The Reflective Mind of the Anxious in Action

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The Attentional Control Theory (ACT) posits that, while trait anxiety may not directly impact performance, it can influence processing efficiency by prompting the use of compensatory mechanisms. The specific nature of these mechanisms, which might be reflective, is not detailed by the ACT.

Keywords: attentional control theory ; executive function ; anxiety

1. Trait Anxiety and Working Memory

The connection between trait anxiety and working memory (WM) is complex, with initial research producing varied and sometimes contradictory outcomes. Eysenck [1] noted that trait anxiety had no effect on digit span (a measure of WM, discussed later) in nine studies. Among those studies that did show significant effects, some demonstrated a positive relationship between trait anxiety and WM, while others showed a negative relationship or no relation at all. In order to explain these differences, the Processing Efficiency Theory (PET) posits that trait anxiety does not necessarily affect performance accuracy (effectiveness) in a task, but rather the speed and cognitive load (efficiency). In other words, for individuals who are predisposed to experiencing anxiety, the cognitive cost and speed of processing a task may be greater [2]. The theory proposes that anxious individuals allocate additional processing resources to implement compensatory strategies designed to improve their performance. According to Owens et al. [3], this advantage is possible for individuals with cognitive resources—such as high working memory, in their study—to compensate for or cope with the negative effects of anxiety. This is why the Attentional Control Theory (ACT), an extension of the PET, predicts that the repercussions would be more likely to manifest when cognitive functions requiring attentional control are engaged [4][5]. The ACT, aligning with Miyake et al.'s model [6], specifically focuses on three major executive functions (EFs): inhibition, updating, and shifting. These functions are crucial for guiding, controlling, and regulating actions and behaviors which are essential to learning and daily tasks [7]. Initially, the Attentional Control Theory (ACT) posited that anxiety would specifically impact inhibition and flexibility, but not updating [8]. This function, defined as "the constant monitoring and rapid addition/removal of contents from working memory" [9] (p. 9), was thought to be sensitive to anxiety only in threatening situations (e.g., using anxiety-inducing words as stimuli). However, Gustavson and Miyake [10] proposed that working memory updating is often assessed in terms of memory span (effectiveness) while the effects of anxiety might be more pronounced in response times (efficiency). Utilizing a computerized task for updating memory, their work confirmed anxiety's impact on efficiency rather than effectiveness, in line with the ACT. The neutral nature of the words used in their study also does not support the ACT's proposal of an impact of anxiety on updating in threatening situations. Furthermore, the ACT suggests that it is necessary for the tasks used to involve attentional control in order for anxiety to have a significant and detrimental effect [8]. In this regard, Moran [11] highlights a more pronounced effect of anxiety on measures of complex span tasks in which simultaneous processing of the items to be remembered is preceded or followed by concurrent activity [12]. Simpler tasks, such as digit span, which do not involve simultaneous processing, would only rely on storage and repetition of the elements to be remembered, making them less sensitive to anxiety. This type of task has been extensively studied, but it has been gradually overshadowed by tasks considered to be more complex and more appropriate for assessing working memory. This leads us to consider the digit span task, a classic yet nuanced tool in cognitive assessment that is still widely used in neuropsychological test batteries. This task comprises multiple subtests, and some researchers or clinicians may consider the forward digit recall component as assessing short-term memory, while backward recall may require more attention, making it a complex span task reflecting both the phonological loop and the central executive of WM [13][14]. Schmeichel [15] reported that backward span was sensitive to reduced executive capacity following previous executive control efforts. He concluded that inhibition, used to test executive control, relied on an underlying capacity shared with information updating. However, St Clair-Thompson and Allen [16] conducted a comparative study of these two tasks and concluded that backward recall behaved more like a simple span task, with relatively minimal additional processing required only during the recall stage. This is consistent with similar findings [17]: backward and forward span reflect the same cognitive abilities. As suggested by Schmeichel's study [15], adding a sequencing task to the digit span (e.g., ascending order sequencing) could make the total score more representative of

complex WM, but evidence does not support this [18]. Considering the observations made by Gustavson and Miyake [10] about the incomplete assessment of working memory tasks when limited to memory span, and its frequent use in clinical settings, it is justified to continue evaluating the digit span task from various angles to analyze the impact of anxiety on this task.

2. Attentional Control Theory and Measurement

At first glance, simple tasks may seem less relevant for research protocols focusing on the evaluation of the ACT. However, the ACT has primarily been studied at an algorithmic level rather than a reflexive level [19][20]. Toplak et al. [21] sought to understand and explain the existing differences in measurements of executive functions (EFs). Drawing on Stanovich's framework [22][23], they propose that the questionnaire-based assessment of EFs may reflect an individual's goals, beliefs associated with those objectives, and the selection of reasoned actions guided by those objectives and beliefs (referred to as the reflexive level). Tasks assessing EF performance allow for the observation of underlying information processing mechanisms, including processes like information coding, perceptual encoding, long-term memory utilization, etc. (referred to as the algorithmic level). Both levels of thinking are likely to be engaged by the compensatory strategies of the ACT when a specific goal is given.

A study by Cécillon et al. [24] has shown some initial interesting findings. They suggest an impact of the reflexive level on the amplification of trait anxiety, which would explain the consequences of problematic behaviors related to EFs and academic outcomes in adolescents. Although they did not measure EF performance, the authors concluded that overreliance on the reflexive level to compensate for performance in anxious individuals could lead to cognitive resource depletion, thus increasing the manifestation of these problematic behaviors as reported by parents in daily life. In this regard, Stanovich [23] emphasizes that both the reflexive and algorithmic levels are slow, require a great deal of attention, and interfere with our thoughts and actions. Compensatory strategies can manifest from both an algorithmic perspective—through a reorientation of information processing—and a reflexive perspective—through changes in goals or beliefs related to one's performance. In other words, the ACT states that effects of anxiety on performance can be observed in certain tasks, such as demanding complex span tasks. Conversely, simple span tasks that require minimal attentional resources should not be affected by trait anxiety. However, the contribution of Stanovich's theory suggests that the repercussions of anxiety could also be visible at a reflexive level, which may not be directly observable in the performance itself. Currently, ACT theorists propose that, if no performance differences are observed between anxious and non-anxious individuals, other indicators are available to account for the additional processing cost, such as an increased response time, heightened conflict monitoring after errors (detected by a high amplitude of the Error-Related Negativity signal), higher error rates, etc. [20][25]. Here again, the ACT considers behavioral indicators as if compensatory strategies only pertain to the algorithmic level.

3. Executive Function and Emotion Regulation

Previously, researchers discussed the involvement of anxiety in executive functions (EFs). In their literature review on EFs, Baggetta and Alexander [7] note that EFs are cognitive processes that also involve the socio-emotional domain. The most influential model that considers this domain is the one proposed by Zelazo and Cunningham [26]. They postulate the existence of distinct pathways that work together depending on the presence or absence of emotions in information processing. "Cool" executive functions are used when individuals face abstract and decontextualized problems. "Hot" executive functions are engaged in tasks requiring emotion regulation to achieve a goal or when the individual is actively involved and motivated in the task. The ACT predicts that, if the task is non-demanding or lacks clear objectives, anxious individuals will have little motivation to use attentional control mechanisms. However, for demanding tasks with specific objectives, the level of motivation would be high [3][19]. It is in these cases that anxious individuals would extensively employ compensatory strategies. According to this hypothesis, the tasks that are most sensitive to anxiety are, by extension, those that engage "hot" executive functions and emotion regulation. Compensatory strategies may be represented, in part, at a reflexive level, by conscious attempts to reduce unpleasant emotions experienced during the task to improve performance. This field was extensively investigated on the basis of conscious emotion regulation strategies (ERS) by developing the Cognitive Emotion Regulation Questionnaire (CERQ) [27]. In this questionnaire, certain strategies are considered adaptive, such as Refocuson planning or Acceptance, and others are considered maladaptive, such as Self-blame or Catastrophizing. While this binary distinction has been criticized and updated by Ford et al., it remains useful for highlighting thought patterns that may influence the maintenance of anxiety or performance in tasks involving executive functions [28]. ERSs have consistently been associated with psychopathology, specifically anxiety. The meta-analysis by Aldao et al. revealed that maladaptive ERSs (Rumination, Avoidance, and Suppression) were associated with greater psychopathology, while adaptive ERSs (Acceptance, Reappraisal, and Problem-solving) were

associated with lower psychopathology across various psychological disorders [29]. Maladaptive ERSs showed a stronger association with psychopathology compared to adaptive ERSs, with the exception of problem-solving. Different associations were observed between mood disorders such as anxiety and depression, and externalizing disorders (substance use and eating disorders), suggesting that the use of ERSs may have different effects on behaviors or emotions. Significant associations between adaptive and maladaptive ERSs and symptoms of anxiety and depression were also described in another meta-analysis conducted with adolescents [30]. A Japanese meta-analysis examining the CERQ and its relation to anxiety (8 studies) and depression (16 studies) confirmed previous findings [31]. Some strategies yielded unexpected results, such as Blaming Others and Acceptance, which were positively associated with anxiety and depression. Although the direction of the relationship was as expected, Blaming Others had the smallest absolute value. Regarding Acceptance, Wilson suggests that it can be applied actively as a form of self-assertion or passively as a form of resignation [32]. Therefore, the sensitivity of the questionnaire, especially concerning this strategy, hinges on the individual's interpretation of acceptance. Despite the instrument's shortcomings and the simplistic binary framework for understanding emotion regulation strategies (ERSs), these strategies are probably significant in the interplay between anxiety and executive functions (EFs). McLaughlin et al. demonstrated that emotional dysregulation could be the cause of anxiety rather than the reverse [33]. ERSs may act upstream of anxiety. However, these conclusions should not be overgeneralized. While their study has robust internal validity, the questionnaires used limit the generalizability of their findings [24]. Researchers suggest continuing to conduct correlations rather than regressions until further studies have been conducted which incorporate additional tools. Regarding the link between ERSs and Executive Functions (EFs), several studies have shown significant correlations between ERSs and EFs as assessed by parents [24][34]. These studies found that adolescents reporting the use of maladaptive ERSs (except for Blaming Others) were more likely to exhibit problematic behaviors related to EFs, as evaluated by the Behavior Rating of Executive Function (BRIEF) [35][36]. Conversely, adaptive ERSs were correlated with less problematic behaviors, except for positive refocusing and reappraisal. Most studies have focused on the influence of cognitive abilities on emotion regulation [37]. Studies on WM suggest that individuals with a low updating capacity may have depleted most of their executive resources, making it difficult for them to regulate their emotional experiences effectively [38][39]. In this regard, Barkus's recent literature review [40] reveals that the increased rejection of maladaptive ERSs could be explained by a greater WM capacity. However, the results were more mixed regarding the influence of WM on the choice of adaptive ERSs [40]. In fact, the development of adaptive ERSs is not necessarily linked to greater EF capabilities [41][42]. For example, Veloso and Ty showed that training in emotional WM was associated with a decrease in trait anxiety, but it did not improve ERSs [43]. The authors argue that training individuals to divert their attention from emotionally salient stimuli and focus on task-relevant information may indeed impact some ERS processes, but not the ones examined in their study (Reappraisal and Suppression). These findings complement those of Pe et al. [38], who suggested that effective updating abilities can preserve cognitive resources for emotion regulation. Some researchers have also attempted to characterize the direction of the relationship between EFs and ERSs. One of the few studies that investigated the influence of emotion regulation on EFs provided evidence that inhibition, but not switching, was more strongly engaged during emotion regulation, leading to interference with the task [44]. Considering the ACT, this suggests that emotion regulation should be considered when studying the relationship between anxiety and EF performance. In this context, the use of working memory tasks such as the digit span might provide limited information about the link between anxiety, emotion regulation, and performance. N-back tasks can provide a wealth of information about how a person makes decisions and mobilizes their capacities. Meule [45] argues that the accuracy score and RT are not interchangeable and provide non-redundant information. Additionally, Meule suggests using omissions (not pressing a button) and commissions (making an error by clicking the wrong button), which would provide additional information on the participants' decision-making. Therefore, the use of this type of working memory task employing emotional stimuli could be an opportunity to better understand the ACT in connection with emotion regulation strategies. The use of maladaptive ERSs could create an interference effect in the task, which could explain the lower efficiency among anxious individuals.

4. Metacognitive Beliefs

Wells [46] proposed a theory and therapy aimed at addressing thoughts that may exacerbate or maintain mood disorders, including anxiety. According to Wells, there is a metacognitive thinking mode that leads individuals to view mental events, perceptions, or emotions as separate from themselves. In contrast, the object mode encourages individuals to see these elements as integral to themselves [46]. These specific thinking styles influence individuals to use strategies to regulate their thoughts and feelings. In the object mode, individuals adhere to certain metacognitive beliefs that perpetuate and exacerbate biased threat evaluation. For example, a positive belief in worry, such as "I need to worry in order to work well," encourages vigilance toward threatening stimuli, while beliefs about thought control (Control factor), such as "If I did not control a worrying thought, and then it happened, it would be my fault," prevent individuals from changing their perspective. It is worth noting that the latter example can significantly contribute to the use of maladaptive ERSs, such as

Self-blame in the CERQ. Other negative beliefs, such as “My worrying could make me go mad,” are likely to increase feelings of danger significantly and persistently. The MetaCognition Questionnaire (e.g., MCQ-65) [47] was developed to assess these beliefs, as well as a lack of confidence in one’s cognitive resources and awareness of one’s thoughts. In adults, this scale has been highly effective in explaining the propensity to experience anxiety (explaining 83% of the variance) [48]. Some findings show that the subscale of negative metacognitive beliefs (MCneg) is consistently linked to various symptoms, including anxiety, in both clinical and non-clinical populations [48][49][50]. Similarly, the global scale and MCneg predict the use of maladaptive ERSs or emotional dysregulation in several studies with healthy individuals [51][52][53]. In contrast, positive metacognitive beliefs and the Consciousness scale have less pronounced effects than the other subscales [54][55][56]. The studies by Mansuetto et al. [57] and Laghi et al. [58] highlight that the Consciousness scale had an inverse relationship with emotional dysregulation. In other words, focusing attention on one’s thoughts was associated with better emotional regulation. Cécillon et al. [24] demonstrated in French adolescents that the Consciousness scale was associated with the use of both maladaptive and adaptive ERSs. The authors concluded that being aware of one’s thoughts prompts individuals to choose ways to regulate their emotions that may not necessarily be maladaptive. Like Sica et al. [59], they propose revising this subscale to emphasize the negative aspects of excessive and rigid consciousness to better represent the object mode advocated by Wells [46].

Ultimately, this new reflective variable has strong links with emotion regulation and anxiety. However, not all sub-scales of the MCQ have the same relationship with trait anxiety and ERSs, which will not necessarily affect information processing in the same way. Spada et al. [60] highlighted how the MCneg and Control factors create a cognitive gridlock, which produces even more worry. Preliminary evidence has been provided on the involvement of metacognitive beliefs in a difficulty to use executive functions [61], including working memory [62]. Therefore, metacognitive beliefs could play a role in the interference of information processing in working memory tasks.

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