LINKING INFORMATION PROCESSING STYLE PREFERENCE, STATISTICAL REASONING, AND STATISTICAL PERFORMANCE IN PSYCHOLOGY STUDENTS

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ABSTRACT

This study sought to examine the nature of the relationships between information processing style preference, statistical reasoning ability (statistical skills and misconceptions), and performance on a psychology-based statistics course (RDA IIA). A non-experimental, correlational research design was used. The sample consisted of 133 University of the Witwatersrand students who had completed the RDA IIA module. Participants completed a brief demographic questionnaire as well as the Rational-Experiential Inventory (Pacini & Epstein, 1999), assessing processing style preference, and the Statistical Reasoning Assessment (Garfield, 2003), assessing statistical reasoning ability. Results indicated statistically significant, positive relationships between preference for a rational information processing style and statistical reasoning ability; as well as between performance on RDA IIA and statistical reasoning ability. There were, however, no significant relationships between performance on RDA IIA

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and processing style preference. These findings yielded useful implications for the teaching of statistical courses and thus contribute to limited knowledge available regarding the links between processing style preference and statistical reasoning and performance, particularly in the South African context.

Keywords: Cognitive experiential self-theory; information processing style; psychological statistics; statistical performance; statistical reasoning ability; teaching

The primary aim of this research was to explore the potential existence and nature of the relationships between information processing style preference (rational and experiential), statistical reasoning ability (ability to reason correctly and misconceptions), and performance on a psychological statistics undergraduate course in a South African sample of students. Statistical reasoning is a fairly new concept that requires a great deal of further investigation and there is limited research relating to both statistical reasoning and information processing styles in the South African context (Garfield, 2002; Tempelaar, 2004). As a result, exploring the possible links between these concepts and academic performance on an undergraduate psychological statistics course, especially in South Africa where education is of paramount importance, could provide valuable insights and directions for teaching approaches and styles in this field.

Information processing style preference

It has been suggested that the way in which one selectively captures, encodes, interprets, and responds to perceptual input determines a great deal of how one interacts with and thinks about the world, and even has a potential impact on the type of personality one develops (Mathews, 2012). Understanding information processing styles is thus fundamental in understanding people and how they respond to the environment in which they live, as well as how they deal with the challenges that they face every day.

There are many theories based on the notion of dual cognitive processing styles and much research has been done on the topic (c.f. Evans, 2003; 2008; Evans & Stanovich, 2013; Kahneman, 2011; Stanovich & West, 2000). Although these theories are diverse, they share the common idea that there are two distinct cognitive processing styles, one that is evolutionary, old, heuristic, intuitive, automatic, and unconscious (System 1); and another that is more uniquely human, rational, logical, deliberate, calculating, and analytic (System 2) (Evans, 2008; Evans & Stanovich, 2013; Kahneman, 2011; Stanovich, 1999). Although both processing styles are present and operate within all human beings, there are differences across individuals in the degree to which and manner in which each system is employed (Evans, 2008; Mathews, 2012).

'Cognitive Experiential Self Theory' (CEST) is one of several dual-processing theories that builds on this foundation (Epstein, 1994; 2003). Its basic premise is that there are two independent processing styles, namely a 'rational' system and an 'experiential' system, which are distinct but interact to process information (Epstein, 2003; Epstein & Pacini, 1999; Epstein, Pacini, Denes-Raj, & Heier, 1996; Pacini & Epstein, 1999). The experiential system is evolutionary-old and is the more holistic and heuristic processing system. It operates quickly, intuitively, and automatically and corresponds with concepts such as faith in intuition, referring to the tendency to rely on feelings and intuition in decision-making (Epstein, 2003; Epstein et al., 1996; Pacini & Epstein, 1999; Zimmerman, Redker, & Gibson, 2011). In contrast, the rational system is evolutionary-new and unique to humans. It is slow, intentional, analytical, and associated with logic and facts (Epstein, 2003; Epstein et al., 1996; Pacini & Epstein, 1999). This system corresponds with concepts such as need for cognition, which can be described as the degree to which people take pleasure in and engage with activities requiring high cognitive effort (Thomas & Millar, 2008). Processing styles can also be divided into ability and engagement. Ability refers to the capacity a person has to either think logically and analytically, relating to the rational processing system, or to act on their feelings, relating to the intuitive processing style (Pacini & Epstein, 1999). Engagement refers to how much a person relies on and enjoys processing information in these different ways (Pacini & Epstein, 1999). Although the rational and experiential systems are autonomous and are both present to a certain degree within everyone, people tend to have a dominance or preference for one system over the other (Evans, 2008; Pacini & Epstein, 1999).

Applications of CEST

CEST has been explored in a wide variety of studies in multiple fields. One such study examined how these styles related to emotional intelligence and wellbeing, revealing that a high preference for both styles predicted higher levels of emotional intelligence, which in turn led to greater personal wellbeing (Schutte, et al, 2010). Other studies have revealed diverse findings such as a positive correlation between experiential processing style and hand hygiene compliance in doctors (Sladek, Bond, & Phillips, 2008), as well as that processing style acts as a moderator between cigarette use and affective associations (Marks, O'Neill, & Hine, 2008). Foroozandeh and Foroozandeh (2011) conducted a comparison study between accounting and psychology students, and found that accounting students scored higher on rational ability and favourability while psychology students had a preference for the experiential processing style. They suggested that this result might be a product of the type of training one receives in the different disciplines (Foroozandeh & Foroozandeh, 2011).

The findings from these studies suggest that there are a wide variety of potential links between information processing style and the ways in which people reason about different aspects of the world around them, including the manner in which people approach learning and the ways they interpret information. It is thus important to consider a possible link between information processing style and reasoning ability in the field of psychological statistics.

Statistical reasoning ability and statistical performance

Statistical reasoning ability has been defined as '…the way people reason with statistical ideas and make sense of statistical information' (Garfield, 1998, p. 781) and is seen as a primary outcome goal of statistics courses (Tempelaar, Gijselaers, & Van Der Loeff, 2006). Statistical reasoning abilities involve making interpretations about data and understanding concepts such as spread, randomness, distribution, and sampling (Garfield, 1998). Statistical performance, on the other hand, relates to how well a student performs on a statistics course in terms of grades on exams and homework assignments, and is not necessarily related to the ability to reason with statistical ideas (Garfield, 2002).

Various correct statistical abilities and misconceptions have been identified in a number of studies, and instruments have been created to measure these phenomena (Garfield, 1998; Garfield, 2002; Garfield, 2003). Garfield (2003) focuses on eight correct skills, namely: correctly interpreting probabilities; understanding how to select an appropriate average; correctly computing probabilities; understanding independence; understanding sampling variability; distinguishing between correlation and causation; correctly interpreting two-way tables; and understanding the importance of large samples. She also identifies eight common statistical misconceptions, namely: misconceptions about averages; outcome orientation misconceptions; misconceptions related to sample representivity; misconceptions re the law of small numbers; respresentativeness misconceptions; correlation implying causation; equiprobability bias; and comparability of groups (Garfield, 2003).

Current research on statistical reasoning

As interest in statistical reasoning abilities has increased, empirical research has identified two puzzles reflecting unanticipated results (Tempelaar, 2004). The first is that statistical reasoning ability does not seem to correlate with final performance on statistics courses (Tempelaar, 2004). This suggests that statistics instructors may teach concepts and straightforward procedures rather than specifically how to use and apply concepts of statistical reasoning (Garfield, 2002). Thus although students might perform well on tests and exams, they may not have developed statistical reasoning skills that enable them to work with the information provided effectively (Garfield, 2002). There may thus be two distinct areas in the teaching and learning of statistics, the first being actual performance on a course, and the second being the ability to deal with material and interpret it effectively, a skill that is very important when conducting psychological research (Lutsky, 2006). The second puzzle involves gender (Tempelaar, 2004). There are prominent differences in how males and females perform regarding statistical reasoning abilities (Tempelaar et al., 2006), with males demonstrating lower levels of misconceptions and higher correct statistical reasoning skills than females (Garfield, 2003).

Linking information processing style, statistical reasoning, and statistical performance

Statistical reasoning as a concept separate from performance is fairly new (Garfield, 2002), and there appears to be very limited research exploring the link between statistical reasoning and information processing style. Despite this, it has been suggested that those who operate with a more rational information processing style reason more using statistical principles, while those with a more experiential style operate more intuitively and reason heuristically (Epstein, 2003; Kahneman, 2011; Naito, Suzuki, & Sakamoto, 2004). It has also been suggested that analytic and logical thinking would correlate positively with rational processing style (Naito et al., 2004). If this is the case, one would expect people who have a higher preference for rational processing style to also potentially have higher statistical reasoning abilities.

Kahneman (2003), however, suggests that when confronted with a statistical problem people's responses may not be the most statistically logical or correct responses even though people think they are rational beings; instead people may approach solving these problems intuitively or heuristically based on statistical misconceptions (Garfield, 1998). As a result, although statistical training may help people to avoid certain biases, it does not completely eradicate heuristic, intuitive thinking or the application of incorrect reasoning principles (Garfield, 1998; Garfield & Ahlgren, 1988; Kahneman, 2003). If this is the case, then although people may have had statistical training and may score well on a statistics course, they may still make heuristic errors, especially if they are more prone to thinking in an intuitive, experiential manner.

Rationale for the current study

Despite the theoretical inter-relationships outlined above, it is important to note that there is almost no available empirical research that specifies the forms or types of relationships that may exist between these concepts, particularly as applied to the South African context. This study thus sought to address a critical gap in existing theory by exploring the nature of the relationships between preferred information processing style, statistical reasoning abilities, and performance on a psychological undergraduate statistics module, namely RDA IIA (Laher, Israel, & Pitman, 2007).

RDA IIA is compulsory module for students majoring in psychology at the University of the Witwatersrand, comprising of a statistical component as well as a research design and psychometrics component (Laher et al., 2007).

Statistics is an important part of psychology as it forms the foundation of understanding complex data analysis in research and journal articles (Lutsky, 2006; Wagner, Kawulich, & Garner, 2012). Gaining a better understanding of the factors which relate to statistical reasoning abilities could thus greatly assist in improving statistical teaching methods. Connecting statistical reasoning abilities with statistical performance could also help to assess whether obtaining a successful grade on a statistics course such as RDA IIA is associated with developing an understanding of the fundamental concepts involved in correct statistical reasoning. It is therefore important to explore if there is a link between cognitive information processing style preference and having a correct understanding of statistical concepts, as well as potentially being prone to certain statistical misconceptions. In addition, examining actual statistical performance in relation to correct statistical reasoning skills and misconceptions is also important in order to assess whether these concepts are related or if there is a discrepancy as suggested in previous studies (Tempelaar, 2004; Tempelaar et al., 2006).

METHODS

The study adopted a quantitative approach and the research design utilized was non-experimental and correlational (Stangor, 2011). After ethical clearance to conduct the study was obtained from the University of the Witwatersrand Human Research Ethics Committee, data was collected through administration of an anonymous online survey. Potential participants were informed that participation in the study was strictly voluntary and were provided with a detailed participant information sheet prior to volunteering to participate. Participants were assured that the data provided would be both anonymous and confidential; data related to RDA IIA performance were coded by a third party to avoid compromising identity in any way when accessing marks using student numbers. Contact details and mechanisms to obtain feedback were also provided.

A non-probability, convenience sample consisting of 133 volunteers from second year, third year, and Honours-level psychology students attending the University of the Witwatersrand who had completed the RDA IIA module was obtained. Of the total sample, 100 participants completed the survey fully. The majority of participants were in their second or third year of study (87.22%), pursuing a Bachelor of Arts degree (74.24%), and were female (86%). The small number of male participants (14%) could be due to the natural gender bias in the field of psychology or to a more specific form of volunteer bias inherent in the sample (Stangor, 2011). The mean age of participants was 21.4 years, with a standard deviation of 3.93. The sample was racially diverse, including Black (42.42%), White (37.12%), Indian (13.64%), and Coloured (3.03%) participants. Comparative RDA IIA results were retrieved for 113 respondents (87 of whom had also completed the SRA).

Data for the study was collected using an online survey consisting of three instruments. The first instrument was a self-developed demographic questionnaire used to collect data to describe the sample. The demographic questionnaire also contained a request for students to provide access to their final percentage mark obtained for the RDA IIA module through provision of their student number. The final overall percentage mark obtained for RDA IIA was used to represent statistical performance in the study. The second instrument was the Rational-Experiential Inventory (REI; Pacini & Epstein, 1999), which was used to assess preferred information processing style. The REI is a 40-item, self-report Likert-type scale that assesses ability for and engagement with processing information in both an experiential and a rational manner (Epstein et al., 1996; Pacini & Epstein, 1999). The reliability and validity of the REI had been supported through a number of studies, with Alphas ranging between 0.78 and 0.84 for the various subscales and validation of the structure obtained through confirmatory factor analysis Bjorklund & Backstrom, 2008; Sladek et al., 2008). The final instrument was the Statistical Reasoning Assessment (SRA); (Garfield, 2003), which was used to assess statistical reasoning skills and misconceptions. The SRA is a 20-item multiple choice test that was developed to identify approaches towards reasoning statistically and to highlight potential statistical misconceptions (Garfield, 2003). Liu (1998, as cited in Garfield, 2003) identified test-retest reliabilities ranging from 0.7 to 0.75 and the test is deemed to have high content validity (Garfield, 2003).

Participants were permitted to complete the survey at a time and in a location convenient to them at any point during a six week period during which online access remained open. They were required to complete the questionnaire in a single sitting. Although this was not ideal in terms of standardization of administration, it proved the only practical option in order to obtain a sufficient sample size.

RESULTS

Internal consistency reliabilities of the REI subscales for the sample obtained in the study were determined using Cronbach Alpha coefficients. These indicated that all of the subscales had Alphas exceeding 0.8, indicating good internal consistency reliability for the scale as applied to this sample. Descriptive statistics for the three main interval variables in the study, namely RDA IIA performance (final percentage mark for the course), the scores obtained on the REI subscales, and the overall SRA score, were examined and distribution analyses were used to test the parametric qualities of the interval variables. Pearson's Correlation Coefficients were then used for analysis of the research questions.

Table 1: Descriptive statistics for key variables

Variable	n	Mean	SD	Max	Min
RDA IIA Mark	113	70.92	10.44	96	38
Rational Ability	113	36.70	6.20	50	15
Rational Engagement	113	37.49	7.14	50	12
Experiential Ability	113	34.20	7.07	49	10
Experiential Engagement	113	33.45	6.71	50	18
Total Rational Preference	113	74.19	12.29	98	34
Total Experiential Preference	113	67.65	12.55	97	37
Total SRA Score	100	42.30	12.78	85	10

As shown in Table 2, analyses of the correlations between information processing style preference and statistical reasoning ability indicated that there was a statistically significant, positive relationship between total score on the SRA and preference for a rational information processing style ($r_{(100)} = 0.31$; $p < 0.01$). This was also true for respondents who indicated a high preference for both perceived rational ability ($r_{(100)} = 0.24$; $p < 0.05$) and perceived rational engagement ($r_{(100)} = 0.31$; $p < 0.01$). There were no significant relationships between scores on the experiential scales and the SRA. There were also no significant relationships identified between RDA IIA performance and either rational or experiential information processing style preference.

Table 2: Correlations between the key variables

	RDA IIA Mark	Total SRA Score
Rational Ability	0.1540	0.2422
	p > 0.05	p < 0.05
	113	100
Rational Engagement	0.1812	0.3115
	p > 0.05	p < 0.01
	113	100
Experiential Ability	-0.1006	0.0843
	p > 0.05	p > 0.05
	113	100

Experiential Engagement	0.1504	0.1831
	p > 0.05	p > 0.05
	113	100
Total Rational Preference	0.1802	0.3055
	p > 0.05	p < 0.01
	113	100
Total Experiential Preference	0.0273	0.1465
	p > 0.05	p > 0.05
	113	100

Correlations between individual statistical conceptions and misconceptions and information processing style preference were also calculated, as shown in Table 3. A statistically significant, positive relationship was found between correctly interpreting probabilities and a high preference for experiential engagement ($r_{(87)} = 0.21$; $p < 0.05$). A significant, positive relationship was also found between understanding how to select an appropriate average and a high preference for rational engagement ($r_{(87)} = 0.21$; $p < 0.05$). Correctly interpreting two-way tables was significantly and positively correlated with overall preference for a rational processing style ($r_{(87)} = 0.29$; $p < 0.01$), as well as with both perceived rational ability ($r_{(87)} = 0.23$; $p < 0.05$), and perceived rational engagement ($r_{(87)} = 0.28$; $p < 0.01$). No significant relationships were found between any of the statistical misconceptions and information processing style.

A statistically significant, positive relationship was found between overall statistical reasoning ability (as assessed by total score on the SRA) and final mark obtained on the RDA IIA course ($r_{(87)} = 0.34$; $p < 0.01$). There were also significant, positive relationships found between RDA IIA mark and understanding how to select an appropriate average ($r_{(87)} = 0.38$; $p < 0.01$); understanding independence ($r_{(87)} = 0.26$; $p < 0.05$); and correctly interpreting two-way tables ($r_{(87)} = 0.23$; $p < 0.05$). There was a significant, negative relationship between RDA IIA marks and those who were prone to misconceptions regarding representativeness ($r_{(87)} = -0.22$; $p < 0.05$). None of the other relationships assessed were statistically significant.

Table 3: Correlations between information processing preference, performance, correct statistical reasoning, and statistical misconceptions (N = 87)

	Rational Ability	Rational Engmt.	Exper. Ability	Exper. Engmt.	Rational Pref.	Exper. Pref.	RDA Mark
CR: Probability Interpration	0.0154	0.1610	0.0155	0.2105	0.1034	0.1234	0.1072
	p > 0.05	p >0.05	p > 0.05	p < 0.05	p > 0.05	p > 0.05	p > 0.05
CR: Average Selection	0.0885	0.2062	0.0130	0.1237	0.1665	0.0747	0.3778
	p > 0.05	p < 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p < 0.01
CR: Probability Computation	0.1370	0.1740	0.1646	0.1086	0.1715	0.1501	0.0305
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
CR: Independence	0.1456	0.0971	-0.0457	0.0144	0.1301	-0.0174	0.2631
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p < 0.05
CR: Sampling Variance	0.1510	0.1127	-0.0650	0.0233	0.1421	-0.0232	0.0274
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
CR: Causation/ Correlation	0.0769	0.0820	0.1367	0.1340	0.0870	0.1486	0.0924
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
CR: Table Interpretation	0.2311	0.2779	0.0609	0.0618	0.2865	0.0751	0.2250
	p < 0.05	p < 0.01	p > 0.05	p > 0.05	p < 0.01	p > 0.05	p < 0.05
CR: Importance Large Sample	0.0790	0.0963	0.0211	0.0172	0.1092	0.0326	0.3125
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
MC: Averages	-0.0304	-0.0045	-0.0233	-0.0156	-0.0086	-0.0346	-0.0365
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
MC: Outcome Orientation	-0.0370	-0.0567	0.0065	-0.0317	-0.0665	-0.0167	0.1291
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
MC; Representation	-0.1295	0.0569	0.0241	0.0246	-0.0467	0.0139	-0.1549
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
MC: Law of Small Numbers	-0.0869	-0.0207	0.0331	0.0116	-0.0485	0.0180	-0.0131
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
MC: Represent-ativeness	-0.0747	-0.0087	-0.0425	0.0150	-0.0526	-0.0230	-0.2186
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p < 0.05
M: Causation/ Correlation	-0.0452	-0.0276	0.0023	-0.0973	-0.0353	-0.0461	-0.2079
	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05

M: Equiprobability	-0.0276	-0.0008	-0.1305	-0.0492	-0.0170	-0.0998	-0.0420
	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$
M: Comparability	0.1048	0.1057	0.1594	0.1949	0.1052	0.1906	-0.0122
	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$

DISCUSSION

Information processing style and statistical reasoning

It has been suggested that the analytic and logical thinking required in statistical reasoning could potentially be linked quite closely to a preference for a more rational processing style; as statistical reasoning is governed by man-made mathematical principles rather than intuitive, natural feelings (Kahneman, 2011; Naito et al., 2004). This notion was supported by results from the current study, which identified statistically significant positive relationships between higher levels of statistical reasoning ability and preferences for both rational ability and rational engagement, as well as overall rational processing preference. These findings imply that there is a connection between stronger statistical reasoning skills and having a preference for interpreting the world in a logical, deliberate, and analytical manner as compared to a preference for interpreting the world in a heuristic and intuitive manner (Epstein, 2003; Pacini & Epstein, 1999; Naito et al., 2004). The latter was found to have no statistically significant relationship with statistical reasoning skills, lending further support to the argument raised above.

These findings suggest that when teaching students statistical reasoning, it may be beneficial to encourage them to adopt a more rational thought process and to discourage them from relying on their intuition. This could be done by teaching students how to slow down their automatic thought processes and resist their impulses in favour of more considered, methodical responses; as well as by providing them with a specific set of rules or steps to follow when attempting to solve statistically-based problems (Garfield & Ahlgren, 1988; Kahneman, 2011). Other scaffolding mechanisms that could also potentially be used to encourage the development of analytical thought when tackling statistical problems include guided peer interactions, specific question prompts, and training in think-aloud techniques (Ge & Land, 2003; Hogan, 1999).

In terms of correct statistical reasoning skills, a significant, positive relationship was identified between understanding how to select an appropriate average and rational engagement. This link might be a result of the interactive and rule-based nature of interpreting averages and deciding between the mean, median, or mode depending on the circumstances (Howell, 2011). This finding suggests that encouraging a high degree of logic-based engagement with certain types of statistical concepts, such as selection of appropriate techniques, may improve students' abilities to reason with and utilize these effectively. Active learning techniques such as class and small group discussions, setting real-world exercises, or creating means through which the task is seen as a 'challenge' may thus be beneficial (Garfield & Ahlgren, 1988; Michael, 2006; Yoder & Hochevar, 2005).

Although experiential processing was not linked to statistical reasoning generally, a significant, positive correlation was identified between experiential engagement and the ability to correctly interpret probabilities. This skill was managed completely correctly by 29% of participants, while 57% managed it partially correctly. This was a particularly interesting finding within this sample, as the RDA IIA syllabus does not focus directly on probability theory. As a result, the questions relating to this skill required a certain amount of intuitive knowledge or instinctive judgment by participants as they could not rely solely on methods taught to them in class; it is therefore sensible that those students with a preference for experiential processing proved more adept in this particular area of statistical reasoning (Garfield, 2003). This outcome does imply that in some situations, students may benefit from utilizing less methodical, more heuristic approaches when encountering unfamiliar problems once a solid base for other principles has been established (Garfield & Ahlgren, 1988).

There were no statistically significant correlations found between information processing style preference and any of the statistical misconceptions. This was in contrast to suggestions that a preference for experiential, heuristic-based processing may lead to more errors in statistical interpretations, particularly in real-world situations (Kahneman, 2011). This finding, combined with the potential value of experiential processing approaches when working with unfamiliar content implied by the results above, suggests that both processing approaches may contribute to constructive ways in which to teach statistical reasoning and, importantly, that over-reliance on encouraging students to think only in rational terms may lessen their ability to deal with statistical material effectively. Encouraging students to be receptive to both methods of processing information and identifying ways in which to effectively distinguish which method can best be applied in particular circumstances would thus be an important future direction for both research and teaching practice (Loo, 2004; McLoughlin, 1999).

Information processing style preference and statistical performance

There were also no statistically significant relationships identified between information processing style preference and performance on RDA IIA. A possible explanation for this could be the nature of the RDA IIA module, which consists of two components (statistics and research design and psychometrics) with each contributing fifty percent towards the final mark (Laher et al., 2007). As a result, the single overall final mark for the module utilized in the analysis may reflect contributions from both processing styles as applied to different aspects of the assessment, thus masking the true nature of the relationships. This limitation is one that merits further exploration in future research.

The finding could also reflect differences in the ways in which various statistical concepts are presented and applied between courses taught in the field of psychology and those given in other disciplines (Foroozandeh & Foroozandeh, 2011; Garfield & Ahlgren, 1988). The RDA IIA module, in particular, encompasses both traditional rule-application and problem-solving as well as expressive examples and real-world application within the statistical component of the course; this could potentially encourage a mixed application of processing and learning styles towards the content (Foroozandeh & Foroozandeh, 2011; Laher et al., 2007; Tempelaar et al., 2006). As a result, effective performance on psychological research methods and statistics courses such as RDA IIA may not link to one particular way of processing information, but may have more to do with the ability to draw on both information-processing styles as appropriate. This lends further support to the need to develop additional research identifying which aspects lend themselves to development through the application of particular processing styles.

Statistical reasoning and statistical performance

In contrast to the findings reported by Garfield (2003) and Tempelaar (2004), which suggested very limited if any relationships between statistical reasoning and performance on statistics courses, there was a statistically significant, positive relationship identified between performance on RDA IIA and statistical reasoning ability. This could again be due to the composition of the RDA IIA module and more general nature of the discipline, in particular that the RDA IIA course covers both statistical material and more general research design and psychometric theory and focuses on integrating understanding of the basic concepts with application thereof in ‘real-world’ settings, an approach common in the psychological field (Laher et al., 2007). As a result, these students may be more adept at considering interpretations of findings and working with conceptual statistical reasoning as compared to students who merely learn straight statistical principles and formulae; this may also align more closely with the principles underlying the SRA as the measure of statistical reasoning employed in this study (Garfield, 2003).

Limitations of the study

It is important to note that within the sample obtained performance on the SRA, which assessed statistical reasoning skills, was generally fairly poor. In addition, the sample evidenced a higher preference for a rational processing style; and the marks obtained for RDA IIA were generally high, and did not adequately reflect the full range of performance on the course, particularly for students performing poorly. Lastly, the sample contained an extremely low proportion of males; thus it was not possible to include analyses on the basis of gender despite this having been identified as a possible contributing factor in previous research (c.f. Tempelaar, 2004). All of these factors may limit the generalizability of the findings and suggest possible factors for correction or further exploration in future research (Stangor, 2011).

It is also important to note that due to high levels of multicolinearity between the variables and the relatively small sample size, it was not possible to conduct effective regression analyses, which limited the scope of the data analysis that could be carried out. Replication of the study using larger samples, samples from a variety of disciplines, student samples from universities across South Africa, more standardized forms of administration, and more sophisticated forms of data analysis would thus be highly recommended. It would also be highly useful to incorporate a more qualitative element in further studies, thus capturing a greater degree of important contextual information such as student attitudes and motivation, teaching styles, and study preferences.

CONCLUSION

Despite the limitations outlined above, several important ideas can be drawn from the results obtained in the study. Firstly, the link between rational processing style and statistical reasoning supports the utilization of scaffolded, logical-analytical problem-solving approaches when attempting to transfer statistical reasoning skills to students in a learning environment (Garfield & Ahlgren, 1988; Ge & Land, 2003; Hogan, 1999; Kahneman, 2011). The use of active learning techniques during this process is also supported, particularly the use of real-world, context-based examples that clearly illustrate to students how the concepts that they are learning in statistics are not merely formulae and rules but can be used beyond the classroom setting in their everyday life (Garfield & Ahlgren, 1988; Michael, 2006; Yoder & Hochevar, 2005). Encouraging students to be reflective of their individual preferences in relation to processing style and to be open to adopting aspects of the other style as appropriate to the demands of the task is another key idea that emerges; as is the importance of considering contextually-specific factors such as the discipline within which and purpose for which teaching is being undertaken (Foroozandeh & Foroozandeh, 2011; Loo, 2004; McLoughlin, 1999; Tempelaar et al., 2006). These notions present a number of interesting challenges for future teaching practice; and highlight the importance of conducting further research to improve understanding of the interplay between processing style preference and statistical reasoning, as well as the role both of these may play in determining statistical performance.

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