The role of metacognitive reading strategies and trait anxiety in critical thinking for a verbal reasoning task.

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Abstract

Metacognitive reading strategies represent a goal driven system that play a role in critical thinking verbal tasks in students. Research reveals that greater attentional focus and use of executive functions is associated with lower trait anxiety, and better verbal reasoning. However, high verbal reasoning is also positively associated with trait anxiety. In this study, 122 undergraduate students were given Metacognitive Awareness Reading Strategy Inventory (MARSI), critical thinking verbal task (WGCTA), and trait anxiety inventory (STAI). High global reading (GLOB) and high problem solving strategy (PROB) groups had highest WGCTA scores, but moderate levels of anxiety. Low GLOB and low PROB groups had lowest WGCTA and high anxiety scores. There was no significant difference between support reading strategy groups (SUP) for WGCTA and trait anxiety. Overall, high GLOB and PROB groups revealed effective use of a goal directed system, which offset the effects of anxiety resulting in high WGCTA scores.

Keywords: Anxiety, metacognition, verbal reasoning task, critical thinking, students

The role of metacognitive reading strategies and trait anxiety in critical thinking for a verbal reasoning task.

One of the most important factors that can determine academic performance in students is the ability to critically evaluate and comprehend written text (Brown et al., 1986; Garner, 1987). Research has revealed how critical thinking provides students with crucial skills to understand complex text that may contain abstract concepts, such as theoretical knowledge (Bovill et al., 2011). The positive association between higher critical thinking and academic achievement has been successfully demonstrated in various disciplines using a variety of methods (Badcock et al., 2010; Niu et al., 2013).

However, by independently engaging in a variety of goal directed behaviors during reading, students may augment their critical thinking. For example, students who ask relevant questions when reading; or monitor their understanding of sentences; or summarize text tend to show a greater understanding of the written text compared to those who do not (Pressley, 2002). Furthermore, research reveals how good readers who use problem solving strategies and preview text before reading tend to show greater comprehension (Yuksel & Yuksel, 2012). The purposeful way in which some students monitor, evaluate and revise to enrich their comprehension of written text is related to the effective management of attentional resources. A skilled reader can demonstrate greater attentional focus towards relevant parts of the text due to the presence of objectives in mind when reading as opposed to the insufficient plans that may be used in less skilled readers (Muijselaar & Jong, 2015).

Researchers have attributed the effective use of objectives and greater attentional focus in some readers as representative of greater metacognitive ability (Brown, 1987). Metacognitive strategies, in particular, play a crucial role in critical thinking and subsequent comprehension of written text (Brown, 2004; Kuhn & Dean, 2004; Sheorey & Mokhtari, 2001). Conversely, students who lack metacognitive strategies tend to show greater difficulty

when reading (Klinger et al., 2011). However, the implementation of crucial strategies such as planning, monitoring, and evaluation, which requires a plan or purpose in mind, would involve executive processing (Sheorey & Mokhtari, 2001). In this sense, metacognitive strategies involve higher level executive functions, which enable a reader to process information effectively to manage their learning (Chamot, 1995).

In the past, research has explored the relationship between metacognition and executive functioning and have revealed key features, such as the predominance of attentional control processes, as characteristic of both (Torgesen, 1994). In addition, Kuhn (1992) suggests that metacognition has similarities with executive functions as both involve the ability to select and control operations to implement appropriate strategies. This is supported by research in developmental psychology, as well as experimental work on comprehension of text (Dole et al., 1991; Jacobs & Paris, 1987).

Overall, research suggests that executive functions involve the ability to selectively direct attention and implement appropriate functions in a goal directed way (Diamond, 2006). The existence of a goal directed system that is under the control of an executive attentional component is a commonly observed characteristic of skilled readers. The flexible use of a variety of reading strategies such as rereading, skimming, and searching for particular information to improve comprehension, reflects the active use of executive functions that is under the control of an executive attentional component (Kieffer et al., 2013). Furthermore, the existence of an executive attentional component for executive functions is reflective of the higher-level cognitive abilities that are demonstrated by individuals with metacognitive ability.

However, researchers have also revealed the detrimental effect of certain individual characteristics on executive functions and attentional control. For example, high trait anxiety in students at college and university have resulted in impaired performance during evaluative

procedures (Andrews & Wilding, 2004). Other researchers have revealed a debilitating effect of anxiety on academic performance as well (Rana & Mahmood, 2010). In relation to the impact of anxiety on reading, research reveals a detrimental effect on a variety of verbal tasks such as verbal reasoning (Darke, 1988) and reading comprehension (Calvo et al., 1992).

In contrast, research has also revealed how individuals who are skilled at voluntarily shifting and focusing attention tend to demonstrate better ability at regulating emotions (Derryberry & Rothbart, 1988). Also, activity in the frontal lobes share commonalities with executive functioning and voluntary control of behavior as well as other functions such as impulse control and emotional regulation (Salthouse et al., 2003). Furthermore, research has revealed how the pursuit of long-term goals is related to attentional focus and inhibitory control of those irrelevant feelings that may cause distraction (Kochanska et al., 1996).

To understand how individuals maintain goals in mind in the face of competing options, researchers have revealed the relationship between trait anxiety and attentional control. For example, low self-reported attentional control is associated with anxiety in individuals (Massar et al., 2011). Further research on executive functions has revealed the relationship between trait anxiety and attentional control (Derryberry & Rothbart, 1988; Eysenck et al., 2007).

Although research has revealed how reduced executive functioning is related to higher trait anxiety, however, other research has revealed a far more complex and multi-dimensional relationship. In particular, research on verbal intelligence, as tested by verbal comprehension test, is a positive predictor for worry and rumination, which are characteristics of trait anxiety (Nolen-Hoeksema, 2000; Penney et al., 2015). Furthermore, Coplan et al. (2012) revealed how individuals with higher intelligence had Generalised Anxiety Disorder compared to healthy controls. Other studies reveal an association between anxiety disorders and those with higher verbal reasoning ability (Gale et al., 2013; Smith et

al., 2015). Researchers have suggested that individuals with higher intelligence are more prone to rumination and worry leading to anxiety disorders (Karpinski et al., 2018). These effects may arise because individuals who have clear task goals for demanding tasks will also have higher level of motivation due to perceived failure or negative evaluation because of their anxiety (Eysenck & Derakshan, 2011).

Overall, cognitive processing and anxiety is not always linearly related. Instead, high intelligent groups, who have superior executive functioning and attentional control resulting in better cognitive task scores, are prone to worry and rumination resulting in anxiety (Penney et al., 2015). Furthermore, research has shown curvilinear relationships for performance and anxiety (Bodas & Ollendick, 2005; Hopko et al., 2003). This is a result of high performing and low performing groups who show differences in attentional focus and executive functions.

Research has revealed that high verbal intelligent groups make use of compensatory strategies, such as attentional control mechanisms or executive functions, to offset or cope with their anxiety and achieve task goals (Hayes et al., 2009). To support this, Owens et al. (2014) has revealed that those individuals with higher working memory capacity showed higher test scores for verbal tasks, even though they had high trait anxiety. However, those individuals with low working memory capacity who had high trait anxiety showed lower test scores. Owens et al. (2014) research suggests that those individuals who have greater use and availability of cognitive resources can perform better even with high levels of anxiety.

To explain such findings researchers have referred to the attentional control theory (ACT). Initially ACT was used to explain the adverse effect that anxiety has on the stimulus driven attentional system (Eysenck et al., 2007). However, ACT also suggests that in a goal directed system where the task goals are clear, but where anxiety may be high, then individuals may reduce some of the disruptive effects of anxiety. Since metacognitive ability

is related to executive functions and attentional control then it may be that individuals who have good metacognitive reading strategies will have clear task goals in a goal directed system. Since high verbal reasoning individuals have some levels of anxiety, as suggested by past research, then such effects may be offset by effective metacognitive reading strategies that have clear task goals. ln a meta-analysis on the effect of anxiety on test performance research has revealed null, positive associations, and negative findings (Seipp, 1991). In this sense, moderating factors such as metacognitive reading strategies may explain some of the contradictory findings.

Furthermore, rather than revealing the detrimental role of anxiety on cognitive performance, however, past research also confirms the facilitating effect of moderate levels of anxiety on performance (Fernandez-Castillo & Gutierrez-Rojas, 2009). This coincides with research by Penny et al. (2015) who has revealed how individuals with greater verbal intelligence, who may also have some anxiety, still show good performance on cognitive tasks. In this sense, individuals who have clear task goals for demanding tasks may show better cognitive performance even with high or moderate levels of anxiety as ACT suggests (Eysenck & Derakshan, 2011).

Research has revealed how metacognitive strategies represent a goal driven system that involves the flexible and active use of executive functions. In relation to reading, metacognitive strategies play a crucial role in critical thinking and subsequent comprehension of written text (Brown, 2004; Kuhn & Dean, 2004; Sheorey & Mokhtari, 2001). Due to task demands, as would be expected in a critical thinking reading task for example, individuals will be distracted by competing options resulting in anxiety related thoughts. However, goal directed behavior allows individuals to deploy greater attentional focus resulting in greater levels of shifting and inhibition and control. In this sense, individuals who have effective use of a goal directed system and attentional focus will be associated with lower levels of trait

anxiety compared to those who have less effective use of a goal directed system and attentional focus (Eysenck et al., 2007). However, research also reveals how verbal intelligence, as tested by verbal comprehension test, is a positive predictor for worry and rumination, which are characteristics of trait anxiety (Karpinski et al., 2018; Nolen-Hoeksema, 2000; Penney et al., 2015). Therefore, the research suggests that individuals who have greater executive functioning, as in high verbal intelligent students, may also have moderate levels of anxiety due to increased rumination and worry. However, as ACT suggests, the advantage of having greater availability and use of cognitive resources will allow the individual to offset or cope with the negative effects of anxiety resulting in better cognitive task performance (Eysenck & Derakshan, 2011; Owen et al., 2014).

To measure the impact of an effective goal directed system that has clear task goals then the present study used Mokhtari and Reichard (2002) Metacognitive Awareness of Reading Strategies Inventory (MARSI). The inventory consists of three strategy subscales involved for assessment, which are global reading strategy, problem solving reading strategy, and support reading strategy. In the present study those students who have greater reading strategies should demonstrate higher level of strategy use, which would involve higher-level executive functioning (Muijselaar et al., 2017).

Also, to test for the impact of an effective goal directed system on performance on verbal reasoning tasks the present study used the Watson-Glaser Critical Thinking Appraisal (WGCTA) (Watson & Glaser, 2002). The WGCTA is a verbal reasoning task and is a measure of critical reasoning ability and involves higher measures of intelligence, including fluid ability. Fluid intelligence is the capability to reason and solve novel dilemmas, separate from previously acquired knowledge and skills and is strongly related to executive functioning of working memory (Williams & Prince, 2017).

ACT suggests that if individuals have clear task goals, then they will have greater access to executive functions and attentional control system. Metacognitive strategies involve executive processing that enable a reader to deploy strategies such as planning, monitoring and evaluation whilst maintaining a goal in mind. This will enable more verbally intelligent students to focus attention preferentially through a goal directed system, resulting in higher critical reasoning scores. This will also act to ameliorate the disruptive effects of anxiety (Chamot, 1995). However, research has also revealed that individuals with high verbal reasoning ability will show some levels of anxiety. But any disruption of cognitive processing that may occur could be easily restrained by the effective use of metacognitive strategies in high verbal intelligent individuals.

In terms of the MARSI, researchers have revealed different findings in relation to the use of global reading, problem solving, and support reading strategies. For example, Mokhtari and Reichard (2002) found that better readers reported the use of more problem solving and global solving strategies than poor readers. However, they found no significant differences in the use of support strategies, which suggested that both poor and good readers had similar use of support strategies during reading. However, Cantrell and Carter (2009) showed how good readers reported using global and problem-solving strategies than poor readers, and poor readers used more support strategies than good readers.

To understand the differences that exist in metacognitive strategies for verbal reasoning score, the present study examined differences for global reading, problem solving, and support reading strategies separately. The present study predicts that high global reading and problem solving strategy group will reveal highest WGCTA scores but will reveal moderate levels of anxiety. However, the lower global reading and problem solving strategy groups will reveal lowest WGCTA scores but reveal highest levels of anxiety. Conversely, the present study predicts that the highest support reading strategy group will reveal lowest

WGCTA scores and highest anxiety, but the lowest support reading strategy group will show the highest WGCTA score and moderate, or lower levels of anxiety.

Method

Participants

The study involved a total of 122 undergraduate students (Mean age = 21.16, SD = 4.58). An opportunity sample was taken and participation was voluntary. Also, English was the first language spoken by every participant since the study required good comprehension of English.

Materials

The State-Trait Anxiety Inventory

The State/Trait Anxiety Inventory (STAI) (Spielberger, 1983) was used, which is a 40-item likert-type scale, comprised of two 20-item sub-scales. For this study, only the trait anxiety scale was used for analysis. A reliability analysis on the 'Trait' scale to verify internal consistency ($\alpha = .93$) demonstrated to be above 0.7. This value was considered to be indication of strong reliability (Field, 2005). The STAI scale has demonstrated high internal reliabilities and demonstrated excellent internal consistency (average $\alpha > 0.89$) (Grös et al., 2007).

Metacognitive Awareness of Reading Strategies Inventory

The Metacognitive Awareness of Reading Strategies Inventory (MARSI) (Mokhtari & Reichard, 2002) was used to record participant's awareness of the reading strategies they use when reading. The MARSI consists of 30 statements relating to three type of reading strategies. For each statement, the participants rated how often they used each strategy on a scale from one to five. The MARSI is composed of three categories: global reading strategies (GLOB), problem solving strategies (PROB), and support reading strategies (SUP). The

MARSI has internal reliability of $\alpha = .89$ (Mokhtari & Reichard, 2002). A total score was created by combining all scores from each category.

Watson and Glaser Critical Thinking Appraisal (WGCTA)

The Watson Glaser Critical Thinking Appraisal (WGCTA) was used to test participant's critical thinking for a verbal task (Watson & Glaser, 2002). Furthermore, the WGCTA has split half reliability of $\alpha = 0.77$ (Watson & Glaser, 2002). The test is composed of five sections: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. The score on each of the five sections were combined to give a total score for the WGCTA.

Design

For the present study, the independent variable was the type of reading strategy, which were: global reading strategies (GLOB), problem solving strategies (PROB) and support reading strategies (SUP). Each reading strategy was divided into low, medium, and high group. This meant the study was a between subjects design. There were two dependent variables, which were the total score on the WGCTA, and the trait anxiety score reported on the STAI.

The research has already established the existence of distinct categories, which provides good justification for tertile splits (Garcia & Gracia, 2009; Richmond et al., 2016). For example, high metacognitive reading strategies are related to higher critical thinking abilities (Klinger et al., 2011; Kuhn & Dean, 2004). Furthermore, high verbal intelligent groups reveal high anxiety (Gale et al., 2013; Smith et al., 2015) but also research reveals how high verbal ability in students is associated with lower anxiety (Rana & Mahmood, 2010). In addition, tertile splits are a common and appropriate used approach to examine working memory and executive function differences for verbal reasoning tasks (Alloway et al., 2010; Kaakinen et al., 2003). Specifically, the current experiment has employed the

procedure used by Richmond et al. (2016) and Kaakinen et al. (2003) that split a sample into low, medium, and high working memory capacity groups for verbal comprehension tasks. Furthermore, Aita et al. (2019) used a tertile split procedure to separate participants into low, medium, and high verbal fluency ability groups. Finally, tertile splits were used to evaluate executive functioning (Hill et al., 2012). The current experiment used tertile splits since they are a commonly used approach in examining differences in executive functions and working memory processes for verbal comprehension tasks.

Procedure

On arrival at the study, all participants were given an information sheet about the study, which they were asked to read through and also, they were briefed about the purpose of the study. Following which, participants were given a consent form to sign. Participants were informed they would be completing the WGCTA first. They were given the instructions, and the answer sheet, then asked to complete the practice section at the start to ensure they understood how to complete the task. Once they confirmed they understood how to complete the task then they were told to proceed with the actual test. After completion, the participants were shown the MARSI and the STAI inventory. They were instructed to read the instructions for each scale carefully. Then they were asked to complete each question in accordance with the instructions. After completion, participants were given a debrief information sheet and the researcher's contact details in case of any further questions. All the participants in the study completed the WGCTA and the MARSI and STAI inventory under test conditions.

Results

For all analysis, three separate one-way ANOVAs were conducted for global reading strategy, problem solving strategy, and support reading strategy scores. For each analysis, the reading strategy group was the IV and total critical reasoning score and trait anxiety were the

DVs. A tertile split was conducted at the 33rd and 66th percentiles for each strategy group score. This resulted in Low (n = 40), Medium (n = 41) and High (n = 41) reading strategy groups. Furthermore, the Bonferroni method was used to adjust p values for multiple pairwise comparisons ($p < .05/3 = .017$, corrected for 3 pairwise comparisons) for each type of strategy. This ensured a more conservative correction for multiple testing.

Analysis of global reading strategy and WGCTA score

The analysis demonstrated that there were significant differences between low, medium and high global reading strategy groups for total critical reasoning score, F (2, 119) = 13.29, $p < 0.001$, $\eta^2 = 0.183$

To see differences between low, medium and high global reading strategy group for total critical score, further independent t-test analysis were done. The independent t-test analysis revealed that there was significantly lower critical reasoning score in the low global reading strategy group (M = 57.25, SD = 12.17) than the medium global strategy group (M = 63.95, SD = 11.02), t(79) = -2.60, p = 0.011, 95% CI [-11.83, -1.57], d = 0.58 (medium effect size). Also there was significantly lower critical reasoning score in the low global reading strategy group (M = 57.25, SD = 12.17) than the high global reading strategy group (M = 70.46, SD = 11.39), t(79) = -5.05, p < 0.001, 95% CI [-18.42, -8.00], d = 1.12 (large effect size). Also there was significantly lower critical reasoning score in the medium global reading strategy group (M = 63.95, SD = 11.02) than the high global reading strategy group (M = 70.46, SD = 11.39), t(80) = -2.63, p = 0.01, 95% CI [-11.44, -1.59], d = 0.58 (medium effect size). The significant results reveal that high global reading groups outperform lower global reading in critical reasoning due to the effective use of global reading strategies (see also table 1).

Analysis of global reading strategy and trait anxiety

The analysis demonstrated that there were significant differences between low, medium and high Global reading strategy groups for trait anxiety, F (2, 119) = 13.61, p < 0.001, $\eta^2 = 0.186$

To see differences between low, medium and high Global reading strategy group for trait anxiety, further independent t-test analysis were done. The independent t-test analysis revealed that there was significantly higher trait anxiety in the low Global reading strategy group (M = 52.25, SD = 9.98) than the medium Global reading strategy group (M = 39.88, SD = 11.29), t(79) = 5.22, p < 0.001, 95% CI [7.65, 17.09], d = 1.16 (large effect size). Also there was a significantly higher trait anxiety in the low Global reading strategy group (M = 52.25, SD = 9.98) than the high Global reading strategy group (M = 45.41, SD = 10.72), t(79) = 2.97, p = 0.004, 95% CI [2.25, 11.42], d = 0.66 (medium effect size). Also there was significantly lower trait anxiety in the medium Global reading strategy group (M = 39.88, SD = 11.29) than the high Global reading strategy group (M = 45.41, SD = 10.72), t(80) = -2.28, p = 0.025, 95% CI [-10.38, -0.70], d = 0.50 (medium effect size), however, after Bonferroni correction this was non-significant. The significant results reveal that low global reading groups reveal higher trait anxiety than higher global reading groups (see also table 2).

Analysis of problem solving strategy and WGCTA score

The analysis demonstrated that there were significant differences between low, medium and high problem solving strategy groups for total critical reasoning score, F (2, 119) = 9.95, p < 0.001, $\eta^2 = 0.143$

To see differences between low, medium and high problem solving strategy groups for total critical score, further independent t-test analysis were done. The independent t-test analysis revealed that there was significantly lower critical reasoning score in the low problem solving strategy group (M = 57.85, SD = 13.01) than the medium problem strategy group (M = 64.29, SD = 10.63), t(79) = -2.44, p = 0.017, 95% CI [-11.69, -1.19], d = 0.54

(medium effect size). Also there was significantly lower critical reasoning score in the low problem solving strategy group (M = 57.85, SD = 13.01) than the high problem solving strategy group (M = 69.54, SD = 11.69), t(79) = 4.26, p < 0.001, 95% CI [-17.15, -6.22], d = 0.95 (large effect size). Also there was significantly lower critical reasoning score in the medium problem solving strategy group (M = 64.29, SD = 10.63) than the high problem solving strategy group (M = 69.54, SD = 11.69), t(80) = -2.12, p = 0.037, 95% CI [-10.16, -0.33], d = 0.47 (small effect size). However, after Bonferroni correction this was non-significant. The significant results reveal that high problem solving groups outperform lower problem solving groups in critical reasoning due to the effective use of problem solving strategies (see also table 1).

Analysis of problem solving strategy and trait anxiety

The analysis demonstrated that there were significant differences between low, medium and high problem solving strategy groups for trait anxiety, F (2, 119) = 10.31, p < 0.001, $\eta^2 = 0.148$

To see differences between low, medium and high problem solving strategy group for trait anxiety, further independent t-test analysis were done. The independent t-test analysis revealed that there was significantly higher trait anxiety in the low problem solving strategy group (M = 51.33, SD = 10.79) than the medium problem solving strategy group (M = 40.29, SD = 11.99), t(79) = 4.35, p < 0.001, 95% CI [5.98, 16.08], d = 0.97 (large effect size). Also there was a significantly higher trait anxiety in the low problem solving strategy group (M = 51.33, SD = 10.79) than the high problem solving strategy group (M = 45.90, SD = 9.92), t(79) = 2.36, p = 0.021, 95% CI [0.84, 10.01], d = 0.52 (medium effect size), however, after Bonferroni correction this just missed significance. Also there was significantly lower trait anxiety in the medium problem solving strategy group (M = 40.29, SD = 11.99) than the high problem solving strategy group (M = 45.90, SD = 9.92), t(80) = -2.31, p = 0.024, 95% CI [-

10.45, -0.77], d = 0.51 (medium effect size). However, after Bonferroni correction this was non-significant. The significant results reveal that low problem solving groups reveal higher trait anxiety than higher problem solving groups (see also table 2).

Analysis of support reading strategy and WGCTA score

The analysis demonstrated that there was a non-significant difference between low, medium and high support reading strategy groups for total critical reasoning score, F (2, 119) = 0.45, p= 0.64, η^2 = 0.007

To see differences between low, medium and high support reading strategy group for total critical score, further independent t-test analysis were done. The independent t-test analysis revealed higher critical reasoning score in the low support reading strategy group (M = 63.65, SD = 13.80) than the medium support reading strategy group (M = 62.78, SD = 11.14), but was non-significant, t(79) = 0.31, p = 0.76, 95% CI [-4.67, 6.41], d = 0.07 (low effect size). Also there was lower critical reasoning score in the low support reading strategy group (M = 63.65, SD = 13.80) than the high support reading strategy group (M = 65.39, SD = 13.07), but was non-significant, t(79) = -0.58, p = 0.56, 95% CI [-7.68, 4.20], d = 0.13 (low effect size). There was lower critical reasoning score in the medium support reading strategy group (M = 62.78, SD = 11.14) than the high support reading strategy group (M = 65.39, SD = 13.07), but was non-significant, t(80) = -0.97, p = 0.33, 95% CI [-7.95, 2.73], d = 0.21 (low effect size). The results reveal that greater use of support reading strategies does not result in significantly higher critical reasoning scores compared to groups with lower support reading strategy use (see also table 1).

Analysis of support reading strategy and trait anxiety

The analysis demonstrated that there was a non-significant difference between low, medium and high support reading strategy groups for trait anxiety, F (2, 119) = 2.92, p = 0.058, η^2 = 0.047

To see differences between low, medium and high support reading strategy group for trait anxiety, further independent t-test analysis were done. The independent t-test analysis revealed that there was higher trait anxiety in the low support reading strategy group (M = 46.90, SD = 10.83) than the medium support reading strategy group (M = 42.32, SD = 12.03), but was non-significant, t(79) = 1.80, p = 0.076, 95% CI [-0.48, 9.65], d = 0.40 (low effect size). Also there was a lower trait anxiety in the low support reading strategy group (M = 46.90, SD = 10.83) than the high support reading strategy group (M = 48.20, SD = 11.78), but was non-significant, t(79) = -0.52, p = 0.61, 95% CI [-6.30, 3.71], d = 0.11 (low effect size). Also there was lower trait anxiety in the medium support reading strategy group (M = 42.32, SD = 12.03) than the high support reading strategy group (M = 48.20, SD = 11.78), which was significant, t(80) = -2.24, p = 0.028, 95% CI [-11.11, -0.65], d = 0.49 (low effect size), however, after Bonferroni correction this was non-significant. The results reveal that low support reading groups do not have significantly higher trait anxiety than higher support reading groups (see also table 2).

Discussion

The present study revealed that high global reading strategy and high problem solving strategy group revealed significantly higher total critical reasoning scores (WGCTA) than medium and low reading strategy group. However, higher support reading strategies resulted in non-significant WGCTA scores.

The data coincides with research on students with higher metacognitive strategies, who demonstrate greater attentional focus towards relevant parts of the text due to the presence of objectives in mind (Kuhn & Dean, 2004; Sheorey & Mokhtari, 2001). Conversely, students who had low metacognitive reading strategies revealed low WGCTA scores, which further supports past research (Klinger et al., 2011). Furthermore, research by Fazal-ur et al. (2010) on chemistry students revealed how performance was associated with

greater metacognitive awareness. Also, Rysz (2004) has revealed how greater cognitive awareness and self-monitoring during reading resulted in better performance in students. The findings reveal that students use a variety of reading strategies, which reflects the active use of executive functions by a goal driven system (Kieffer et al., 2013; Pressley, 2002).

However, high problem solving and global reading strategy groups had higher trait anxiety scores compared to the medium metacognitive strategy groups, but was lower compared to the low metacognitive strategy groups. After Bonferroni corrections, two out of six comparisons were non-significant and an additional one comparison just missed significance. The findings do support past research that has revealed contradictory findings in students that have shown positive, negative and null findings (Bodas & Ollendick, 2005; Hopko et al., 2003; Rana & Mahmood, 2010; Seipp, 1991).

To explain the findings, researchers refer to ACT, which initially explains the adverse effect of anxiety on the stimulus driven attentional system (Eysenck & Derakshan, 2011). However, any negative effects can be reduced by making extensive use of compensatory strategies, such as attentional control mechanisms and by having clear task goals (Hayes et al., 2009). For example, Owens et al. (2014) has revealed that greater use and availability of cognitive resources results in better performance and offset the negative effects of anxiety. To support this proposition, high verbal intelligent individuals, who show high trait anxiety, continue to demonstrate high verbal comprehension ability (Gale et al., 2013; Nolen-Hoeksema, 2000; Penney et al., 2015; Smith et al., 2015). This may be due to more rumination and worry due to high personal expectations leading to anxiety in high verbal intelligent students (Abdollahi & Talib 2015; Coplan et al., 2012; Karpinski et al., 2018). Furthermore, research by Chamberlain et al. (2011) on students revealed how anxiety aided exam performance and only adversely affected a few of them. This means the development of

effective strategies to ameliorate some of the negative effects of anxiety may be a commonly used approach amongst particularly verbal intelligent students (Eysenck et al., 2007).

The current experiment has revealed an interesting approach of using metacognition as a variable to understand levels of anxiety and WGCTA scores. In the past, research has revealed how trait anxiety could act as a variable, which may hinder the development of metacognitive skills, or even obscure it, and prevent critical thinking. For example, research has revealed that lower levels of anxiety are associated with higher cognitive skills (Eysenck et al., 2007). However, more modern research has revealed how the use of metacognitive reading strategies in skilled readers enables them to deploy appropriate executive functions and increase attentional focus resulting in better performance and emotional constraint (Muijselaar & Jong, 2015; Yuksel & Yuksel, 2012). This coincides with the direction of studies that have used verbal intelligence as a variable rather than anxiety. In this sense, the approach used in the current experiment overlaps with past approaches and reveals similar findings. In other words, the use of flexible reading strategies allows high verbal intelligent students to reduce attentional disruption due to anxiety.

Furthermore, the approach in the current experiment overlaps with research on the revised Blooms taxonomy (Anderson et al., 2001). In Blooms taxonomy, cognitive units, such as critical thinking are separate from knowledge units, such as metacognition, which exists at the highest level, and represents the awareness of one's own cognition (Anderson et al., 2001). As students develop metacognitive knowledge, they are able to apply more cognitive skills such as critical thinking, or creativity. Using the revised Blooms taxonomy Zhao et al. (2014) revealed how the development of metacognitive learning strategies in students led to increased evaluative and critical thinking skills, resulting in improved exam performance. Also, Klebba and Hamilton (2007) revealed how differences existed in critical thinking skills and metacognitive knowledge between those students who attended a course

that used Bloom's taxonomy and a course that did not. Also, Razmjoo and Madani (2013) used the revised Bloom's Taxonomy and showed how cognitive skills, such as critical thinking, and high order knowledge, such as metacognition, differed in university students. Essentially, the revised Bloom's taxonomy reveals how the development of high order skills, such as metacognition, can aid cognitive skills, such as critical thinking. Both the current research and the revised Blooms taxonomy inform us of the importance of the development and learning of metacognitive knowledge. This enables students to adopt strategies to conduct high order tasks, which would result in the reduction of any negative effects from anxiety.

For the current experiment, Bonferroni corrections were applied, however, the conservative use of Bonferroni criteria may have resulted in failure to demonstrate differences between conditions, even though past research has demonstrated significant differences in these groups. Nevertheless, the non-significant findings after Bonferroni corrections may be due to the small sample size used in the experiment. Research has revealed that metacognitive strategies encompass a variety of cognitive abilities; however, this is dependent on individual differences that exist in working memory, anxiety and verbal tasks (Owens et al., 2014). Since metacognition involves processes that coordinate cognition, then presumably regulating one's metacognition would also differ in a student population. For this reason, Ariasi and Mason (2014) recommend the use of large sample sizes when measuring working memory. In the current experiment, the small sample size may have been a combination of high metacognitive reading strategy group containing high verbal intelligent students with high anxiety, and good comprehension students who had lower anxiety. This coincides with past research that has revealed the existence of a variety of individual differences in samples. For example, research reveals high anxiety amongst high verbal intelligent groups (Gale et al., 2013; Smith et al., 2015) but also the existence of negative

relationships between anxiety and verbal ability in students (Rana & Mahmood, 2010; Zuckerman & Spielberger, 2015). Furthermore, the high and low support reading strategy groups revealed non-significance, which may have contained greater individual differences resulting in greater variance in the sample. Again, past research reveals contradictory findings in relation to support reading strategies in students, which supports the existence of greater individual differences (Cantrell & Carter, 2009; Mokhtari & Reichard, 2002). Future research should include large sample sizes to ensure a balanced distribution of categories resulting in an accurate representation of the distinct groups that is reported in the literature. Finally, the effect sizes reported in the analysis for the global reading strategy and problem solving strategy were large. This provides support to further examine the magnitude of differences that may exist between metacognitive groups.

Overall, the current findings support past research on metacognitive reading strategies and the role it plays in critical thinking and subsequent comprehension of written text as well as offsetting any effects of anxiety. To gather a greater understanding of academic performance more research is needed to understand how students apply the ability to critically evaluate and comprehend written text (Brown et al., 1986; Garner, 1987).

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Table 1

Mean and standard deviations scores for total critical thinking score (WGCTA) between low, medium, and high groups for global reading, problem solving and support reading strategies.

	Critical thinking score (WGCTA)	
Metacognitive strategy	*M*	*SD*
Global reading strategy		
Low (N = 40)	57.25	12.17
Medium (N = 41)	63.95	11.02
High (N = 41)	70.46	11.39
Problem solving strategy		
Low (N = 40)	57.85	13.01
Medium (N = 41)	64.29	10.63
High (N = 41)	69.54	11.69
Support reading strategy		
Low (N = 40)	63.65	13.80
Medium (N = 41)	62.78	11.14
High (N = 41)	65.39	13.07

Table 2

Mean and standard deviations scores for trait anxiety between low, medium, and high groups for global reading, problem solving and support reading strategies.

	Trait anxiety	
Metacognitive strategy	*M*	*SD*
Global reading strategy		
Low (N = 40)	52.25	9.99
Medium (N = 41)	39.88	11.29
High (N = 41)	45.41	10.72
Problem solving strategy		
Low (N = 40)	51.33	10.79
Medium (N = 41)	40.29	11.99
High (N = 41)	45.90	9.92
Support reading strategy		
Low (N = 40)	46.90	10.83
Medium (N = 41)	42.32	12.03
High (N = 41)	48.20	11.78