achieved by measurement of changes in both stable and dynamic resilience features.

State aspects of resilience identified in this study may be useful as the primary target of interventions to more effectively build resilience, and therefore more effectively combat depression and anxiety. A need for a reliable measure of state-resilience has been identified, this study may inform research to create such a scale. The similarity of the SPF item with the highest SCI value 'when working on something I plan things out' (SCI = 0.63) and SPF item with the highest TCI value ‘when working on something I organize my time well’ (TCI = 0.84) bears further investigation to ascertain whether the distinction between planning and time organization is critical in this context, or if other factors such as question wording have shaped this result. The sample for this study was obtained from a predominantly European and female university class population. Future replications of this research would benefit from a more diverse sample population to increase the generalizability of findings.

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Table 1. *Test-retest reliability, Cronbach's alpha values and factor structures of the five major resilience scales ordered by number of google scholar citations.*

	Test-Retest Reliability	Cronbach's Alpha	Citations Scholar	Number of Items	Number of Factors	Factors Assessed
CD-RISC (2003)	0.87	0.89-0.96	5823	25	5	Personal competence, high standards & tenacity; trust in instincts, tolerance of negative affect, and strengthening effects of stress; positive acceptance of change and secure relationships; control; spiritual Influences
TRS (1993)	0.89-0.94	0.90	3978	25	4	Perseverance, self-confidence, serenity, meaning, existential loneliness
SPF (2015)		0.91-0.93	23	24	4	Social support, social skill, self-efficacy, planning and prioritizing
ER89(1996)	0.87	0.73-0.81	2743	14	1	Active engagement with the world Integrated performance under stress Repertoire of problem-solving strategies
BRS (2008)	0.80-0.91		1716	6	1	Ability to bounce back/recover from stress

Table 2. *Cronbach's alpha, test-retest bivariate correlation and ICC for all scales.*

Scale/Assessment	Occasion 1	Occasion 2	Occasion 3	ICC (95%CI)
CD-RISC				
Mean (SD)	3.64 (0.48)	3.62 (0.54)	3.63 (0.50)	
Cronbach's alpha	0.89	0.93	0.92	
Test-retest *(r)*[a]	--	0.88**	0.86**	0.92(0.83-0.91)
TRS				
Mean (SD)	3.67 (.48)	3.63 (0.53)	3.69 (0.51)	
Cronbach's alpha	0.89	0.92	0.91	
Test-retest *(r)*[a]	--	0.85**	0.82**	0.81(0.70-0.87)
SPF				
Mean (SD)	3.61(0.62)	3.62 (0.65)	3.63 (0.61)	
Cronbach's alpha	0.94	0.95	0.94	
Test-retest *(r)*[a]	--	0.92**	0.88**	0.91(0.88-0.94)
ER89				
Mean (SD)	3.46 (0.53)	3.46 (0.53)	3.52 (0.55)	
Cronbach's alpha	0.81	0.84	0.86	
Test-retest *(r)*[a]	--	0.83**	0.84**	0.84(0.78-0.88)
BRS				
Mean (SD)	3.32 (0.72)	3.35 (0.76)	3.38 (0.74)	
Cronbach's alpha	0.87	0.89	0.89	
Test-retest *(r)*[a]	--	0.84**	0.84**	0.86(0.81-0.90)

Table 3. *G-study estimates for five major resilience scales including Coefficient G relative (Gr), Coefficient G absolute (Ga), Trait Component Index (TCI), State Component Index (SCI), variance components (in %), and for the Person (P) × Occasion (O) × Item (I) design including interactions (n = 103). Three decimal points used for variance components to distinguish small values.*

	CD-RISC		TRS		SPF		ER89		BRS	
Facets	σ^2	%	σ^2	%	σ^2	%	σ^2	%	σ^2	%
P	0.21		0.17		0.25		0.25		0.27	
I	0.000	1.70	0.000	0.30	0.001	6.60	0.000	0.00	0.003	9.60
O	0.000	1.90	0.000	0.70	0.000	0.00	0.000	0.00	0.001	4.10
PxI	0.002	16.90	0.003	31.80	0.002	23.20	0.006	25.50	0.005	13.70
PxO	0.002	15.60	0.001	6.60	0.000	3.80	0.003	13.10	0.000	0.00
IxO	0.001	7.80	0.001	8.00	0.000	4.80	0.002	8.80	0.001	2.00
PxIxO	0.006	56.00	0.005	52.50	0.006	61.60	0.012	52.50	0.026	70.60
Gr	0.96		0.95		0.97		0.93		0.90	
Ga	0.95		0.94		0.96		0.92		0.88	
TCI	0.99		1.00		1.00		0.99		1.00	
SCI	0.01		0.00		0.00		0.01		0.00	

Table 4. *D-Study Results for items in the CD-RISC, including person variance, person x occasion variance, and state component index.*

CD-RISC	*P*	*PxO*	*SCI*
1. Ability to adapt to changes	0.10	0.33	0.77
2. Close and secure relationships.	0.23	0.14	0.38
3. Belief in a higher power.	0.37	0.24	0.40
4. Self-belief to deal with any challenge.	0.21	0.14	0.40
5. Confidence from past successes	0.37	0.16	0.30
6. Effort to see humor in the face of problems.	0.19	0.17	0.48
7. Belief in strengthening effects of stress.	0.24	0.22	0.48
8. Tendency to bounce back after illness, injury or other hardships.	0.37	0.14	0.28
9. Belief that most things happen for a reason.	0.25	0.12	0.33
10. Concerted effort despite challenges.	0.08	0.21	0.72
11. Belief in ability to achieve goals, despite obstacles.	0.48	0.18	0.27
12. Perseverance in the face of hopelessness.	0.18	0.26	0.59
13. Confidence of resources in times of trouble.	0.02	0.29	0.94
14. Focus and clear-headedness under pressure.	0.44	0.14	0.24
15. Leadership in problem-solving.	0.19	0.16	0.46
16. Lack of discouragement by failure.	0.46	0.17	0.27
17. Self-perception as strong when dealing with challenges and difficulties.	0.16	0.27	0.63
18. Ability to make unpopular or difficult decisions.	0.27	0.19	0.42
19. Ability to regulate negative emotions.	0.37	0.28	0.44
20. Trust in one's own instincts.	0.08	0.23	0.75
21. Strong sense of purpose in life.	0.25	0.20	0.43
22. Feelings of control.	0.39	0.17	0.30
23. Enjoyment of challenges.	0.44	0.13	0.23
24. Effort towards goal obtainment.	0.30	0.25	0.46
25. Sense of pride in achievements.	0.33	0.24	0.42

Table 5. *D-Study Results for items in TRS, including person variance, person x occasion variance, and state component index.*

TRS	*P*	*PxO*	*SCI*
1. When I make plans I follow through with them	0.12	0.24	0.67
2. I usually manage one way or another	0.37	0.10	0.21
3. I am able to depend on myself more than anyone else	0.46	0.18	0.28
4. Keeping interested in things is important to me	0.59	0.18	0.23
5. I can be on my own if I need to	0.24	0.16	0.40
6. I feel proud that I have accomplished things in life	0.38	0.18	0.31
7. I usually take things in stride	0.07	0.21	0.74
8. I am friends with myself	0.27	0.26	0.50
9. I feel that I can handle many things at a time	0.36	0.11	0.24
10. I am determined	0.22	0.22	0.49
11. I seldom wonder what the point of it all is	0.30	0.16	0.35
12. I take things one day at a time	0.27	0.14	0.33
13. I can get through difficult times because I've experienced difficulty before.	0.20	0.19	0.50
14. I have self-discipline	0.43	0.14	0.24
15. I keep interested in things	0.32	0.12	0.28
16. I can usually find something to laugh about.	0.14	0.13	0.47
17. My belief in myself gets me through hard times.	0.14	0.22	0.61
18. In an emergency, I'm someone people can generally rely on.	0.44	0.13	0.23
19. I can usually look at a situation in a number of ways.	0.21	0.24	0.54
20. Sometimes I make myself do things whether I want to or not.	0.27	0.18	0.39
21. My life has meaning.	0.23	0.17	0.41
22. I do not dwell on things that I can't do anything about.	0.25	0.22	0.46
23. When I'm in a difficult situation, I can usually find my way out of it.	0.10	0.25	0.72
24. I have enough energy to do what I have to do.	0.21	0.20	0.48
25. It's okay if there are people who don't like me.	0.30	0.25	0.45

Table 6. *D-Study Results for items in the SPF including person variance, person x occasion variance, and state component index.*

SPF	P	PxO	SCI
1. I am good at starting new conversations	0.27	0.14	0.34
2. My friends and/or family, keep me up to speed on important events	0.14	0.14	0.49
3. I am good at making new friendships	0.17	0.19	0.53
4. My friends and/or family, are supportive of one another	0.39	0.15	0.27
5. When working on something, I make a list of things to do in order of importance	0.30	0.23	0.43
6. I am confident in my ability to solve problems	0.20	0.18	0.48
7. My friends and/or family, spend free time together	0.39	0.15	0.28
8. When working on something, I set priorities before I start	0.28	0.20	0.42
9. I am confident in my ability to succeed	0.36	0.18	0.33
10. I am confident in my ability to think out and plan	0.16	0.22	0.58
11. I am confident in my ability to think on my feet	0.31	0.21	0.40
12. I am good at working with others as part of a team	0.33	0.28	0.46
13. I am good at socializing with new people	0.16	0.19	0.55
14. I am confident in my ability to achieve goals	0.25	0.22	0.47
15 - When working on something, I organize my time well	0.54	0.11	0.16
16. I am good at interacting with others	0.43	0.14	0.24
17. I am good at being with other people	0.68	0.16	0.19
18. When working on something, I plan things out	0.14	0.24	0.63
19. I am confident in my ability to make good decisions/choices	0.25	0.22	0.47
20. My friends and/or family see things the same way as I do	0.36	0.14	0.27
21. My friends and/or family are seen as united	0.45	0.19	0.29
22. When working on something, I do better if I set a goal	0.52	0.15	0.23
23. My friends and/or family are optimistic	0.38	0.15	0.29
24. When working on something, I can see the order in which to do things	0.23	0.15	0.39

Table 7. *D-Study Results for items in the ER89, BRS, and state items over 0.6 SCI including person variance, person x occasion variance, and state component index.*

ER89	*P*	*PxO*	*SCI*
1. I am generous with my friends.	0.26	0.22	0.46
2. I quickly get over and recover from being startled.	0.18	0.20	0.52
3. I enjoy dealing with new and unusual situations.	0.26	0.22	0.46
4. I usually succeed in making a favorable impression on people.	0.60	0.14	0.19
5. I enjoy trying new foods I have never tasted before.	0.29	0.22	0.43
6. I am regarded as a very energetic person.	0.48	0.17	0.26
7. I like to take different paths to familiar places.	0.29	0.20	0.41
8. I am more curious than most people	0.42	0.12	0.23
9. Most of the people I meet are likable	0.62	0.13	0.17
10. I usually think carefully about something before acting	0.45	0.18	0.28
11. I like to do new and different things.	0.37	0.16	0.30
12. My daily life is full of things that keep me interested.	0.38	0.21	0.35
13. I would be willing to describe myself as a pretty "strong" personality.	0.14	0.18	0.57
14. I get over my anger at someone reasonably quickly.	0.07	0.30	0.82
BRS	*P*	*PxO*	*SCI*
1. I tend to bounce back quickly after hard times	0.26	0.13	0.33
2. I have a hard time making it through stressful events	0.29	0.20	0.40
3. It does not take me long to recover from a stressful event	0.20	0.14	0.40
4. It is hard for me to snap back when something bad happens	0.37	0.15	0.29
5. I usually come through difficult times with little trouble	0.34	0.14	0.29
6. I tend to take a long time to get over set-backs in my life	0.32	0.18	0.36
State Items over 0.6 SCI	*P*	*PxO*	*SCI*
11 items above 0.6	0.06	0.00	0.00
10 items above 0.62	0.06	0.00	0.02
8 items above 0.63	0.05	0.01	0.10
7 items above 0.71	0.05	0.00	0.06
5 items above 0.73	0.06	0.00	0.00
4 items above 0.74	0.06	0.00	0.00

Appendix A2

Ethics Approval

Division of Arts, Law, Psychology & Social Sciences

The University of Waikato
Private Bag 3105
Hamilton 3240
New Zealand

Te Piringa – Faculty of Law
Dr Nathan John Cooper
Tel: +64 7 838 4463
Email: nathan.cooper@waikato.ac.nz
www.waikato.ac.nz

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Lucy Child
Oleg Medvedev

Psychology

2 September 2019

Dear Lucy

Re: **FS2018-29 Investigating dynamic and stable factors of psychological resilience and evaluating components of the overall construct of resilience**

Thank you for submitting your revised application to the D-ALPSS Human Research Ethics Committee. We have reviewed the final electronic version of your application and the Committee is now pleased to offer formal approval for your research activities, as detailed in your revised application.

We encourage you to continue to work closely with your supervisor, and to contact the committee should issues arise during your data collection, or should you wish to add further research activities or make changes to your project as it unfolds. We wish you all the best with your research.

Kind regards

Nathan Cooper, Chair
Division of Arts, Law, Psychology & Social Sciences Human Research Ethics

Appendix B1

Connor Davidson Resilience Scale

Questions and scoring for this scale are not available for free use. This information can be requested from http://www.connordavidson-resiliencescale.com/

Appendix B2

<u>The Resilience Scale</u>

The Resilience Scale™ (RS™)

2	March	3911

Please read the following statements. To the right of each you will find seven numbers, ranging from "1" (Strongly Disagree) on the left to "7" (Strongly Agree) on the right. Click the circle below the number which best indicates your feelings about that statement. For example, if you strongly disagree with a statement, click "1". If you are neutral, click "4", and if you strongly agree, click "7", etc.

	Strongly Disagree						Strongly Agree
1. When I make plans, I follow through with them.	1	2	3	4	5	6	7
2. I usually manage one way or another.	1	2	3	4	5	6	7
3. I am able to depend on myself more than anyone else.	1	2	3	4	5	6	7
4. Keeping interested in things is important to me.	1	2	3	4	5	6	7
5. I can be on my own if I have to.	1	2	3	4	5	6	7
6. I feel proud that I have accomplished things in life.	1	2	3	4	5	6	7
7. I usually take things in stride.	1	2	3	4	5	6	7
8. I am friends with myself.	1	2	3	4	5	6	7
9. I feel that I can handle many things at a time.	1	2	3	4	5	6	7
10. I am determined.	1	2	3	4	5	6	7
11. I seldom wonder what the point of it all is.	1	2	3	4	5	6	7
12. I take things one day at a time.	1	2	3	4	5	6	7
13. I can get through difficult times because I've experienced difficulty before.	1	2	3	4	5	6	7
14. I have self-discipline.	1	2	3	4	5	6	7
15. I keep interested in things.	1	2	3	4	5	6	7

	☐	☐	☐	☐	☐	☐	☐
16. I can usually find something to laugh about.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
17. My belief in myself gets me through hard times.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
18. In an emergency, I'm someone people can generally rely on.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
19. I can usually look at a situation in a number of ways.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
20. Sometimes I make myself do things whether I want to or not.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
21. My life has meaning.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
22. I do not dwell on things that I can't do anything about.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
23. When I'm in a difficult situation, I can usually find my way out of it.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
24. I have enough energy to do what I have to do.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
25. It's okay if there are people who don't like me.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

Appendix B3

Scale of Protective Factors

Scale of Protective Factors

Ponce-Garcia, Madewell, & Kennison, 2015

The following sentences describe how you feel about yourself. Read each statement carefully. Please circle a number next to each statement that most reflects your life. There are no right or wrong answers.

1=disagree completely, 2=disagree moderately, 3=disagree somewhat, 4= neither disagree not agree, 5=agree somewhat, 6=agree moderately, 7=agree completely

1. I am good at starting new conversations	1	2	3	4	5	6	7
2. My friends and/or family, keep me up to speed on important events	1	2	3	4	5	6	7
3. I am good at making new friendships	1	2	3	4	5	6	7
4. My friends and/or family, are supportive of one another	1	2	3	4	5	6	7
5. When working on something, I make a list of things to do in order of importance	1	2	3	4	5	6	7
6. I am confident in my ability to solve problems	1	2	3	4	5	6	7
7. My friends and/or family, spend free time together	1	2	3	4	5	6	7
8. When working on something, I set priorities before I start	1	2	3	4	5	6	7
9. I am confident in my ability to succeed	1	2	3	4	5	6	7
10. I am confident in my ability to think out and plan	1	2	3	4	5	6	7
11. I am confident in my ability to think on my feet	1	2	3	4	5	6	7
12. I am good at working with others as part of a team	1	2	3	4	5	6	7
13. I am good at socializing with new people	1	2	3	4	5	6	7
14. I am confident in my ability to achieve goals	1	2	3	4	5	6	7
15. When working on something, I organize my time well	1	2	3	4	5	6	7
16. I am good at interacting with others	1	2	3	4	5	6	7
17. I am good at being with other people	1	2	3	4	5	6	7
18. When working on something, I plan things out	1	2	3	4	5	6	7
19. I am confident in my ability to make good decisions/choices	1	2	3	4	5	6	7
20. My friends and/or family see things the same way as I do	1	2	3	4	5	6	7
21. My friends and/or family are seen as united	1	2	3	4	5	6	7
22. When working on something, I do better if I set a goal	1	2	3	4	5	6	7
23. My friends and/or family are optimistic	1	2	3	4	5	6	7
24. When working on something, I can see the order in which to do things	1	2	3	4	5	6	7

I.D. ____

Ethnicity____

Age____

Sex____ Grade_______________________________________	
FOR ADMINISTRATIVE USE ONLY	
A. Total for questions 1, 3, 12, 13, 16, and 17	
B. Total for questions 2, 4, 7, 20, 21, and 23	
C. Total for questions 6, 9, 10, 11, 14, and 19	
D. Total for questions 5, 8, 15, 18, 22, and 24	
E. Total for all questions	
F. School ID (please indicate the school in which the child is enrolled)	

Please calculate the Mean scores for each of the subscales as follows:
The total for row A/6 =______________Social Skills

The total for row B/6 =______________Social Support

The total for row C/6 =______________Goal Efficacy

The total for row D/6 =______________Planning Prioritizing Behavior

The total score is the SUM of the Mean score for each subscale.

Total Score ____________________

Mean scores below 5 on any subscale indicate a deficit in that protective factor.
Please circle the type of administration which best applies:

Self-report   Counselor Assisted

For additional materials please contact the SPF Lab at eponcega@cameron.edu or amadewell@se.edu.

Reference:

Ponce-Garcia, E., Madewell, A. N., & Kennison, S. (2015). The Development of the Scale of Protective Factors (SPF): Resilience in a Violent Trauma Sample. *Journal of Violence and Victims*, 10, 1-32.

Appendix B4

Brief Resilience Scale

Brief Resilience Scale (BRS)

Please respond to each item by marking one box per row		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
BRS 1	I tend to bounce back quickly after hard times	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
BRS 2	I have a hard time making it through stressful events.	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
BRS 3	It does not take me long to recover from a stressful event.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
BRS 4	It is hard for me to snap back when something bad happens.	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1
BRS 5	I usually come through difficult times with little trouble.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
BRS 6	I tend to take a long time to get over set-backs in my life.	☐ 5	☐ 4	☐ 3	☐ 2	☐ 1

Scoring: Add the responses varying from 1-5 for all six items giving a range from 6-30. Divide the total sum by the total number of questions answered.

My score: ______ item average / 6

Smith, B. W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The brief resilience scale: assessing the ability to bounce back. *International journal of behavioral medicine*, *15*(3), 194-200.

Appendix B5

<u>Ego Resiliency Scale</u>

The Ego Resilience Scale				
Please read the below statements about yourself and indicate how well it applies to you by circling the answer to the right from 1 (*does not apply at all*) to 4 (*applies very strongly*). Let me know how true the following characteristics are as they apply to you generally:				
Characteristics About You	Does not Apply at All			Applies Very Strongly
1. I am generous with my friends.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
2. I quickly get over and recover from being startled.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
3. I enjoy dealing with new and unusual situations.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
4. I usually succeed in making a favorable impression on people.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
5. I enjoy trying new foods I have never tasted before.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
6. I am regarded as a very energetic person.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
7. I like to take different paths to familiar places.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
8. I am more curious than most people.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
9. Most of the people I meet are likable.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
10. I usually think carefully about something before acting.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
11. I like to do new and different things.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
12. My daily life is full of things that keep me interested.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
13. I would be willing to describe myself as a pretty "strong" personality.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly
14. I get over my anger at someone reasonably quickly.	1 Does not apply at all	2 Applies slightly	3 Applies somewhat	4 Applies very strongly

Source: (J. Block & Kremen, 1996)

Scoring Interpretation

Score	47-56	35-46	23-34	11-22	0-10
Level of Resilience	**Very High** Resiliency Trait	**High** Resiliency Trait	**Undetermined** Trait	**Low** Resiliency Trait	**Very Low** Resiliency Trait

Appendix C1

EduG analyses output for total CD-RISC, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	1522.85745	93	16.37481	0.20834	0.20899	0.20899	21.6	0.03169
I	252.32255	24	10.51344	0.00633	0.00633	0.00626	0.6	0.01199
O	15.67745	2	7.83872	-0.00029	0.00061	0.00061	0.1	0.00247
PI	1752.55745	2232	0.78520	0.06082	0.06082	0.06082	6.3	0.00891
PO	105.44255	186	0.56690	-0.00143	0.00498	0.00498	0.5	0.00239
IO	410.21617	48	8.54617	0.08450	0.08450	0.08450	8.7	0.01818
PIO	2690.66383	4464	0.60275	0.60275	0.60275	0.60275	62.2	0.01276
Total	6749.73745	7049					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.20899		.....		.....	
	.....	I	.....		0.00019	1.7
	.....	O	.....		0.00020	1.9
	.....	PI	0.00180	19.1	0.00180	16.9
	.....	PO	0.00166	17.6	0.00166	15.6
	.....	IO	.....		0.00084	7.8
	.....	PIO	0.00596	63.3	0.00596	56.0
Sum of variances	0.20899		0.00943	100%	0.01065	100%
Standard deviation	0.45715		Relative SE: 0.09709		Absolute SE: 0.10321	
Coef_G relative	0.96					
Coef_G absolute	0.95					

Grand mean for levels used: 3.60298
Variance error of the mean for levels used: 0.00355
Standard error of the grand mean: 0.05958

Appendix C2

EduG analyses output for total TRS, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components: Random	Mixed	Corrected	%	SE
P	1226.65660	93	13.18986	0.16537	0.16655	0.16655	18.2	0.02553
I	217.87745	24	9.07823	0.00102	0.00102	0.00101	0.1	0.01076
O	13.60369	2	6.80184	-0.00066	0.00023	0.00023	0.0	0.00217
PI	1967.82922	2232	0.88164	0.11080	0.11080	0.11080	12.1	0.00961
PO	84.58298	186	0.45475	-0.00378	0.00206	0.00206	0.2	0.00193
IO	406.02043	48	8.45876	0.08414	0.08414	0.08414	9.2	0.01800
PIO	2451.79291	4464	0.54924	0.54924	0.54924	0.54924	60.1	0.01162
Total	6368.36326	7049					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differentiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.16655		.....		.....	
	.....	I	.....		0.00003	0.3
	.....	O	.....		0.00008	0.7
	.....	PI	0.00329	34.9	0.00329	31.8
	.....	PO	0.00069	7.3	0.00069	6.6
	.....	IO	.....		0.00083	8.0
	.....	PIO	0.00543	57.7	0.00543	52.5
Sum of variances	0.16655		0.00941	100%	0.01035	100%
Standard deviation	0.40810		Relative SE: 0.09700		Absolute SE: 0.10173	
Coef_G relative	0.95					
Coef_G absolute	0.94					

Grand mean for levels used: 3.65716
Variance error of the mean for levels used: 0.00281
Standard error of the grand mean: 0.05302

Appendix C3

EduG analyses output for total SPF, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	1744.31811	93	18.75611	0.25164	0.25237	0.25237	27.1	0.03780
I	236.80482	23	10.29586	0.01979	0.01979	0.01958	2.1	0.01083
O	1.54817	2	0.77408	-0.00161	-0.00116	-0.00116	0.0	0.00048
PI	1608.48685	2139	0.75198	0.06865	0.06865	0.06865	7.4	0.00861
PO	80.36850	186	0.43209	-0.00475	0.00106	0.00106	0.1	0.00192
IO	207.45183	46	4.50982	0.04217	0.04217	0.04217	4.5	0.00979
PIO	2335.96483	4278	0.54604	0.54604	0.54604	0.54604	58.7	0.01180
Total	6214.94311	6767					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.25237		.....		.....	
	.....	I	.....		0.00061	6.6
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00215	26.2	0.00215	23.2
	.....	PO	0.00035	4.3	0.00035	3.8
	.....	IO	.....		0.00044	4.8
	.....	PIO	0.00571	69.5	0.00571	61.6
Sum of variances	0.25237		0.00821	100%	0.00927	100%
Standard deviation	0.50236		Relative SE: 0.09064		Absolute SE: 0.09628	
Coef_G relative	0.97					
Coef_G absolute	0.96					

Grand mean for levels used: 3.56989
Variance error of the mean for levels used: 0.00383
Standard error of the grand mean: 0.06186

Appendix C4

EduG analyses output for total ER89 including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components: Random	Mixed	Corrected	%	SE
P	1061.06712	93	11.40932	0.25068	0.25166	0.25166	24.8	0.03945
I	86.93744	13	6.68750	-0.01100	-0.01100	-0.01088	0.0	0.01250
O	15.18136	2	7.59068	-0.00149	-0.00048	-0.00048	0.0	0.00451
PI	1019.27685	1209	0.84307	0.09193	0.09193	0.09193	9.1	0.01265
PO	112.48531	186	0.60476	0.00268	0.00871	0.00871	0.9	0.00461
IO	247.32928	26	9.51266	0.09516	0.09516	0.09516	9.4	0.02705
PIO	1371.67072	2418	0.56727	0.56727	0.56727	0.56727	55.9	0.01631
Total	3913.94807	3947					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.25166		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00565	28.0	0.00565	25.5
	.....	PO	0.00290	14.4	0.00290	13.1
	.....	IO	.....		0.00195	8.8
	.....	PIO	0.01162	57.6	0.01162	52.5
Sum of variances	0.25166		0.02017	100%	0.02212	100%
Standard deviation	0.50166		Relative SE: 0.14203		Absolute SE: 0.14873	
Coef_G relative	0.93					
Coef_G absolute	0.92					

Grand mean for levels used: 3.55750
Variance error of the mean for levels used: 0.00484
Standard error of the grand mean: 0.06958

Appendix C5

EduG analyses output for total BRS including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components: Random	Mixed	Corrected	%	SE
P	485.66962	93	5.22225	0.26482	0.26516	0.26516	32.1	0.04222
I	40.77128	5	8.15426	0.02229	0.02229	0.02205	2.7	0.01567
O	8.15248	2	4.07624	0.00431	0.00445	0.00445	0.5	0.00527
PI	270.95095	465	0.58269	0.03161	0.03161	0.03161	3.8	0.01478
PO	67.06974	186	0.36059	-0.02121	-0.01602	-0.01602	0.0	0.00725
IO	17.74113	10	1.77411	0.01368	0.01368	0.01368	1.7	0.00771
PIO	453.70331	930	0.48785	0.48785	0.48785	0.48785	59.1	0.02260
Total	1344.05851	1691					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26516		.....		.....	
	.....	I	.....		0.00348	9.6
	.....	O	.....		0.00148	4.1
	.....	PI	0.00499	16.3	0.00499	13.7
	.....	PO	(0.00000)	0.0	(0.00000)	0.0
	.....	IO	.....		0.00072	2.0
	.....	PIO	0.02565	83.7	0.02565	70.6
Sum of variances	0.26516		0.03063	100%	0.03631	100%
Standard deviation	0.51494		Relative SE: 0.17502		Absolute SE: 0.19056	
Coef_G relative	0.90					
Coef_G absolute	0.88					

Grand mean for levels used: 3.59397
Variance error of the mean for levels used: 0.00883
Standard error of the grand mean: 0.09396

Appendix C6

EduG analyses output for individual CD-RISC items 1-25, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components: Random	Mixed	Corrected	%	SE
P	121.47518	93	1.30618	0.09918	0.09918	0.09918	4.8	0.07207
I	.....	.....	.....	.....	.....	.....	.....	.....
O	178.39007	2	89.19504	0.93815	0.93815	0.93815	45.9	0.67096
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	187.60993	186	1.00866	1.00866	1.00866	1.00866	49.3	0.10403
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	487.47518	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.09918		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.31272	48.2
	.....	PI	.....		.....	
	.....	PO	0.33622	100.0	0.33622	51.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.09918		0.33622	100%	0.64894	100%
Standard deviation	0.31492		Relative SE: 0.57984		Absolute SE: 0.80557	
Coef_G relative			0.23			
Coef_G absolute			0.13			

Grand mean for levels used: 3.56028
Variance error of the mean for levels used: 0.31735

Standard error of the grand mean: 0.56334

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	103.74823	93	1.11557	0.23046	0.23046	0.23046	33.7	0.05589
I	.....	.....	.....	.....	.....	.....	.....	.....
O	6.43262	2	3.21631	0.02970	0.02970	0.02970	4.3	0.02420
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	78.90071	186	0.42420	0.42420	0.42420	0.42420	62.0	0.04375
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	189.08156	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.23046		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00990	6.5
	.....	PI	.....		.....	
	.....	PO	0.14140	100.0	0.14140	93.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.23046		0.14140	100%	0.15130	100%
Standard deviation	0.48006		Relative SE: 0.37603		Absolute SE: 0.38897	
Coef_G relative			0.62			
Coef_G absolute			0.60			

Grand mean for levels used: 3.76241
Variance error of the mean for levels used: 0.01386
Standard error of the grand mean: 0.11772

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	170.65248	93	1.83497	0.36746	0.36746	0.36746	33.1	0.09225
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.07092	2	1.53546	0.00854	0.00854	0.00854	0.8	0.01158
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	136.26241	186	0.73259	0.73259	0.73259	0.73259	66.1	0.07556
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	309.98582	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differentiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36746		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00285	1.2
	.....	PI	.....		.....	
	.....	PO	0.24420	100.0	0.24420	98.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36746		0.24420	100%	0.24704	100%
Standard deviation	0.60618		Relative SE: 0.49416		Absolute SE: 0.49704	
Coef_G relative			0.60			
Coef_G absolute			0.60			

Grand mean for levels used: 3.67376
Variance error of the mean for levels used: 0.00935
Standard error of the grand mean: 0.09672

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	96.73759	93	1.04019	0.21319	0.21319	0.21319	34.7	0.05216
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.14894	2	0.07447	-0.00347	-0.00347	-0.00347	0.0	0.00071
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	74.51773	186	0.40063	0.40063	0.40063	0.40063	65.3	0.04132
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	171.40426	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.21319		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.13354	100.0	0.13354	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.21319		0.13354	100%	0.13354	100%
Standard deviation	0.46172		Relative SE: 0.36544		Absolute SE: 0.36544	
Coef_G relative			0.61			
Coef_G absolute			0.61			

Grand mean for levels used: 3.87234
Variance error of the mean for levels used: 0.00369
Standard error of the grand mean: 0.06073

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	147.80496	93	1.58930	0.37207	0.37207	0.37207	42.7	0.07857
I	.....	.....	.....	.....	.....	.....	.....	.....
O	6.00709	2	3.00355	0.02692	0.02692	0.02692	3.1	0.02260
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	87.99291	186	0.47308	0.47308	0.47308	0.47308	54.2	0.04879
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	241.80496	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.37207		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00897	5.4
	.....	PI	.....		.....	
	.....	PO	0.15769	100.0	0.15769	94.6
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.37207		0.15769	100%	0.16667	100%
Standard deviation	0.60998		Relative SE: 0.39711		Absolute SE: 0.40825	
Coef_G relative			0.70			
Coef_G absolute			0.69			

Grand mean for levels used: 3.54965
Variance error of the mean for levels used: 0.01461
Standard error of the grand mean: 0.12087

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	99.80496	93	1.07317	0.18527	0.18527	0.18527	23.7	0.05487
I	.....	.....	.....	.....	.....	.....	.....	.....
O	15.77305	2	7.88652	0.07840	0.07840	0.07840	10.0	0.05933
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	96.22695	186	0.51735	0.51735	0.51735	0.51735	66.2	0.05336
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	211.80496	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.18527		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02613	13.2
	.....	PI	.....		.....	
	.....	PO	0.17245	100.0	0.17245	86.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.18527		0.17245	100%	0.19858	100%
Standard deviation	0.43043		Relative SE: 0.41527		Absolute SE: 0.44562	
Coef_G relative			0.52			
Coef_G absolute			0.48			

Grand mean for levels used: 3.45035
Variance error of the mean for levels used: 0.02994
Standard error of the grand mean: 0.17302

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	125.95745	93	1.35438	0.23835	0.23835	0.23835	26.8	0.06909
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.75177	2	1.87589	0.01315	0.01315	0.01315	1.5	0.01413
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	118.91489	186	0.63933	0.63933	0.63933	0.63933	71.8	0.06594
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	248.62411	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.23835		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00438	2.0
	.....	PI	.....		.....	
	.....	PO	0.21311	100.0	0.21311	98.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.23835		0.21311	100%	0.21749	100%
Standard deviation	0.48821		Relative SE: 0.46164		Absolute SE: 0.46636	
Coef_G relative			0.53			
Coef_G absolute			0.52			

Grand mean for levels used: 3.41844
Variance error of the mean for levels used: 0.00919
Standard error of the grand mean: 0.09585

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	141.90071	93	1.52581	0.36738	0.36738	0.36738	45.1	0.07522
I	.....	.....	.....	.....	.....	.....	.....	.....
O	5.19858	2	2.59929	0.02314	0.02314	0.02314	2.8	0.01956
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	78.80142	186	0.42366	0.42366	0.42366	0.42366	52.0	0.04370
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	225.90071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36738		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00771	5.2
	.....	PI	.....		.....	
	.....	PO	0.14122	100.0	0.14122	94.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36738		0.14122	100%	0.14894	100%
Standard deviation	0.60612		Relative SE: 0.37579		Absolute SE: 0.38592	
Coef_G relative			0.72			
Coef_G absolute			0.71			

Grand mean for levels used: 3.54610
Variance error of the mean for levels used: 0.01313
Standard error of the grand mean: 0.11457

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	103.24823	93	1.11020	0.24674	0.24674	0.24674	38.7	0.05518
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.51773	2	2.25887	0.02009	0.02009	0.02009	3.2	0.01700
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	68.81560	186	0.36998	0.36998	0.36998	0.36998	58.1	0.03816
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	176.58156	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.24674		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00670	5.2
	.....	PI	.....		.....	
	.....	PO	0.12333	100.0	0.12333	94.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.24674		0.12333	100%	0.13002	100%
Standard deviation	0.49673		Relative SE: 0.35118		Absolute SE: 0.36059	
Coef_G relative			0.67			
Coef_G absolute			0.65			

Grand mean for levels used: 3.92908
Variance error of the mean for levels used: 0.01064
Standard error of the grand mean: 0.10313

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	79.75887	93	0.85762	0.08034	0.08034	0.08034	11.4	0.04658
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.64539	2	1.32270	0.00751	0.00751	0.00751	1.1	0.00997
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	114.68794	186	0.61660	0.61660	0.61660	0.61660	87.5	0.06360
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	197.09220	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.08034		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00250	1.2
	.....	PI	.....		.....	
	.....	PO	0.20553	100.0	0.20553	98.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.08034		0.20553	100%	0.20804	100%
Standard deviation	0.28344		Relative SE: 0.45336		Absolute SE: 0.45611	
Coef_G relative			0.28			
Coef_G absolute			0.28			

Grand mean for levels used: 4.05674
Variance error of the mean for levels used: 0.00555
Standard error of the grand mean: 0.07447

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	181.45035	93	1.95108	0.47560	0.47560	0.47560	47.0	0.09607
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.14894	2	1.57447	0.01117	0.01117	0.01117	1.1	0.01186
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	97.51773	186	0.52429	0.52429	0.52429	0.52429	51.9	0.05408
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	282.11702	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.47560		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00372	2.1
	.....	PI	.....		.....	
	.....	PO	0.17476	100.0	0.17476	97.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.47560		0.17476	100%	0.17849	100%
Standard deviation	0.68964		Relative SE: 0.41805		Absolute SE: 0.42248	
Coef_G relative			0.73			
Coef_G absolute			0.73			

Grand mean for levels used: 3.75532
Variance error of the mean for levels used: 0.01064
Standard error of the grand mean: 0.10316

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	119.90071	93	1.28925	0.17460	0.17460	0.17460	13.1	0.06768
I	.....	.....	.....	.....	.....	.....	.....	.....
O	75.62411	2	37.81206	0.39411	0.39411	0.39411	29.5	0.28444
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	142.37589	186	0.76546	0.76546	0.76546	0.76546	57.4	0.07895
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	337.90071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.17460		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.13137	34.0
	.....	PI	.....		.....	
	.....	PO	0.25515	100.0	0.25515	66.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.17460		0.25515	100%	0.38652	100%
Standard deviation	0.41785		Relative SE: 0.50513		Absolute SE: 0.62171	
Coef_G relative			0.41			
Coef_G absolute			0.31			

Grand mean for levels used: 3.45390
Variance error of the mean for levels used: 0.13594
Standard error of the grand mean: 0.36870

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	87.23404	93	0.93800	0.01987	0.01987	0.01987	2.0	0.05450
I	.....	.....	.....	.....	.....	.....	.....	.....
O	17.28369	2	8.64184	0.08259	0.08259	0.08259	8.4	0.06501
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	163.38298	186	0.87840	0.87840	0.87840	0.87840	89.6	0.09060
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	267.90071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.01987		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02753	8.6
	.....	PI	.....		.....	
	.....	PO	0.29280	100.0	0.29280	91.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.01987		0.29280	100%	0.32033	100%
Standard deviation	0.14095		Relative SE: 0.54111		Absolute SE: 0.56598	
Coef_G relative			0.06			
Coef_G absolute			0.06			

Grand mean for levels used: 3.54610
Variance error of the mean for levels used: 0.03086
Standard error of the grand mean: 0.17566

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	162.53901	93	1.74773	0.44029	0.44029	0.44029	50.2	0.08579
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.60284	2	1.30142	0.00930	0.00930	0.00930	1.1	0.00980
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	79.39716	186	0.42687	0.42687	0.42687	0.42687	48.7	0.04403
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	244.53901	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.44029		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00310	2.1
	.....	PI	.....		.....	
	.....	PO	0.14229	100.0	0.14229	97.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.44029		0.14229	100%	0.14539	100%
Standard deviation	0.66354		Relative SE: 0.37721		Absolute SE: 0.38130	
Coef_G relative			0.76			
Coef_G absolute			0.75			

Grand mean for levels used: 3.68794
Variance error of the mean for levels used: 0.00930
Standard error of the grand mean: 0.09643

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	94.92553	93	1.02070	0.18524	0.18524	0.18524	27.8	0.05189
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.17730	2	2.08865	0.01727	0.01727	0.01727	2.6	0.01572
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	86.48936	186	0.46500	0.46500	0.46500	0.46500	69.7	0.04796
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	185.59220	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.18524		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00576	3.6
	.....	PI	.....		.....	
	.....	PO	0.15500	100.0	0.15500	96.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.18524		0.15500	100%	0.16076	100%
Standard deviation	0.43039		Relative SE: 0.39370		Absolute SE: 0.40094	
Coef_G relative			0.54			
Coef_G absolute			0.54			

Grand mean for levels used: 3.89007
Variance error of the mean for levels used: 0.00938
Standard error of the grand mean: 0.09684

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	173.23404	93	1.86273	0.45520	0.45520	0.45520	42.3	0.09170
I	.....	.....	.....	.....	.....	.....	.....	.....
O	24.19858	2	12.09929	0.12343	0.12343	0.12343	11.5	0.09102
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	92.46809	186	0.49714	0.49714	0.49714	0.49714	46.2	0.05128
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	289.90071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.45520		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.04114	19.9
	.....	PI	.....		.....	
	.....	PO	0.16571	100.0	0.16571	80.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.45520		0.16571	100%	0.20686	100%
Standard deviation	0.67468		Relative SE: 0.40708		Absolute SE: 0.45481	
Coef_G relative			0.73			
Coef_G absolute			0.69			

Grand mean for levels used: 3.45390
Variance error of the mean for levels used: 0.04775
Standard error of the grand mean: 0.21851

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	120.32979	93	1.29387	0.16110	0.16110	0.16110	14.8	0.06850
I	.....	.....	.....	.....	.....	.....	.....	.....
O	23.23404	2	11.61702	0.11496	0.11496	0.11496	10.6	0.08739
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	150.76596	186	0.81057	0.81057	0.81057	0.81057	74.6	0.08360
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	294.32979	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.16110		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.03832	12.4
	.....	PI	.....		.....	
	.....	PO	0.27019	100.0	0.27019	87.6
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.16110		0.27019	100%	0.30851	100%
Standard deviation	0.40137		Relative SE: 0.51980		Absolute SE: 0.55544	
Coef_G relative			0.37			
Coef_G absolute			0.34			

Grand mean for levels used: 3.67021
Variance error of the mean for levels used: 0.04291
Standard error of the grand mean: 0.20714

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	127.60638	93	1.37211	0.26588	0.26588	0.26588	31.5	0.06924
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.81560	2	0.90780	0.00355	0.00355	0.00355	0.4	0.00686
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	106.85106	186	0.57447	0.57447	0.57447	0.57447	68.1	0.05925
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	236.27305	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26588		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00118	0.6
	.....	PI	.....		.....	
	.....	PO	0.19149	100.0	0.19149	99.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26588		0.19149	100%	0.19267	100%
Standard deviation	0.51564		Relative SE: 0.43759		Absolute SE: 0.43894	
Coef_G relative			0.58			
Coef_G absolute			0.58			

Grand mean for levels used: 3.47163
Variance error of the mean for levels used: 0.00605
Standard error of the grand mean: 0.07777

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	180.97872	93	1.94601	0.36639	0.36639	0.36639	27.7	0.09852
I	.....	.....	.....	.....	.....	.....	.....	.....
O	22.48936	2	11.24468	0.11062	0.11062	0.11062	8.4	0.08459
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	157.51064	186	0.84683	0.84683	0.84683	0.84683	64.0	0.08734
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	360.97872	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36639		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.03687	11.6
	.....	PI	.....		.....	
	.....	PO	0.28228	100.0	0.28228	88.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36639		0.28228	100%	0.31915	100%
Standard deviation	0.60530		Relative SE: 0.53130		Absolute SE: 0.56493	
Coef_G relative			0.56			
Coef_G absolute			0.53			

Grand mean for levels used: 3.29787
Variance error of the mean for levels used: 0.04377
Standard error of the grand mean: 0.20922

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	86.78369	93	0.93316	0.07870	0.07870	0.07870	10.1	0.05110
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.34752	2	0.17376	-0.00557	-0.00557	-0.00557	0.0	0.00151
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	129.65248	186	0.69706	0.69706	0.69706	0.69706	89.9	0.07190
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	216.78369	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.07870		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.23235	100.0	0.23235	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.07870		0.23235	100%	0.23235	100%
Standard deviation	0.28054		Relative SE: 0.48203		Absolute SE: 0.48203	
Coef_G relative			0.25			
Coef_G absolute			0.25			

Grand mean for levels used: 3.57801
Variance error of the mean for levels used: 0.00331
Standard error of the grand mean: 0.05752

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	125.16667	93	1.34588	0.25395	0.25395	0.25395	30.0	0.06812
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.70213	2	1.35106	0.00816	0.00816	0.00816	1.0	0.01018
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	108.63121	186	0.58404	0.58404	0.58404	0.58404	69.0	0.06024
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	236.50000	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.25395		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00272	1.4
	.....	PI	.....		.....	
	.....	PO	0.19468	100.0	0.19468	98.6
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.25395		0.19468	100%	0.19740	100%
Standard deviation	0.50393		Relative SE: 0.44123		Absolute SE: 0.44430	
Coef_G relative			0.57			
Coef_G absolute			0.56			

Grand mean for levels used: 3.50000
Variance error of the mean for levels used: 0.00749
Standard error of the grand mean: 0.08656

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components				
				Random	Mixed	Corrected	%	SE
P	154.82624	93	1.66480	0.38794	0.38794	0.38794	42.7	0.08234
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.81560	2	2.40780	0.02029	0.02029	0.02029	2.2	0.01812
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	93.18440	186	0.50099	0.50099	0.50099	0.50099	55.1	0.05167
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	252.82624	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.38794		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00676	3.9
	.....	PI	.....		.....	
	.....	PO	0.16700	100.0	0.16700	96.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.38794		0.16700	100%	0.17376	100%
Standard deviation	0.62284		Relative SE: 0.40865		Absolute SE: 0.41684	
Coef_G relative			0.70			
Coef_G absolute			0.69			

Grand mean for levels used: 3.35816
Variance error of the mean for levels used: 0.01267
Standard error of the grand mean: 0.11254

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components				
				Random	Mixed	Corrected	%	SE
P	157.64539	93	1.69511	0.43716	0.43716	0.43716	53.3	0.08304
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.64539	2	0.32270	-0.00065	-0.00065	-0.00065	0.0	0.00246
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	71.35461	186	0.38363	0.38363	0.38363	0.38363	46.7	0.03957
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	229.64539	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.43716		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.12788	100.0	0.12788	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.43716		0.12788	100%	0.12788	100%
Standard deviation	0.66118		Relative SE: 0.35760		Absolute SE: 0.35760	
Coef_G relative			0.77			
Coef_G absolute			0.77			

Grand mean for levels used: 3.36879
Variance error of the mean for levels used: 0.00601
Standard error of the grand mean: 0.07753

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	152.21277	93	1.63670	0.29463	0.29463	0.29463	28.1	0.08328
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.97872	2	0.98936	0.00252	0.00252	0.00252	0.2	0.00749
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	140.02128	186	0.75280	0.75280	0.75280	0.75280	71.7	0.07765
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	294.21277	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.29463		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00084	0.3
	.....	PI	.....		.....	
	.....	PO	0.25093	100.0	0.25093	99.7
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.29463		0.25093	100%	0.25177	100%
Standard deviation	0.54280		Relative SE: 0.50093		Absolute SE: 0.50177	
Coef_G relative			0.54			
Coef_G absolute			0.54			

Grand mean for levels used: 3.53191
Variance error of the mean for levels used: 0.00664
Standard error of the grand mean: 0.08150

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	159.49291	93	1.71498	0.33192	0.33192	0.33192	29.6	0.08655
I	.....	.....	.....	.....	.....	.....	.....	.....
O	14.89362	2	7.44681	0.07157	0.07157	0.07157	6.4	0.05602
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	133.77305	186	0.71921	0.71921	0.71921	0.71921	64.1	0.07418
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	308.15957	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.33192		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02386	9.1
	.....	PI	.....		.....	
	.....	PO	0.23974	100.0	0.23974	90.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.33192		0.23974	100%	0.26359	100%
Standard deviation	0.57613		Relative SE: 0.48963		Absolute SE: 0.51341	
Coef_G relative			0.58			
Coef_G absolute			0.56			

Grand mean for levels used: 3.69149
Variance error of the mean for levels used: 0.02994
Standard error of the grand mean: 0.17303

Appendix C7

EduG analyses output for individual TRS items 1-25, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	100.64184	93	1.08217	0.12011	0.12011	0.12011	14.1	0.05792
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.07092	2	1.53546	0.00866	0.00866	0.00866	1.0	0.01158
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	134.26241	186	0.72184	0.72184	0.72184	0.72184	84.9	0.07445
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	237.97518	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.12011		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00289	1.2
	.....	PI	.....		.....	
	.....	PO	0.24061	100.0	0.24061	98.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.12011		0.24061	100%	0.24350	100%
Standard deviation	0.34657		Relative SE: 0.49052		Absolute SE: 0.49346	
Coef_G relative	0.33					
Coef_G absolute	0.33					

Grand mean for levels used: 3.72695
Variance error of the mean for levels used: 0.00672
Standard error of the grand mean: 0.08199

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	132.80851	93	1.42805	0.37394	0.37394	0.37394	53.7	0.06987
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.70922	2	1.85461	0.01647	0.01647	0.01647	2.4	0.01396
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	56.95745	186	0.30622	0.30622	0.30622	0.30622	44.0	0.03158
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	193.47518	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.37394		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00549	5.1
	.....	PI	.....		.....	
	.....	PO	0.10207	100.0	0.10207	94.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.37394		0.10207	100%	0.10757	100%
Standard deviation	0.61151		Relative SE: 0.31949		Absolute SE: 0.32797	
Coef_G relative			0.79			
Coef_G absolute			0.78			

Grand mean for levels used: 3.77305
Variance error of the mean for levels used: 0.01055
Standard error of the grand mean: 0.10274

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components Random	Mixed	Corrected	%	SE
P	177.66312	93	1.91036	0.46012	0.46012	0.46012	45.7	0.09417
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.08511	2	2.04255	0.01609	0.01609	0.01609	1.6	0.01538
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	98.58156	186	0.53001	0.53001	0.53001	0.53001	52.7	0.05467
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	280.32979	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.46012		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00536	2.9
	.....	PI	.....		.....	
	.....	PO	0.17667	100.0	0.17667	97.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.46012		0.17667	100%	0.18203	100%
Standard deviation	0.67832		Relative SE: 0.42032		Absolute SE: 0.42665	
Coef_G relative			0.72			
Coef_G absolute			0.72			

Grand mean for levels used: 3.67021
Variance error of the mean for levels used: 0.01214
Standard error of the grand mean: 0.11017

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	213.47872	93	2.29547	0.58934	0.58934	0.58934	52.4	0.11249
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.56028	2	1.28014	0.00801	0.00801	0.00801	0.7	0.00965
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	98.10638	186	0.52745	0.52745	0.52745	0.52745	46.9	0.05440
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	314.14539	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.58934		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00267	1.5
	.....	PI	.....		.....	
	.....	PO	0.17582	100.0	0.17582	98.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.58934		0.17582	100%	0.17849	100%
Standard deviation	0.76768		Relative SE: 0.41931		Absolute SE: 0.42248	
Coef_G relative			0.77			
Coef_G absolute			0.77			

Grand mean for levels used: 3.53546
Variance error of the mean for levels used: 0.01081
Standard error of the grand mean: 0.10397

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	111.21986	93	1.19591	0.24113	0.24113	0.24113	29.6	0.06008
I	.....	.....	.....	.....	.....	.....	.....	.....
O	20.11348	2	10.05674	0.10196	0.10196	0.10196	12.5	0.07565
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	87.88652	186	0.47251	0.47251	0.47251	0.47251	57.9	0.04874
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	219.21986	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.24113		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.03399	17.7
	.....	PI	.....		.....	
	.....	PO	0.15750	100.0	0.15750	82.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.24113		0.15750	100%	0.19149	100%
Standard deviation	0.49105		Relative SE: 0.39687		Absolute SE: 0.43759	
Coef_G relative			0.60			
Coef_G absolute			0.56			

Grand mean for levels used: 3.56738
Variance error of the mean for levels used: 0.03823
Standard error of the grand mean: 0.19552

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	155.60284	93	1.67315	0.38279	0.38279	0.38279	42.0	0.08291
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.72340	2	0.86170	0.00358	0.00358	0.00358	0.4	0.00651
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	97.60993	186	0.52478	0.52478	0.52478	0.52478	57.6	0.05413
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	254.93617	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.38279		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00119	0.7
	.....	PI	.....		.....	
	.....	PO	0.17493	100.0	0.17493	99.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.38279		0.17493	100%	0.17612	100%
Standard deviation	0.61870		Relative SE: 0.41824		Absolute SE: 0.41967	
Coef_G relative			0.69			
Coef_G absolute			0.68			

Grand mean for levels used: 3.57447
Variance error of the mean for levels used: 0.00713
Standard error of the grand mean: 0.08443

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components				
				Random	Mixed	Corrected	%	SE
P	77.94326	93	0.83810	0.07416	0.07416	0.07416	9.3	0.04573
I	.....	.....	.....	.....	.....	.....	.....	.....
O	21.49645	2	10.74823	0.10779	0.10779	0.10779	13.5	0.08086
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	114.50355	186	0.61561	0.61561	0.61561	0.61561	77.2	0.06350
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	213.94326	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.07416		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.03593	14.9
	.....	PI	.....		.....	
	.....	PO	0.20520	100.0	0.20520	85.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.07416		0.20520	100%	0.24113	100%
Standard deviation	0.27233		Relative SE: 0.45299		Absolute SE: 0.49105	
Coef_G relative			0.27			
Coef_G absolute			0.24			

Grand mean for levels used: 4.01418
Variance error of the mean for levels used: 0.03890
Standard error of the grand mean: 0.19724

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	146.55319	93	1.57584	0.26504	0.26504	0.26504	15.8	0.08080
I	.....	.....	.....	.....	.....	.....	.....	.....
O	119.45390	2	59.72695	0.62709	0.62709	0.62709	37.5	0.44929
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	145.21277	186	0.78071	0.78071	0.78071	0.78071	46.7	0.08052
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	411.21986	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26504		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.20903	44.5
	.....	PI	.....		.....	
	.....	PO	0.26024	100.0	0.26024	55.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26504		0.26024	100%	0.46927	100%
Standard deviation	0.51482		Relative SE: 0.51014		Absolute SE: 0.68503	
Coef_G relative			0.50			
Coef_G absolute			0.36			

Grand mean for levels used: 3.43262
Variance error of the mean for levels used: 0.21462
Standard error of the grand mean: 0.46327

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	133.20567	93	1.43232	0.36388	0.36388	0.36388	51.1	0.07026
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.96454	2	0.98227	0.00683	0.00683	0.00683	1.0	0.00740
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	63.36879	186	0.34069	0.34069	0.34069	0.34069	47.9	0.03514
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	198.53901	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36388		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00228	2.0
	.....	PI	.....		.....	
	.....	PO	0.11356	100.0	0.11356	98.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36388		0.11356	100%	0.11584	100%
Standard deviation	0.60322		Relative SE: 0.33699		Absolute SE: 0.34035	
Coef_G relative			0.76			
Coef_G absolute			0.76			

Grand mean for levels used: 3.68794
Variance error of the mean for levels used: 0.00735
Standard error of the grand mean: 0.08576

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	122.01773	93	1.31202	0.22176	0.22176	0.22176	24.3	0.06724
I	.....	.....	.....	.....	.....	.....	.....	.....
O	9.70922	2	4.85461	0.04476	0.04476	0.04476	4.9	0.03653
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	120.29078	186	0.64672	0.64672	0.64672	0.64672	70.8	0.06670
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	252.01773	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.22176		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01492	6.5
	.....	PI	.....		.....	
	.....	PO	0.21557	100.0	0.21557	93.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.22176		0.21557	100%	0.23050	100%
Standard deviation	0.47092		Relative SE: 0.46430		Absolute SE: 0.48010	
Coef_G relative			0.51			
Coef_G absolute			0.49			

Grand mean for levels used: 3.76950
Variance error of the mean for levels used: 0.01957
Standard error of the grand mean: 0.13991

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	128.32979	93	1.37989	0.29940	0.29940	0.29940	35.9	0.06876
I	.....	.....	.....	.....	.....	.....	.....	.....
O	11.07092	2	5.53546	0.05376	0.05376	0.05376	6.4	0.04164
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	89.59574	186	0.48170	0.48170	0.48170	0.48170	57.7	0.04968
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	228.99645	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.29940		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01792	10.0
	.....	PI	.....		.....	
	.....	PO	0.16057	100.0	0.16057	90.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.29940		0.16057	100%	0.17849	100%
Standard deviation	0.54717		Relative SE: 0.40071		Absolute SE: 0.42248	
Coef_G relative			0.65			
Coef_G absolute			0.63			

Grand mean for levels used: 3.66312
Variance error of the mean for levels used: 0.02281
Standard error of the grand mean: 0.15104

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	114.62411	93	1.23252	0.27343	0.27343	0.27343	36.4	0.06127
I	.....	.....	.....	.....	.....	.....	.....	.....
O	13.32624	2	6.66312	0.06650	0.06650	0.06650	8.8	0.05012
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	76.67376	186	0.41222	0.41222	0.41222	0.41222	54.8	0.04252
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	204.62411	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.27343		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02217	13.9
	.....	PI	.....		.....	
	.....	PO	0.13741	100.0	0.13741	86.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.27343		0.13741	100%	0.15957	100%
Standard deviation	0.52291		Relative SE: 0.37069		Absolute SE: 0.39947	
Coef_G relative			0.67			
Coef_G absolute			0.63			

Grand mean for levels used: 3.58156
Variance error of the mean for levels used: 0.02654
Standard error of the grand mean: 0.16290

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	108.41489	93	1.16575	0.19584	0.19584	0.19584	25.0	0.05978
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.11348	2	1.55674	0.01041	0.01041	0.01041	1.3	0.01173
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	107.55319	186	0.57824	0.57824	0.57824	0.57824	73.7	0.05964
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	219.08156	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.19584		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00347	1.8
	.....	PI	.....		.....	
	.....	PO	0.19275	100.0	0.19275	98.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.19584		0.19275	100%	0.19622	100%
Standard deviation	0.44253		Relative SE: 0.43903		Absolute SE: 0.44296	
Coef_G relative			0.50			
Coef_G absolute			0.50			

Grand mean for levels used: 3.42908
Variance error of the mean for levels used: 0.00760
Standard error of the grand mean: 0.08720

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	156.99291	93	1.68810	0.42534	0.42534	0.42534	50.8	0.08286
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.68794	2	0.34397	-0.00072	-0.00072	-0.00072	0.0	0.00263
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	76.64539	186	0.41207	0.41207	0.41207	0.41207	49.2	0.04250
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	234.32624	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.42534		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.13736	100.0	0.13736	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.42534		0.13736	100%	0.13736	100%
Standard deviation	0.65218		Relative SE: 0.37062		Absolute SE: 0.37062	
Coef_G relative			0.76			
Coef_G absolute			0.76			

Grand mean for levels used: 3.52482
Variance error of the mean for levels used: 0.00599
Standard error of the grand mean: 0.07737

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	123.15248	93	1.32422	0.31892	0.31892	0.31892	45.0	0.06528
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.98582	2	2.49291	0.02261	0.02261	0.02261	3.2	0.01876
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	68.34752	186	0.36746	0.36746	0.36746	0.36746	51.8	0.03790
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	196.48582	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.31892		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00754	5.8
	.....	PI	.....		.....	
	.....	PO	0.12249	100.0	0.12249	94.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.31892		0.12249	100%	0.13002	100%
Standard deviation	0.56473		Relative SE: 0.34998		Absolute SE: 0.36059	
Coef_G relative			0.72			
Coef_G absolute			0.71			

Grand mean for levels used: 3.82624
Variance error of the mean for levels used: 0.01223
Standard error of the grand mean: 0.11060

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	74.82624	93	0.80458	0.14280	0.14280	0.14280	27.5	0.04101
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.02837	2	0.01418	-0.00385	-0.00385	-0.00385	0.0	0.00043
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	69.97163	186	0.37619	0.37619	0.37619	0.37619	72.5	0.03880
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	144.82624	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.14280		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.12540	100.0	0.12540	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.14280		0.12540	100%	0.12540	100%
Standard deviation	0.37789		Relative SE: 0.35411		Absolute SE: 0.35411	
Coef_G relative			0.53			
Coef_G absolute			0.53			

Grand mean for levels used: 4.02482
Variance error of the mean for levels used: 0.00285
Standard error of the grand mean: 0.05341

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	100.18440	93	1.07725	0.13902	0.13902	0.13902	16.1	0.05683
I	.....	.....	.....	.....	.....	.....	.....	.....
O	13.87234	2	6.93617	0.06677	0.06677	0.06677	7.7	0.05218
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	122.79433	186	0.66018	0.66018	0.66018	0.66018	76.2	0.06809
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	236.85106	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.13902		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02226	9.2
	.....	PI	.....		.....	
	.....	PO	0.22006	100.0	0.22006	90.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.13902		0.22006	100%	0.24232	100%
Standard deviation	0.37286		Relative SE: 0.46911		Absolute SE: 0.49226	
Coef_G relative			0.39			
Coef_G absolute			0.36			

Grand mean for levels used: 3.93617
Variance error of the mean for levels used: 0.02608
Standard error of the grand mean: 0.16148

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	160.20213	93	1.72260	0.44178	0.44178	0.44178	49.5	0.08443
I	.....	.....	.....	.....	.....	.....	.....	.....
O	10.77305	2	5.38652	0.05308	0.05308	0.05308	5.9	0.04052
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	73.89362	186	0.39728	0.39728	0.39728	0.39728	44.5	0.04098
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	244.86879	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.44178		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01769	11.8
	.....	PI	.....		.....	
	.....	PO	0.13243	100.0	0.13243	88.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.44178		0.13243	100%	0.15012	100%
Standard deviation	0.66466		Relative SE: 0.36390		Absolute SE: 0.38745	
Coef_G relative			0.77			
Coef_G absolute			0.75			

Grand mean for levels used: 3.71986
Variance error of the mean for levels used: 0.02380
Standard error of the grand mean: 0.15428

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	126.32979	93	1.35838	0.21002	0.21002	0.21002	17.3	0.07031
I	.....	.....	.....	.....	.....	.....	.....	.....
O	53.19858	2	26.59929	0.27522	0.27522	0.27522	22.7	0.20009
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	135.46809	186	0.72832	0.72832	0.72832	0.72832	60.0	0.07512
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	314.99645	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.21002		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.09174	27.4
	.....	PI	.....		.....	
	.....	PO	0.24277	100.0	0.24277	72.6
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.21002		0.24277	100%	0.33452	100%
Standard deviation	0.45828		Relative SE: 0.49272		Absolute SE: 0.57837	
Coef_G relative			0.46			
Coef_G absolute			0.39			

Grand mean for levels used: 3.33688
Variance error of the mean for levels used: 0.09656
Standard error of the grand mean: 0.31074

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	123.87234	93	1.33196	0.26863	0.26863	0.26863	33.0	0.06691
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.81560	2	2.40780	0.02002	0.02002	0.02002	2.5	0.01812
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	97.85106	186	0.52608	0.52608	0.52608	0.52608	64.6	0.05426
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	226.53901	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26863		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00667	3.7
	.....	PI	.....		.....	
	.....	PO	0.17536	100.0	0.17536	96.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26863		0.17536	100%	0.18203	100%
Standard deviation	0.51829		Relative SE: 0.41876		Absolute SE: 0.42665	
Coef_G relative			0.61			
Coef_G absolute			0.60			

Grand mean for levels used: 3.64539
Variance error of the mean for levels used: 0.01140
Standard error of the grand mean: 0.10675

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	111.13475	93	1.19500	0.23347	0.23347	0.23347	28.2	0.06025
I	.....	.....	.....	.....	.....	.....	.....	.....
O	20.00709	2	10.00355	0.10116	0.10116	0.10116	12.2	0.07525
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	91.99291	186	0.49459	0.49459	0.49459	0.49459	59.6	0.05101
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	223.13475	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.23347		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.03372	17.0
	.....	PI	.....		.....	
	.....	PO	0.16486	100.0	0.16486	83.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.23347		0.16486	100%	0.19858	100%
Standard deviation	0.48319		Relative SE: 0.40603		Absolute SE: 0.44562	
Coef_G relative			0.59			
Coef_G absolute			0.54			

Grand mean for levels used: 3.84397
Variance error of the mean for levels used: 0.03796
Standard error of the grand mean: 0.19483

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	131.10993	93	1.40978	0.25311	0.25311	0.25311	21.3	0.07176
I	.....	.....	.....	.....	.....	.....	.....	.....
O	54.34752	2	27.17376	0.28216	0.28216	0.28216	23.8	0.20441
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	120.98582	186	0.65046	0.65046	0.65046	0.65046	54.9	0.06709
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	306.44326	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.25311		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.09405	30.3
	.....	PI	.....		.....	
	.....	PO	0.21682	100.0	0.21682	69.7
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.25311		0.21682	100%	0.31087	100%
Standard deviation	0.50310		Relative SE: 0.46564		Absolute SE: 0.55756	
Coef_G relative			0.54			
Coef_G absolute			0.45			

Grand mean for levels used: 3.51418
Variance error of the mean for levels used: 0.09905
Standard error of the grand mean: 0.31473

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	95.60638	93	1.02803	0.09655	0.09655	0.09655	11.4	0.05583
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.32624	2	1.66312	0.00984	0.00984	0.00984	1.2	0.01254
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	137.34043	186	0.73839	0.73839	0.73839	0.73839	87.4	0.07616
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	236.27305	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.09655		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00328	1.3
	.....	PI	.....		.....	
	.....	PO	0.24613	100.0	0.24613	98.7
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.09655		0.24613	100%	0.24941	100%
Standard deviation	0.31072		Relative SE: 0.49611		Absolute SE: 0.49941	
Coef_G relative			0.28			
Coef_G absolute			0.28			

Grand mean for levels used: 3.47163
Variance error of the mean for levels used: 0.00692
Standard error of the grand mean: 0.08321

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	114.82624	93	1.23469	0.21307	0.21307	0.21307	22.2	0.06313
I	.....	.....	.....	.....	.....	.....	.....	.....
O	29.24113	2	14.62057	0.14920	0.14920	0.14920	15.6	0.10998
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	110.75887	186	0.59548	0.59548	0.59548	0.59548	62.2	0.06142
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	254.82624	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.21307		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.04973	20.0
	.....	PI	.....		.....	
	.....	PO	0.19849	100.0	0.19849	80.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.21307		0.19849	100%	0.24823	100%
Standard deviation	0.46160		Relative SE: 0.44553		Absolute SE: 0.49822	
Coef_G relative			0.52			
Coef_G absolute			0.46			

Grand mean for levels used: 3.64184
Variance error of the mean for levels used: 0.05411
Standard error of the grand mean: 0.23262

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	153.74468	93	1.65317	0.30066	0.30066	0.30066	27.5	0.08402
I	.....	.....	.....	.....	.....	.....	.....	.....
O	8.94326	2	4.47163	0.03958	0.03958	0.03958	3.6	0.03365
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	139.72340	186	0.75120	0.75120	0.75120	0.75120	68.8	0.07748
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	302.41135	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.30066		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01319	5.0
	.....	PI	.....		.....	
	.....	PO	0.25040	100.0	0.25040	95.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.30066		0.25040	100%	0.26359	100%
Standard deviation	0.54832		Relative SE: 0.50040		Absolute SE: 0.51341	
Coef_G relative			0.55			
Coef_G absolute			0.53			

Grand mean for levels used: 3.51773
Variance error of the mean for levels used: 0.01906
Standard error of the grand mean: 0.13804

Appendix C8

EduG analyses output for individual SPF items 1-24, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	113.43617	93	1.21974	0.26630	0.26630	0.26630	35.1	0.06074
I	.....	.....	.....	.....	.....	.....	.....	.....
O	14.39007	2	7.19504	0.07207	0.07207	0.07207	9.5	0.05413
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	78.27660	186	0.42084	0.42084	0.42084	0.42084	55.4	0.04341
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	206.10284	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26630		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02402	14.6
	.....	PI	.....		.....	
	.....	PO	0.14028	100.0	0.14028	85.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26630		0.14028	100%	0.16430	100%
Standard deviation	0.51604		Relative SE: 0.37454		Absolute SE: 0.40534	
Coef_G relative			0.65			
Coef_G absolute			0.62			

Grand mean for levels used: 3.74113
Variance error of the mean for levels used: 0.02835
Standard error of the grand mean: 0.16837

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	76.14184	93	0.81873	0.13795	0.13795	0.13795	24.3	0.04197
I	.....	.....	.....	.....	.....	.....	.....	.....
O	5.36170	2	2.68085	0.02421	0.02421	0.02421	4.3	0.02017
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	75.30496	186	0.40487	0.40487	0.40487	0.40487	71.4	0.04176
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	156.80851	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.13795		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00807	5.6
	.....	PI	.....		.....	
	.....	PO	0.13496	100.0	0.13496	94.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.13795		0.13496	100%	0.14303	100%
Standard deviation	0.37142		Relative SE: 0.36736		Absolute SE: 0.37819	
Coef_G relative			0.51			
Coef_G absolute			0.49			

Grand mean for levels used: 3.89362
Variance error of the mean for levels used: 0.01097
Standard error of the grand mean: 0.10476

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	101.87234	93	1.09540	0.17300	0.17300	0.17300	23.1	0.05656
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.78723	2	0.39362	-0.00194	-0.00194	-0.00194	0.0	0.00303
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	107.21277	186	0.57641	0.57641	0.57641	0.57641	76.9	0.05945
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	209.87234	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.17300		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.19214	100.0	0.19214	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.17300		0.19214	100%	0.19214	100%
Standard deviation	0.41593		Relative SE: 0.43834		Absolute SE: 0.43834	
Coef_G relative			0.47			
Coef_G absolute			0.47			

Grand mean for levels used: 3.97872
Variance error of the mean for levels used: 0.00388
Standard error of the grand mean: 0.06232

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	151.23404	93	1.62617	0.39385	0.39385	0.39385	46.1	0.08012
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.96454	2	1.98227	0.01636	0.01636	0.01636	1.9	0.01492
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	82.70213	186	0.44464	0.44464	0.44464	0.44464	52.0	0.04586
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	237.90071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.39385		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00545	3.5
	.....	PI	.....		.....	
	.....	PO	0.14821	100.0	0.14821	96.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.39385		0.14821	100%	0.15366	100%
Standard deviation	0.62757		Relative SE: 0.38498		Absolute SE: 0.39200	
Coef_G relative			0.73			
Coef_G absolute			0.72			

Grand mean for levels used: 3.54610
Variance error of the mean for levels used: 0.01122
Standard error of the grand mean: 0.10592

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	147.97163	93	1.59109	0.30271	0.30271	0.30271	23.0	0.08046
I	.....	.....	.....	.....	.....	.....	.....	.....
O	63.63830	2	31.81915	0.33124	0.33124	0.33124	25.2	0.23936
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	127.02837	186	0.68295	0.68295	0.68295	0.68295	51.9	0.07044
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	338.63830	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.30271		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.11041	32.7
	.....	PI	.....		.....	
	.....	PO	0.22765	100.0	0.22765	67.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.30271		0.22765	100%	0.33806	100%
Standard deviation	0.55020		Relative SE: 0.47713		Absolute SE: 0.58143	
Coef_G relative			0.57			
Coef_G absolute			0.47			

Grand mean for levels used: 3.38298
Variance error of the mean for levels used: 0.11605
Standard error of the grand mean: 0.34067

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components				
				Random	Mixed	Corrected	%	SE
P	105.90426	93	1.13876	0.19576	0.19576	0.19576	25.1	0.05825
I	.....	.....	.....	.....	.....	.....	.....	.....
O	7.42553	2	3.71277	0.03363	0.03363	0.03363	4.3	0.02794
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	102.57447	186	0.55148	0.55148	0.55148	0.55148	70.6	0.05688
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	215.90426	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.19576		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01121	5.7
	.....	PI	.....		.....	
	.....	PO	0.18383	100.0	0.18383	94.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.19576		0.18383	100%	0.19504	100%
Standard deviation	0.44245		Relative SE: 0.42875		Absolute SE: 0.44163	
Coef_G relative			0.52			
Coef_G absolute			0.50			

Grand mean for levels used: 3.62766
Variance error of the mean for levels used: 0.01525
Standard error of the grand mean: 0.12348

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	151.70213	93	1.63121	0.38942	0.38942	0.38942	42.1	0.08048
I	.....	.....	.....	.....	.....	.....	.....	.....
O	14.56028	2	7.28014	0.07252	0.07252	0.07252	7.8	0.05477
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	86.10638	186	0.46294	0.46294	0.46294	0.46294	50.1	0.04775
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	252.36879	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.38942		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02417	13.5
	.....	PI	.....		.....	
	.....	PO	0.15431	100.0	0.15431	86.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.38942		0.15431	100%	0.17849	100%
Standard deviation	0.62404		Relative SE: 0.39283		Absolute SE: 0.42248	
Coef_G relative			0.72			
Coef_G absolute			0.69			

Grand mean for levels used: 3.78014
Variance error of the mean for levels used: 0.02996
Standard error of the grand mean: 0.17309

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	132.31206	93	1.42271	0.27473	0.27473	0.27473	31.4	0.07182
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.34043	2	0.67021	0.00076	0.00076	0.00076	0.1	0.00508
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	111.32624	186	0.59853	0.59853	0.59853	0.59853	68.5	0.06173
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	244.97872	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.27473		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00025	0.1
	.....	PI	.....		.....	
	.....	PO	0.19951	100.0	0.19951	99.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.27473		0.19951	100%	0.19976	100%
Standard deviation	0.52414		Relative SE: 0.44666		Absolute SE: 0.44695	
Coef_G relative			0.58			
Coef_G absolute			0.58			

Grand mean for levels used: 3.70213
Variance error of the mean for levels used: 0.00530
Standard error of the grand mean: 0.07280

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	150.65248	93	1.61992	0.36090	0.36090	0.36090	35.9	0.08050
I	.....	.....	.....	.....	.....	.....	.....	.....
O	21.41135	2	10.70567	0.10818	0.10818	0.10818	10.7	0.08053
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	99.92199	186	0.53721	0.53721	0.53721	0.53721	53.4	0.05541
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	271.98582	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36090		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.03606	16.8
	.....	PI	.....		.....	
	.....	PO	0.17907	100.0	0.17907	83.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36090		0.17907	100%	0.21513	100%
Standard deviation	0.60075		Relative SE: 0.42317		Absolute SE: 0.46382	
Coef_G relative			0.67			
Coef_G absolute			0.63			

Grand mean for levels used: 3.32624
Variance error of the mean for levels used: 0.04180
Standard error of the grand mean: 0.20446

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	107.23759	93	1.15309	0.16323	0.16323	0.16323	18.3	0.06025
I	.....	.....	.....	.....	.....	.....	.....	.....
O	13.27660	2	6.63830	0.06356	0.06356	0.06356	7.1	0.04994
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	123.39007	186	0.66339	0.66339	0.66339	0.66339	74.5	0.06842
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	243.90426	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.16323		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02119	8.7
	.....	PI	.....		.....	
	.....	PO	0.22113	100.0	0.22113	91.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.16323		0.22113	100%	0.24232	100%
Standard deviation	0.40402		Relative SE: 0.47024		Absolute SE: 0.49226	
Coef_G relative			0.42			
Coef_G absolute			0.40			

Grand mean for levels used: 3.62766
Variance error of the mean for levels used: 0.02528
Standard error of the grand mean: 0.15899

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	145.70567	93	1.56673	0.31091	0.31091	0.31091	32.6	0.07885
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.74468	2	1.37234	0.00785	0.00785	0.00785	0.8	0.01035
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	117.92199	186	0.63399	0.63399	0.63399	0.63399	66.5	0.06539
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	266.37234	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.31091		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00262	1.2
	.....	PI	.....		.....	
	.....	PO	0.21133	100.0	0.21133	98.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.31091		0.21133	100%	0.21395	100%
Standard deviation	0.55760		Relative SE: 0.45971		Absolute SE: 0.46255	
Coef_G relative			0.60			
Coef_G absolute			0.59			

Grand mean for levels used: 3.52128
Variance error of the mean for levels used: 0.00817
Standard error of the grand mean: 0.09041

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	169.95745	93	1.82750	0.32723	0.32723	0.32723	26.7	0.09305
I	.....	.....	.....	.....	.....	.....	.....	.....
O	11.34752	2	5.67376	0.05136	0.05136	0.05136	4.2	0.04269
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	157.31915	186	0.84580	0.84580	0.84580	0.84580	69.1	0.08724
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	338.62411	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.32723		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01712	5.7
	.....	PI	.....		.....	
	.....	PO	0.28193	100.0	0.28193	94.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.32723		0.28193	100%	0.29905	100%
Standard deviation	0.57204		Relative SE: 0.53097		Absolute SE: 0.54686	
Coef_G relative			0.54			
Coef_G absolute			0.52			

Grand mean for levels used: 3.24823
Variance error of the mean for levels used: 0.02360
Standard error of the grand mean: 0.15363

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	97.37943	93	1.04709	0.15565	0.15565	0.15565	21.2	0.05443
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.09220	2	0.04610	-0.00568	-0.00568	-0.00568	0.0	0.00072
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	107.90780	186	0.58015	0.58015	0.58015	0.58015	78.8	0.05984
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	205.37943	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.15565		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.19338	100.0	0.19338	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.15565		0.19338	100%	0.19338	100%
Standard deviation	0.39452		Relative SE: 0.43975		Absolute SE: 0.43975	
Coef_G relative			0.45			
Coef_G absolute			0.45			

Grand mean for levels used: 3.63475
Variance error of the mean for levels used: 0.00371
Standard error of the grand mean: 0.06094

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	131.66312	93	1.41573	0.25036	0.25036	0.25036	26.8	0.07218
I	.....	.....	.....	.....	.....	.....	.....	.....
O	5.04255	2	2.52128	0.01975	0.01975	0.01975	2.1	0.01898
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	123.62411	186	0.66465	0.66465	0.66465	0.66465	71.1	0.06855
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	260.32979	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.25036		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00658	2.9
	.....	PI	.....		.....	
	.....	PO	0.22155	100.0	0.22155	97.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.25036		0.22155	100%	0.22813	100%
Standard deviation	0.50036		Relative SE: 0.47069		Absolute SE: 0.47763	
Coef_G relative			0.53			
Coef_G absolute			0.52			

Grand mean for levels used: 3.32979
Variance error of the mean for levels used: 0.01160
Standard error of the grand mean: 0.10772

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	178.71277	93	1.92164	0.53523	0.53523	0.53523	62.4	0.09357
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.90071	2	0.95035	0.00675	0.00675	0.00675	0.8	0.00716
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	58.76596	186	0.31595	0.31595	0.31595	0.31595	36.8	0.03259
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	239.37943	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differentiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.53523		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00225	2.1
	.....	PI	.....		.....	
	.....	PO	0.10532	100.0	0.10532	97.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.53523		0.10532	100%	0.10757	100%
Standard deviation	0.73160		Relative SE: 0.32452		Absolute SE: 0.32797	
Coef_G relative			0.84			
Coef_G absolute			0.83			

Grand mean for levels used: 3.30142
Variance error of the mean for levels used: 0.00906
Standard error of the grand mean: 0.09521

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	158.32979	93	1.70247	0.43102	0.43102	0.43102	50.1	0.08353
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.51773	2	2.25887	0.01968	0.01968	0.01968	2.3	0.01700
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	76.14894	186	0.40940	0.40940	0.40940	0.40940	47.6	0.04223
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	238.99645	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.43102		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00656	4.6
	.....	PI	.....		.....	
	.....	PO	0.13647	100.0	0.13647	95.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.43102		0.13647	100%	0.14303	100%
Standard deviation	0.65652		Relative SE: 0.36942		Absolute SE: 0.37819	
Coef_G relative			0.76			
Coef_G absolute			0.75			

Grand mean for levels used: 3.33688
Variance error of the mean for levels used: 0.01260
Standard error of the grand mean: 0.11223

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	233.16312	93	2.50713	0.67879	0.67879	0.67879	58.3	0.12233
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.77305	2	1.88652	0.01506	0.01506	0.01506	1.3	0.01420
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	87.56028	186	0.47075	0.47075	0.47075	0.47075	40.4	0.04855
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	324.49645	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.67879		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00502	3.1
	.....	PI	.....		.....	
	.....	PO	0.15692	100.0	0.15692	96.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.67879		0.15692	100%	0.16194	100%
Standard deviation	0.82389		Relative SE: 0.39613		Absolute SE: 0.40242	
Coef_G relative			0.81			
Coef_G absolute			0.81			

Grand mean for levels used: 3.50355
Variance error of the mean for levels used: 0.01391
Standard error of the grand mean: 0.11794

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	106.95035	93	1.15000	0.14257	0.14257	0.14257	16.4	0.06091
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.31915	2	1.15957	0.00465	0.00465	0.00465	0.5	0.00876
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	134.34752	186	0.72230	0.72230	0.72230	0.72230	83.1	0.07450
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	243.61702	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.14257		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00155	0.6
	.....	PI	.....		.....	
	.....	PO	0.24077	100.0	0.24077	99.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.14257		0.24077	100%	0.24232	100%
Standard deviation	0.37758		Relative SE: 0.49068		Absolute SE: 0.49226	
Coef_G relative			0.37			
Coef_G absolute			0.37			

Grand mean for levels used: 3.74468
Variance error of the mean for levels used: 0.00563
Standard error of the grand mean: 0.07502

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	130.97872	93	1.40837	0.24865	0.24865	0.24865	27.3	0.07182
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.78723	2	0.39362	-0.00286	-0.00286	-0.00286	0.0	0.00305
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	123.21277	186	0.66243	0.66243	0.66243	0.66243	72.7	0.06832
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	254.97872	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.24865		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.22081	100.0	0.22081	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.24865		0.22081	100%	0.22081	100%
Standard deviation	0.49864		Relative SE: 0.46991		Absolute SE: 0.46991	
Coef_G relative			0.53			
Coef_G absolute			0.53			

Grand mean for levels used: 3.70213
Variance error of the mean for levels used: 0.00499
Standard error of the grand mean: 0.07067

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	138.64184	93	1.49077	0.36033	0.36033	0.36033	46.8	0.07346
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.44681	2	0.22340	-0.00198	-0.00198	-0.00198	0.0	0.00174
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	76.21986	186	0.40978	0.40978	0.40978	0.40978	53.2	0.04227
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	215.30851	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36033		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.13659	100.0	0.13659	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36033		0.13659	100%	0.13659	100%
Standard deviation	0.60027		Relative SE: 0.36959		Absolute SE: 0.36959	
Coef_G relative			0.73			
Coef_G absolute			0.73			

Grand mean for levels used: 3.60638
Variance error of the mean for levels used: 0.00529
Standard error of the grand mean: 0.07271

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	177.54610	93	1.90910	0.44944	0.44944	0.44944	42.4	0.09433
I	.....	.....	.....	.....	.....	.....	.....	.....
O	10.36170	2	5.18085	0.04915	0.04915	0.04915	4.6	0.03898
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	104.30496	186	0.56078	0.56078	0.56078	0.56078	52.9	0.05784
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	292.21277	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.44944		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01638	8.1
	.....	PI	.....		.....	
	.....	PO	0.18693	100.0	0.18693	91.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.44944		0.18693	100%	0.20331	100%
Standard deviation	0.67040		Relative SE: 0.43235		Absolute SE: 0.45090	
Coef_G relative			0.71			
Coef_G absolute			0.69			

Grand mean for levels used: 3.46809
Variance error of the mean for levels used: 0.02315
Standard error of the grand mean: 0.15216

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	188.41489	93	2.02597	0.52314	0.52314	0.52314	53.2	0.09924
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.75177	2	0.87589	0.00446	0.00446	0.00446	0.5	0.00661
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	84.91489	186	0.45653	0.45653	0.45653	0.45653	46.4	0.04709
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	275.08156	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.52314		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00149	1.0
	.....	PI	.....		.....	
	.....	PO	0.15218	100.0	0.15218	99.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.52314		0.15218	100%	0.15366	100%
Standard deviation	0.72329		Relative SE: 0.39010		Absolute SE: 0.39200	
Coef_G relative			0.77			
Coef_G absolute			0.77			

Grand mean for levels used: 3.57092
Variance error of the mean for levels used: 0.00867
Standard error of the grand mean: 0.09312

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	150.07092	93	1.61367	0.38401	0.38401	0.38401	41.4	0.07964
I	.....	.....	.....	.....	.....	.....	.....	.....
O	16.13475	2	8.06738	0.08091	0.08091	0.08091	8.7	0.06069
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	85.86525	186	0.46164	0.46164	0.46164	0.46164	49.8	0.04761
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	252.07092	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.38401		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02697	14.9
	.....	PI	.....		.....	
	.....	PO	0.15388	100.0	0.15388	85.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.38401		0.15388	100%	0.18085	100%
Standard deviation	0.61968		Relative SE: 0.39228		Absolute SE: 0.42527	
Coef_G relative			0.71			
Coef_G absolute			0.68			

Grand mean for levels used: 3.46099
Variance error of the mean for levels used: 0.03269
Standard error of the grand mean: 0.18081

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	106.82624	93	1.14867	0.23168	0.23168	0.23168	33.6	0.05770
I	.....	.....	.....	.....	.....	.....	.....	.....
O	1.62411	2	0.81206	0.00381	0.00381	0.00381	0.6	0.00613
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	84.37589	186	0.45363	0.45363	0.45363	0.45363	65.8	0.04679
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	192.82624	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.23168		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00127	0.8
	.....	PI	.....		.....	
	.....	PO	0.15121	100.0	0.15121	99.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.23168		0.15121	100%	0.15248	100%
Standard deviation	0.48133		Relative SE: 0.38886		Absolute SE: 0.39049	
Coef_G relative			0.61			
Coef_G absolute			0.60			

Grand mean for levels used: 3.64184
Variance error of the mean for levels used: 0.00534
Standard error of the grand mean: 0.07310

Appendix C9

EduG analyses output for individual ER89 items 1-14, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	135.10638	93	1.45276	0.26295	0.26295	0.26295	26.7	0.07388
I	.....	.....	.....	.....	.....	.....	.....	.....
O	12.51064	2	6.25532	0.05948	0.05948	0.05948	6.0	0.04706
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	123.48936	186	0.66392	0.66392	0.66392	0.66392	67.3	0.06848
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	271.10638	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26295		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01983	8.2
	.....	PI	.....		.....	
	.....	PO	0.22131	100.0	0.22131	91.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26295		0.22131	100%	0.24113	100%
Standard deviation	0.51278		Relative SE: 0.47043		Absolute SE: 0.49105	
Coef_G relative			0.54			
Coef_G absolute			0.52			

Grand mean for levels used: 3.36170
Variance error of the mean for levels used: 0.02498
Standard error of the grand mean: 0.15805

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	106.56738	93	1.14589	0.18421	0.18421	0.18421	23.1	0.05906
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.98582	2	2.49291	0.02021	0.02021	0.02021	2.5	0.01876
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	110.34752	186	0.59327	0.59327	0.59327	0.59327	74.4	0.06119
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	221.90071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.18421		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00674	3.3
	.....	PI	.....		.....	
	.....	PO	0.19776	100.0	0.19776	96.7
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.18421		0.19776	100%	0.20449	100%
Standard deviation	0.42919		Relative SE: 0.44470		Absolute SE: 0.45221	
Coef_G relative			0.48			
Coef_G absolute			0.47			

Grand mean for levels used: 3.45390
Variance error of the mean for levels used: 0.01080
Standard error of the grand mean: 0.10392

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	134.99291	93	1.45154	0.26214	0.26214	0.26214	27.9	0.07383
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.62411	2	1.81206	0.01220	0.01220	0.01220	1.3	0.01365
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	123.70922	186	0.66510	0.66510	0.66510	0.66510	70.8	0.06860
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	262.32624	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26214		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00407	1.8
	.....	PI	.....		.....	
	.....	PO	0.22170	100.0	0.22170	98.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26214		0.22170	100%	0.22577	100%
Standard deviation	0.51200		Relative SE: 0.47085		Absolute SE: 0.47515	
Coef_G relative			0.54			
Coef_G absolute			0.54			

Grand mean for levels used: 3.47518
Variance error of the mean for levels used: 0.00921
Standard error of the grand mean: 0.09599

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	206.31206	93	2.21841	0.59555	0.59555	0.59555	57.5	0.10832
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.36170	2	1.18085	0.00797	0.00797	0.00797	0.8	0.00890
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	80.30496	186	0.43175	0.43175	0.43175	0.43175	41.7	0.04453
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	288.97872	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.59555		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00266	1.8
	.....	PI	.....		.....	
	.....	PO	0.14392	100.0	0.14392	98.2
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.59555		0.14392	100%	0.14657	100%
Standard deviation	0.77172		Relative SE: 0.37936		Absolute SE: 0.38285	
Coef_G relative			0.81			
Coef_G absolute			0.80			

Grand mean for levels used: 3.29787
Variance error of the mean for levels used: 0.01052
Standard error of the grand mean: 0.10258

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	144.00000	93	1.54839	0.29181	0.29181	0.29181	28.6	0.07838
I	.....	.....	.....	.....	.....	.....	.....	.....
O	11.49645	2	5.74823	0.05399	0.05399	0.05399	5.3	0.04325
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	125.17021	186	0.67296	0.67296	0.67296	0.67296	66.1	0.06941
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	280.66667	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.29181		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01800	7.4
	.....	PI	.....		.....	
	.....	PO	0.22432	100.0	0.22432	92.6
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.29181		0.22432	100%	0.24232	100%
Standard deviation	0.54019		Relative SE: 0.47362		Absolute SE: 0.49226	
Coef_G relative			0.57			
Coef_G absolute			0.55			

Grand mean for levels used: 3.33333
Variance error of the mean for levels used: 0.02349
Standard error of the grand mean: 0.15326

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	180.24468	93	1.93811	0.47647	0.47647	0.47647	45.6	0.09535
I	.....	.....	.....	.....	.....	.....	.....	.....
O	12.04965	2	6.02482	0.05868	0.05868	0.05868	5.6	0.04532
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	94.61702	186	0.50869	0.50869	0.50869	0.50869	48.7	0.05247
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	286.91135	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.47647		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01956	10.3
	.....	PI	.....		.....	
	.....	PO	0.16956	100.0	0.16956	89.7
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.47647		0.16956	100%	0.18913	100%
Standard deviation	0.69027		Relative SE: 0.41178		Absolute SE: 0.43489	
Coef_G relative			0.74			
Coef_G absolute			0.72			

Grand mean for levels used: 3.68440
Variance error of the mean for levels used: 0.02643
Standard error of the grand mean: 0.16258

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	136.04610	93	1.46286	0.28594	0.28594	0.28594	32.1	0.07375
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.79433	2	0.39716	-0.00221	-0.00221	-0.00221	0.0	0.00306
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	112.53901	186	0.60505	0.60505	0.60505	0.60505	67.9	0.06241
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	249.37943	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.28594		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.20168	100.0	0.20168	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.28594		0.20168	100%	0.20168	100%
Standard deviation	0.53473		Relative SE: 0.44909		Absolute SE: 0.44909	
Coef_G relative			0.59			
Coef_G absolute			0.59			

Grand mean for levels used: 3.69858
Variance error of the mean for levels used: 0.00519
Standard error of the grand mean: 0.07202

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	149.51773	93	1.60772	0.41512	0.41512	0.41512	52.7	0.07875
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.60284	2	1.30142	0.00999	0.00999	0.00999	1.3	0.00980
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	67.39716	186	0.36235	0.36235	0.36235	0.36235	46.0	0.03737
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	219.51773	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.41512		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00333	2.7
	.....	PI	.....		.....	
	.....	PO	0.12078	100.0	0.12078	97.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.41512		0.12078	100%	0.12411	100%
Standard deviation	0.64430		Relative SE: 0.34754		Absolute SE: 0.35230	
Coef_G relative			0.77			
Coef_G absolute			0.77			

Grand mean for levels used: 3.73050
Variance error of the mean for levels used: 0.00903
Standard error of the grand mean: 0.09503

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	207.06738	93	2.22653	0.61473	0.61473	0.61473	59.9	0.10849
I	.....	.....	.....	.....	.....	.....	.....	.....
O	6.21986	2	3.10993	0.02902	0.02902	0.02902	2.8	0.02340
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	71.11348	186	0.38233	0.38233	0.38233	0.38233	37.3	0.03943
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	284.40071	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.61473		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00967	7.1
	.....	PI	.....		.....	
	.....	PO	0.12744	100.0	0.12744	92.9
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.61473		0.12744	100%	0.13712	100%
Standard deviation	0.78405		Relative SE: 0.35699		Absolute SE: 0.37029	
Coef_G relative			0.83			
Coef_G absolute			0.82			

Grand mean for levels used: 3.62057
Variance error of the mean for levels used: 0.01757
Standard error of the grand mean: 0.13254

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	176.86879	93	1.90181	0.45367	0.45367	0.45367	43.2	0.09384
I	.....	.....	.....	.....	.....	.....	.....	.....
O	11.41135	2	5.70567	0.05495	0.05495	0.05495	5.2	0.04292
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	100.58865	186	0.54080	0.54080	0.54080	0.54080	51.5	0.05578
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	288.86879	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.45367		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01832	9.2
	.....	PI	.....		.....	
	.....	PO	0.18027	100.0	0.18027	90.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.45367		0.18027	100%	0.19858	100%
Standard deviation	0.67355		Relative SE: 0.42458		Absolute SE: 0.44562	
Coef_G relative			0.72			
Coef_G absolute			0.70			

Grand mean for levels used: 3.61348
Variance error of the mean for levels used: 0.02506
Standard error of the grand mean: 0.15830

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	148.82270	93	1.60024	0.37120	0.37120	0.37120	42.8	0.07918
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.81560	2	1.40780	0.00980	0.00980	0.00980	1.1	0.01060
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	90.51773	186	0.48665	0.48665	0.48665	0.48665	56.1	0.05019
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	242.15603	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differentiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.37120		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00327	2.0
	.....	PI	.....		.....	
	.....	PO	0.16222	100.0	0.16222	98.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.37120		0.16222	100%	0.16548	100%
Standard deviation	0.60926		Relative SE: 0.40276		Absolute SE: 0.40680	
Coef_G relative			0.70			
Coef_G absolute			0.69			

Grand mean for levels used: 3.70922
Variance error of the mean for levels used: 0.00894
Standard error of the grand mean: 0.09456

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	163.74468	93	1.76070	0.37989	0.37989	0.37989	35.3	0.08779
I	.....	.....	.....	.....	.....	.....	.....	.....
O	15.15603	2	7.57801	0.07401	0.07401	0.07401	6.9	0.05701
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	115.51064	186	0.62102	0.62102	0.62102	0.62102	57.8	0.06405
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	294.41135	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.37989		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.02467	10.6
	.....	PI	.....		.....	
	.....	PO	0.20701	100.0	0.20701	89.4
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.37989		0.20701	100%	0.23168	100%
Standard deviation	0.61635		Relative SE: 0.45498		Absolute SE: 0.48133	
Coef_G relative			0.65			
Coef_G absolute			0.62			

Grand mean for levels used: 3.48227
Variance error of the mean for levels used: 0.03091
Standard error of the grand mean: 0.17582

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	89.51773	93	0.96256	0.13841	0.13841	0.13841	19.7	0.05021
I	.....	.....	.....	.....	.....	.....	.....	.....
O	4.19858	2	2.09929	0.01651	0.01651	0.01651	2.4	0.01580
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	101.80142	186	0.54732	0.54732	0.54732	0.54732	77.9	0.05645
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	195.51773	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.13841		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00550	2.9
	.....	PI	.....		.....	
	.....	PO	0.18244	100.0	0.18244	97.1
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.13841		0.18244	100%	0.18794	100%
Standard deviation	0.37204		Relative SE: 0.42713		Absolute SE: 0.43352	
Coef_G relative			0.43			
Coef_G absolute			0.42			

Grand mean for levels used: 3.73050
Variance error of the mean for levels used: 0.00892
Standard error of the grand mean: 0.09443

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	101.53546	93	1.09178	0.06455	0.06455	0.06455	3.5	0.06117
I	.....	.....	.....	.....	.....	.....	.....	.....
O	172.28369	2	86.14184	0.90685	0.90685	0.90685	48.5	0.64800
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	167.04965	186	0.89812	0.89812	0.89812	0.89812	48.0	0.09263
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	440.86879	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.06455		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.30228	50.2
	.....	PI	.....		.....	
	.....	PO	0.29937	100.0	0.29937	49.8
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.06455		0.29937	100%	0.60165	100%
Standard deviation	0.25408		Relative SE: 0.54715		Absolute SE: 0.77566	
Coef_G relative			0.18			
Coef_G absolute			0.10			

Grand mean for levels used: 3.61348
Variance error of the mean for levels used: 0.30615
Standard error of the grand mean: 0.55331

Appendix C10

EduG analyses output for individual BRS items 1-6, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	110.31206	93	1.18615	0.26417	0.26417	0.26417	37.5	0.05894
I	.....	.....	.....	.....	.....	.....	.....	.....
O	9.44681	2	4.72340	0.04606	0.04606	0.04606	6.5	0.03553
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	73.21986	186	0.39366	0.39366	0.39366	0.39366	55.9	0.04060
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	192.97872	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.26417		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01535	10.5
	.....	PI	.....		.....	
	.....	PO	0.13122	100.0	0.13122	89.5
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.26417		0.13122	100%	0.14657	100%
Standard deviation	0.51397		Relative SE: 0.36224		Absolute SE: 0.38285	
Coef_G relative			0.67			
Coef_G absolute			0.64			

Grand mean for levels used: 3.70213
Variance error of the mean for levels used: 0.01956
Standard error of the grand mean: 0.13986

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	134.42553	93	1.44544	0.28670	0.28670	0.28670	32.5	0.07275
I	.....	.....	.....	.....	.....	.....	.....	.....
O	3.12766	2	1.56383	0.01041	0.01041	0.01041	1.2	0.01178
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	108.87234	186	0.58534	0.58534	0.58534	0.58534	66.3	0.06037
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	246.42553	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.28670		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00347	1.7
	.....	PI	.....		.....	
	.....	PO	0.19511	100.0	0.19511	98.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.28670		0.19511	100%	0.19858	100%
Standard deviation	0.53544		Relative SE: 0.44171		Absolute SE: 0.44562	
Coef_G relative			0.60			
Coef_G absolute			0.59			

Grand mean for levels used: 3.72340
Variance error of the mean for levels used: 0.00860
Standard error of the grand mean: 0.09271

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	95.32270	93	1.02498	0.20400	0.20400	0.20400	33.1	0.05157
I	.....	.....	.....	.....	.....	.....	.....	.....
O	0.51773	2	0.25887	-0.00164	-0.00164	-0.00164	0.0	0.00200
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	76.81560	186	0.41299	0.41299	0.41299	0.41299	66.9	0.04260
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	172.65603	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.20400		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		(0.00000)	0.0
	.....	PI	.....		.....	
	.....	PO	0.13766	100.0	0.13766	100.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.20400		0.13766	100%	0.13766	100%
Standard deviation	0.45166		Relative SE: 0.37103		Absolute SE: 0.37103	
Coef_G relative			0.60			
Coef_G absolute			0.60			

Grand mean for levels used: 3.79078
Variance error of the mean for levels used: 0.00363
Standard error of the grand mean: 0.06029

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	144.04610	93	1.54888	0.36460	0.36460	0.36460	44.0	0.07653
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.68794	2	1.34397	0.00946	0.00946	0.00946	1.1	0.01012
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	84.64539	186	0.45508	0.45508	0.45508	0.45508	54.9	0.04694
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	231.37943	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.36460		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00315	2.0
	.....	PI	.....		.....	
	.....	PO	0.15169	100.0	0.15169	98.0
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.36460		0.15169	100%	0.15485	100%
Standard deviation	0.60382		Relative SE: 0.38948		Absolute SE: 0.39351	
Coef_G relative			0.71			
Coef_G absolute			0.70			

Grand mean for levels used: 3.36525
Variance error of the mean for levels used: 0.00864
Standard error of the grand mean: 0.09298

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	134.14539	93	1.44242	0.34332	0.34332	0.34332	43.5	0.07119
I	.....	.....	.....	.....	.....	.....	.....	.....
O	7.28369	2	3.64184	0.03436	0.03436	0.03436	4.3	0.02740
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	76.71631	186	0.41245	0.41245	0.41245	0.41245	52.2	0.04254
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	218.14539	281					100%	

G Study Table (Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.34332		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.01145	7.7
	.....	PI	.....		.....	
	.....	PO	0.13748	100.0	0.13748	92.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.34332		0.13748	100%	0.14894	100%
Standard deviation	0.58594		Relative SE: 0.37079		Absolute SE: 0.38592	
Coef_G relative			0.71			
Coef_G absolute			0.70			

Grand mean for levels used: 3.53546
Variance error of the mean for levels used: 0.01657
Standard error of the grand mean: 0.12871

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components				
				Random	Mixed	Corrected	%	SE
P	138.36879	93	1.48784	0.31583	0.31583	0.31583	36.5	0.07432
I	.....	.....	.....	.....	.....	.....	.....	.....
O	2.82979	2	1.41489	0.00930	0.00930	0.00930	1.1	0.01066
PI	.....	.....	.....	.....	.....	.....	.....	.....
PO	100.50355	186	0.54034	0.54034	0.54034	0.54034	62.4	0.05573
IO	.....	.....	.....	.....	.....	.....	.....	.....
PIO	.....	.....	.....	.....	.....	.....	.....	.....
Total	241.70213	281					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.31583		.....		.....	
	.....	I	.....		.....	
	.....	O	.....		0.00310	1.7
	.....	PI	.....		.....	
	.....	PO	0.18011	100.0	0.18011	98.3
	.....	IO	.....		.....	
	.....	PIO	.....		.....	
Sum of variances	0.31583		0.18011	100%	0.18322	100%
Standard deviation	0.56199		Relative SE: 0.42440		Absolute SE: 0.42804	
Coef_G relative			0.64			
Coef_G absolute			0.63			

Grand mean for levels used: 3.44681
Variance error of the mean for levels used: 0.00838
Standard error of the grand mean: 0.09153

Appendix C11

EduG analyses output for 11 items with SCI above 0.60, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 11 12 14 15 16 18 19 21 22 23 24 25 27 28 29 30 31 33 34 35 36 37 38 39 40 41 43 44 45 46 47 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	252.52643	93	2.71534	0.05909	0.05950	0.05950	5.5	0.01220
I	112.44681	10	11.24468	-0.03681	-0.03681	-0.03642	0.0	0.02818
O	8.08769	2	4.04384	-0.01677	-0.01443	-0.01443	0.0	0.00685
PI	825.91683	930	0.88808	0.03875	0.03875	0.03875	3.6	0.01610
PO	120.76080	186	0.64925	-0.01115	-0.00293	-0.00293	0.0	0.00651
IO	430.18182	20	21.50909	0.22061	0.22061	0.22061	20.2	0.06899
PIO	1435.63636	1860	0.77185	0.77185	0.77185	0.77185	70.8	0.02530
Total	3185.55674	3101					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.05950		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00314	13.1	0.00314	10.5
	.....	PO	(0.00000)	0.0	(0.00000)	0.0
	.....	IO	.....		0.00597	19.9
	.....	PIO	0.02087	86.9	0.02087	69.6
Sum of variances	0.05950		0.02402	100%	0.02998	100%
Standard deviation	0.24392		Relative SE: 0.15498		Absolute SE: 0.17316	
Coef_G relative			0.71			
Coef_G absolute			0.66			

Grand mean for levels used: 3.71986
Variance error of the mean for levels used: 0.00685
Standard error of the grand mean: 0.08279

Appendix C12

EduG analyses output for 10 items with SCI above 0.62, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 11 12 14 15 16 18 19 21 22 23 24 25 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

Source	SS	df	MS	Components				
				Random	Mixed	Corrected	%	SE
P	233.55780	93	2.51137	0.05558	0.05599	0.05599	5.0	0.01252
I	97.93227	9	10.88136	-0.04443	-0.04443	-0.04396	0.0	0.03088
O	5.04113	2	2.52057	-0.02205	-0.01951	-0.01951	0.0	0.00806
PI	744.70106	837	0.88973	0.03813	0.03813	0.03813	3.4	0.01701
PO	135.69220	186	0.72953	-0.00458	0.00367	0.00367	0.3	0.00799
IO	419.35603	18	23.29756	0.23960	0.23960	0.23960	21.5	0.07838
PIO	1297.91064	1674	0.77533	0.77533	0.77533	0.77533	69.7	0.02678
Total	2934.19113	2819					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.05599		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00344	12.3	0.00344	9.8
	.....	PO	0.00122	4.4	0.00122	3.5
	.....	IO	.....		0.00721	20.5
	.....	PIO	0.02334	83.3	0.02334	66.3
Sum of variances	0.05599		0.02801	100%	0.03522	100%
Standard deviation	0.23662		Relative SE: 0.16736		Absolute SE: 0.18768	
Coef_G relative			0.67			
Coef_G absolute			0.61			

Grand mean for levels used: 3.69823
Variance error of the mean for levels used: 0.00811
Standard error of the grand mean: 0.09004

Appendix C13

EduG analyses output for 8 items with SCI above 0.66, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 11 12 14 15 16 17 18 19 21 22 23 24 25 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	203.48582	93	2.18802	0.05291	0.05319	0.05319	4.6	0.01390
I	97.09043	7	13.87006	-0.04958	-0.04958	-0.04905	0.0	0.04183
O	10.04344	2	5.02172	-0.03035	-0.02730	-0.02730	0.0	0.01388
PI	547.49291	651	0.84100	0.02627	0.02627	0.02627	2.3	0.01843
PO	156.12323	186	0.83937	0.00965	0.01776	0.01776	1.5	0.01145
IO	388.80053	14	27.77147	0.28733	0.28733	0.28733	25.1	0.10445
PIO	992.36613	1302	0.76219	0.76219	0.76219	0.76219	66.5	0.02985
Total	2395.40248	2255					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.05319		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00304	7.9	0.00304	6.1
	.....	PO	0.00592	15.4	0.00592	12.0
	.....	IO	.....		0.01107	22.4
	.....	PIO	0.02937	76.6	0.02937	59.5
Sum of variances	0.05319		0.03832	100%	0.04939	100%
Standard deviation	0.23063		Relative SE: 0.19576		Absolute SE: 0.22225	
Coef_G relative			0.58			
Coef_G absolute			0.52			

Grand mean for levels used: 3.69592

Variance error of the mean for levels used: 0.01204

Standard error of the grand mean: 0.10975

Appendix C14

EduG analyses output for 7 items with SCI above 0.71, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 11 12 14 15 16 17 18 19 21 22 23 24 25 26 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	176.16464	93	1.89424	0.04968	0.04993	0.04993	4.2	0.01394
I	96.78014	6	16.13002	-0.05777	-0.05777	-0.05715	0.0	0.05194
O	7.58663	2	3.79331	-0.04340	-0.03983	-0.03983	0.0	0.01902
PI	474.17224	558	0.84977	0.02366	0.02366	0.02366	2.0	0.02018
PO	145.08004	186	0.78000	0.00017	0.00846	0.00846	0.7	0.01242
IO	388.18642	12	32.34887	0.33585	0.33585	0.33585	28.1	0.13007
PIO	869.14691	1116	0.77881	0.77881	0.77881	0.77881	65.1	0.03294
Total	2157.11702	1973					100%	

G Study Table (Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.04993		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00316	7.8	0.00316	5.7
	.....	PO	0.00282	6.9	0.00282	5.1
	.....	IO	.....		0.01496	26.9
	.....	PIO	0.03469	85.3	0.03469	62.4
Sum of variances	0.04993		0.04067	100%	0.05563	100%
Standard deviation	0.22345		Relative SE: 0.20168		Absolute SE: 0.23587	
Coef_G relative			0.55			
Coef_G absolute			0.47			

Grand mean for levels used: 3.69149
Variance error of the mean for levels used: 0.01593
Standard error of the grand mean: 0.12619

5 items above 0.73 SCI

Appendix C15

EduG analyses output for 5 items with SCI above 0.73, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19 21 22 23 24 25 26 27 28 29 30 31 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	152.37447	93	1.63844	0.06047	0.06054	0.06054	4.3	0.01736
I	44.33617	4	11.08404	-0.12881	-0.12881	-0.12744	0.0	0.07850
O	10.70780	2	5.35390	-0.08914	-0.08388	-0.08388	0.0	0.04580
PI	322.59716	372	0.86720	0.00682	0.00682	0.00682	0.5	0.02570
PO	132.22553	186	0.71089	-0.02717	-0.01816	-0.01816	0.0	0.01709
IO	379.09362	8	47.38670	0.49511	0.49511	0.49511	35.1	0.22545
PIO	629.97305	744	0.84674	0.84674	0.84674	0.84674	60.1	0.04384
Total	1671.30780	1409					100%	

G Study Table (Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.06054		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00131	2.4	0.00131	1.5
	.....	PO	(0.00000)	0.0	(0.00000)	0.0
	.....	IO	.....		0.03159	36.3
	.....	PIO	0.05402	97.6	0.05402	62.2
Sum of variances	0.06054		0.05533	100%	0.08691	100%
Standard deviation	0.24606		Relative SE: 0.23522		Absolute SE: 0.29481	
Coef_G relative			0.52			
Coef_G absolute			0.41			

Grand mean for levels used: 3.66241
Variance error of the mean for levels used: 0.03282
Standard error of the grand mean: 0.18116

Appendix C16

EduG analyses output for 4 items with SCI above 0.74, including observation and estimation designs, ANOVA and G-study tables.

Observation and Estimation Designs

Facet	Label	Levels	Univ.	Reduction (levels to exclude)
Person	P	94	INF	
Item	I	94	94	2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
Occasion	O	3	INF	

Analysis of variance

				Components				
Source	SS	df	MS	Random	Mixed	Corrected	%	SE
P	136.24468	93	1.46500	0.06438	0.06439	0.06439	4.1	0.02034
I	0.71631	3	0.23877	-0.19594	-0.19594	-0.19385	0.0	0.09839
O	35.36702	2	17.68351	-0.09990	-0.09373	-0.09373	0.0	0.08094
PI	260.78369	279	0.93471	0.00120	0.00120	0.00120	0.1	0.03217
PO	128.13298	186	0.68889	-0.06056	-0.05065	-0.05065	0.0	0.02256
IO	332.93794	6	55.48966	0.58041	0.58041	0.58041	36.8	0.29516
PIO	519.56206	558	0.93111	0.93111	0.93111	0.93111	59.0	0.05564
Total	1413.74468	1127					100%	

G Study Table
(Measurement design P/IO)

Source of variance	Differ-entiation variance	Source of variance	Relative error variance	% relative	Absolute error variance	% absolute
P	0.06439		.....		.....	
	.....	I	.....		(0.00000)	0.0
	.....	O	.....		(0.00000)	0.0
	.....	PI	0.00029	0.4	0.00029	0.2
	.....	PO	(0.00000)	0.0	(0.00000)	0.0
	.....	IO	.....		0.04681	38.3
	.....	PIO	0.07509	99.6	0.07509	61.5
Sum of variances	0.06439		0.07538	100%	0.12219	100%
Standard deviation	0.25375		Relative SE: 0.27455		Absolute SE: 0.34955	
Coef_G relative			0.46			
Coef_G absolute			0.35			

Grand mean for levels used: 3.57447
Variance error of the mean for levels used: 0.04829
Standard error of the grand mean: 0.21976