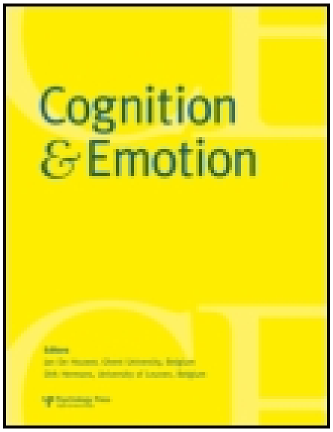

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Flexible control in processing affective and non-affective material predicts individual differences in trait resilience

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BRIEF REPORT

Flexible control in processing affective and non-affective material predicts individual differences in trait resilience

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Trait resilience is a stable personality characteristic that involves the self-reported ability to flexibly adapt to emotional events and situations. The present study examined cognitive processes that may explain individual differences in trait resilience. Participants completed self-report measures of trait resilience, cognitive flexibility and working memory capacity tasks, and a novel affective task-switching paradigm that assesses the ability to flexibly switch between processing the affective versus non-affective qualities of affective stimuli (i.e., flexible affective processing). As hypothesised, cognitive flexibility and flexible affective processing were unique predictors of trait resilience. Working memory capacity was not predictive of trait resilience, indicating that trait resilience is tied to specific cognitive processes rather than overall better cognitive functioning. Cognitive flexibility and flexible affective processing were not associated with other trait measures, suggesting that these flexibility processes are unique to trait resilience. This study was among the first to investigate the cognitive abilities underlying trait resilience.

Keywords: Resilience; Cognitive flexibility; Executive control; Task-switching.

People differ in how they react to negative life events such as the death of a loved one or being the victim of sexual assault. Numerous studies have shown that negative life events such as these lead some people to experience extreme distress for long periods of time, which may result in the development of debilitating psychological disorders. Defying the common assumption that severe negative experiences invariably lead to disruption and pathology, research has shown that many individuals maintain a stable pattern of healthy functioning or experience positive growth in the wake of a negative life event (Bonanno, 2004). Surprisingly, little is known about the protective factors that foster adaptive outcomes in adults faced with adversity (Bonanno, 2004; Campbell-Sills, Cohan, & Stein, 2006). The goal of the current study was to explore the cognitive

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mechanisms that promote psychological resilience among adults.

Researchers have used various methods to measure resilience; some examine level of distress after a negative event (e.g., Bonanno, Papa, Lalande, Westphal, & Coifman, 2004), while others administer self-report scales to measure trait resilience. Trait resilience can be conceptualised as a stable personality characteristic that involves the ability to bounce back from negative life events and adapt to both significant negative life events and more minor everyday stressors (Block & Kremen, 1996, Ong, Bergeman, Bisconti, & Wallace, 2006). Several recent studies have demonstrated that trait resilience is associated with successful psychological and physiological adaptation to stress (Campbell-Sills et al., 2006; Fredrickson, Tugade, Waugh, & Larkin, 2003).

At its core, the construct of trait resilience involves flexibility in adapting to change. Accordingly, some authors have linked resilience to flexibility in thinking. Fredrickson's (2001) broaden-and-build theory, for example, proposes that positive emotions promote cognitive broadening and flexibility, which, in turn, leads to increased resilience. Empirical support for this model stems from studies that show that positive affect increases flexibility in thinking (Isen, 2002) and promotes broader attention (Fredrickson & Branigan, 2005), and that positive affect is associated with trait resilience (e.g., Fredrickson et al., 2003). Empirical investigations that demonstrate a direct link between trait resilience and cognitive flexibility would lend additional support for this model.

Cognitive flexibility is part of executive functioning and involves the ability to shift a course of thought or action according to the changing demands of the situation (Lezak, 1995). Executive functions entail a variety of higher order cognitive processes that play an important role in the top-down control of thoughts and actions based on internal representations of goals (Zelazo & Cunningham, 2007). Cognitive flexibility involves two central components (e.g., Miyake, Friedman, Emerson, Witzki, & Howerter, 2000): inhibition and shifting. Inhibition involves the ability to override prepotent responses and to inhibit the processing of irrelevant material. Shifting involves switching back and forth between mental sets by activating relevant material and disengaging from irrelevant material.

Researchers have recently suggested that cognitive flexibility is linked to emotion regulation (ER; Ochsner & Gross, 2007). Conversely, research has demonstrated that deficits in executive functioning are associated with emotion dysregulation. Cognitive *inflexibility* has been associated with both depression and rumination, a maladaptive thought pattern that involves focusing attention on one's negative emotional state (Cannon, 1996; Whitmer & Banich, 2007). Hence, one way in which cognitive flexibility may be linked to trait resilience is by promoting effective ER. Indeed, previous research suggests that trait resilience is strongly tied to effective ER. Ong et al. (2006), for example, conducted a daily diary study with bereaved widows and found that participants with high levels of trait resilience reported less negative emotion in response to daily stressors than participants with low levels of trait resilience. The idea that cognitive flexibility promotes trait resilience by enabling effective ER also suggests that flexibility may be especially important for the processing of *emotional* material. Traditional cognitive flexibility tasks, however, fail to incorporate affective stimuli. Given that the ability to flexibly attend to and disengage from emotional material is crucial for effective emotion regulation (Gross, 2007), cognitive flexibility with affective material or "flexible affective processing" may be a critical process underlying resilience.

In summary, cognitive processes that promote flexibly attending to and disengaging from emotional material should be essential for adaptive responses seen in highly resilient people. We predict that trait resilience involves both general cognitive flexibility and "flexible affective processing", which we define as the specific ability to switch back and forth between processing the affective versus non-affective qualities of affective information. We believe that the capacity to flexibly process affective information is critically involved in meeting emotional demands in affectively laden situations. Importantly, our conceptualisation of "flexible affective processing" focuses on switches in the processing of affective material and not on switches between experienced emotional states. While we believe that flexible affective processing is essential for effective ER, this link is not the primary focus of the current study.

Goals of the present study

A primary goal of the present study was to develop a sound operationalisation of flexible affective processing. We measured both cognitive flexibility and flexible affective processing using a standard and an affective task-switching paradigm, respectively. Both tasks measured the ability to switch back and forth between mental tasks by activating new task sets and inhibiting irrelevant task sets. Our main predictions were: (a) individual differences in general cognitive flexibility are related to individual differences in trait resilience; and (b) individual differences in flexible affective processing are especially predictive of individual differences in trait resilience.

METHOD

Participants

Participants were 41 female and 23 male introductory psychology students (mean age = 19) who participated for course credit.

Materials

Resilience measures. Participants completed two self-report measures of resilience: the Ego-Resiliency Scale (ER89; Block & Kremen, 1996) and the Connor–Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003). Both the ER89 and CD-RISC have high internal consistency in non-clinical samples with alphas of .76 and .89, respectively (Block & Kremen, 1996; Connor & Davidson, 2003). In this sample, the alphas for the ER89 and CD-RISC were .70 and .87, respectively. Both scales have shown convergent validity with related constructs.

Additional trait measures. Participants completed the extroversion and neuroticism subscales of the Revised NEO Five-Factor Inventory (NEO-FFI; McCrae & Costa, 2004), and the Behavioural Inhibition/Behavioural Activation Scale (BIS/BAS; Carver & White, 1994) to measure an individual's responsiveness to reward (BAS) and sensitivity to punishment (BIS).

Measure of general cognitive flexibility. A modified version of Schneider and Logan's (2005) task-switching task was administered. Participants were presented with a cue ("odd–even" or "higher than 5–lower than 5") and a number (between 1 and 9), simultaneously.

Participants categorised the number according to the rule indicated by the cue by pressing buttons on a computer keyboard. Performance requires inhibition of the previous rule and shifting from the previous rule to the active rule.

Measure of flexible affective processing. We developed an affective task-switching task that incorporated affective stimuli (negative and positive words), and affective and non-affective processing rules, indicated by a cue. The non-affective rule required the participant to sort words by the part of speech (adjective or noun) and the affective rule required participants to sort the words by valence (positive or negative). Cue and valenced word were presented simultaneously and participants sorted the word according to the rule indicated by the cue.[1]

Participants used adjacent keys on a keyboard to indicate their responses. The categories were spatially mapped on to the left and right response key (e.g., adjective and positive mapped on to a left-side key and noun and negative mapped on to a right-side key). Trials were separated into one consistent and one inconsistent block depending on whether responses for the two task sets were mapped on to consistent or inconsistent response

[1] This task is structurally similar to the extrinsic affective Simon task (Voss & Klauer, 2007).

keys. That is, on the consistent block, words were presented that required the participant to press the same key in the presence of both cues (e.g., only positive adjectives and negative nouns appeared when positive–adjective and negative–noun were mapped on to the same key). As a result, the response associated with the non-active task set did not interfere with the correct response. On the inconsistent block, correct responses for the relevant cue mapped on to different response keys than correct responses for the irrelevant cue (e.g., only negative adjectives and positive nouns appeared when positive–adjective and negative–noun were mapped on to the same key). For example, if a negative adjective appeared with the "adjective–noun" cue, participants had to press the left-side key, while the non-active task set ("positive–negative") was associated with pressing the right-side key. Thus, the response associated with the non-active task set interfered with the correct response. As a result, task-switching on inconsistent trials required the participants to inhibit the response associated with the non-active task set because it was incompatible with the active task set.

Words for this task were drawn from the Affective Norms of English Words list (ANEW; Bradley & Lang, 1999). Negative words had a mean valence rating between 1 and 3 (on a 9-point bipolar scale) and positive words had a mean valence rating between 7 and 9.

Measure of working memory capacity. The automated reading span test developed by Unsworth, Heitz, Schrock, and Engle (2005) was administered.

Procedure

Participants were tested individually. The order of the computer tasks was counterbalanced across participants. Participants completed self-report questionnaires after the first two tasks. All computer tasks were run in E-Prime software on a 19″ monitor.

Cognitive and flexible affective processing tasks. The cognitive flexibility task contained two practice blocks of 24 trials each, during which the participants sorted numbers by one rule. The third (task-switching) block contained 240 trials. The flexible affective processing task contained two practice blocks of 30 trials each during which the participant sorted valenced words by one rule. The third (consistent) and forth (inconsistent) blocks each contained 120 trials. The task performed was either consistent with the task on the previous trial (task-repetition), or the task changed from the previous to the current trial (task-switch). Task-switching costs were calculated in both tasks as the difference in response time between task-switch and task-repetition trials. For the flexible affective processing paradigm, task-switching costs on consistent and inconsistent blocks were calculated separately. The association of response categories and response keys was counterbalanced across participants.

For both flexibility tasks, participants were instructed to use their right-hand index finger to press the left-side key and their right-hand middle finger to press the right-side key. The cue and stimuli changed on response with no time limit for the response. Cues randomly switched after two to five trials. Participants were instructed to respond as quickly and accurately as possible. The cues and words were presented in white with a 26-point, Courier New font on a black background.

Working memory capacity. Participants characterised sentences as true or false. A letter was then presented, followed by another sentence-letter problem. At the end of each set, participants were asked to recall the letters from the set (see Unsworth et al., 2005, for procedural details).

Preliminary analysis of resilience measures

The two resilience scales (ER89 and CD-RISC) were highly correlated, $r(64) = .65$, $p < .001$, indicating high convergent validity of these measures. Due to this high correlation, as well as similarity in the content of the items, we combined both scales to create one *Resilience Score* for each participant. Specifically, we performed a z-transformation on both scales and summed the z-scores so that each scale was weighted equally. The split-half reliability of the combined resilience scale was .90.

Trait resilience (*Resilience Score*) and other personality traits were correlated. Trait resilience was positively correlated with extroversion, $r(64) = .522$, $p < .001$, and negatively correlated with neuroticism, $r(64) = -.504$, $p < .001$. Trait resilience was also positively correlated with subscales of the BAS including reward responsiveness, $r(64) = .444$, $p < .001$), drive, $r(64) = .423$, $p < .001$, and fun seeking, $r(64) = .400$, $p < .01$. Trait resilience was not associated with the BIS subscale, $r(64) = -.203$, $p > .05$.

RESULTS

Five participants did not complete all computer tasks due to equipment malfunction and were removed from further analysis. On the cognitive flexibility task, response time (RT) data were analysed in the following way. First, trials with incorrect responses (9.3% of trials) were eliminated. Second, in accordance with the methods used by Whitmer and Banich (2007) in a similar study on individual differences in task-switching ability, trials with a RT exceeding 2500 ms were excluded (4.2% of trials). Furthermore, trials with a RT below 250 ms were also considered outliers and eliminated (0.68% of trials). RT data from the remaining trials were used to calculate a task-switching cost score for each participant. A paired-samples *t*-test showed that, as expected, RTs on task-switch trials ($M = 1207.08$ ms, $SD = 242.73$ ms) were significantly higher than those on task-repetition trials ($M = 995.16$ ms, $SD = 141.98$ ms), $t(58) = 10.16$, $p < .001$, confirming the presence of task-switching costs. There was no evidence of a speed–accuracy trade-off; the proportion of correct responses did not differ across task-switch and task-repetition trials, $t(58) = 0.072$, $p = .943$.

RT data from the flexible affective processing task were analysed in the same way. Trials with incorrect responses (7.4% of trials) were not included in the analysis. Of the remaining trials, those with a RT above 2500 ms (14.4% of trials)[2] and below 250 ms (0.13% of trials) were excluded. Results from a paired samples *t*-test comparing RTs on task-switch and task-repetition trials confirmed the presence of task-switching costs, $t(58) = -14.98$, $p < .001$, as RTs on task-switch trials ($M = 1575.50$ ms, $SD = 275.78$ ms) were significantly higher than those on task-repetition trials ($M = 1366.09$ ms, $SD = 217.22$ ms). Results also showed that the proportion of correct responses on task-switch trials ($M = 0.91$, $SD = 0.10$) was significantly lower than the proportion of correct responses on the task-repetition trials ($M = 0.94$, $SD = 0.11$), $t(59) = 4.99$, $p < .001$. Since lower RTs were associated with a pattern of increased accuracy, there was no evidence of a speed–accuracy trade-off. As expected, there were significantly greater task-switching costs on inconsistent trials ($M = 251.29$ ms, $SD = 150.28$ ms) than on consistent trials ($M = 161.59$ ms, $SD = 121.15$ ms), $t(58) = -4.434$, $p < .001$.

The automated reading-span task of working memory was evaluated following recommendations by Conway et al. (2005) by using a partial-credit unit (PCU) scoring procedure (i.e., credit was assigned to partly correct items and each correct item carried equal weight).

Prediction of resilience

We found that resilience was, as predicted, significantly associated with lower task-switching costs and, thus, with higher general cognitive flexibility (see Table 1). We also found, as predicted, that resilience was related to lower task-switching costs in the affective task-switching task (i.e., more flexible affective processing). Resilience was associated with flexible affective processing, however, only when it was captured by

[2] Given the relatively large number of excluded trials, we repeated all analyses with a response window of 4000 ms, leading to the exclusion of 4.8% of trials (approximately the same number of excluded trials as in the cognitive flexibility task).

Table 1. *Intercorrelation matrix for regression analysis (N = 59)*

	1	2	3	4	5
1. Resilience score	—	−.268*	.080	−.250*	−.141
2. Inconsistent affective switching costs		—	.360**	−.101	−.050
3. Consistent affective switching costs			—	.188	.108
4. General cognitive flexibility				—	−.044
5. Working memory capacity					—

Notes: *$p < .05$; **$p < .01$; ***$p < .001$.

task-switching costs in inconsistent trials (i.e., trials with relatively higher task-switching costs: *Inconsistent Affective Switching Costs*, see Table 1), and not by task-switching costs in consistent trials (*Consistent Affective Switching Costs*). Working memory capacity was not significantly related to resilience.

Next, we tested whether flexible affective processing predicted level of trait resilience over and above general cognitive flexibility and working memory. We conducted a multiple regression analysis with *Resilience Score* as the dependent variable and *Working Memory Capacity*, *Cognitive Flexibility*, *Inconsistent Affective Switching Costs*, and *Consistent Affective Switching Costs* as the predictors. This analysis revealed that general cognitive flexibility significantly predicted resilience scores (see Table 2). Importantly, and in line with our hypotheses, flexible affective processing, as measured by inconsistent affective task-switching costs, significantly predicted level of trait resilience when controlling for general cognitive flexibility and working memory capacity (see Table 2).[3] Finally, consistent affective task-switching costs also predicted trait resilience. It appears that task-switching costs on consistent trials acted as a classical suppressor in the model because it was unrelated to trait resilience but was correlated with other predictors (see Table 1). Thus, it predicted trait resilience by suppressing variance in the other predictors that was irrelevant for the prediction of resilience.

Table 2. *Summary of simultaneous regression analysis for variables predicting resilience (N = 59)*

Predictors	*B*	*SE B*	β	*Part*
Inconsistent affective switching costs	−0.004	0.002	−.328*	−.306
Consistent affective switching costs	0.004	0.002	.268*	.245
Cognitive flexibility	−0.003	0.002	−.275*	−.269
Working memory capacity	−2.702	2.000	−.166	−.164

Notes: $R^2 = .201$; *$p < .05$.

Relationship between performance on behavioural tasks and other trait measures

To establish that obtained results were specific to trait resilience, we correlated cognitive flexibility, flexible affective processing, and working memory, with all traits that were found to be significantly correlated with trait resilience in the current study (i.e., extroversion, neuroticism and the BAS subscales). No significant positive or negative correlations were found.

DISCUSSION

The goal of this study was to explore cognitive mechanisms underlying trait resilience. Based on the notion that trait resilience is the ability to flexibly adapt to emotional life events, we argued that cognitive processes that promote flexibility are central to trait resilience. We predicted and found that both general cognitive flexibility and the ability to flexibly switch back and forth between processing affective and non-affective properties of affective stimuli—an ability we called "flexible affective processing"—predicted individual differences in trait resilience.

Our finding that cognitive flexibility, as measured by a conventional task-switching paradigm,

[3] When using the 4000 ms response window, the main results were replicated, although the effects were somewhat weaker due to increased RT standard deviations. Inconsistent affective switches remained a significant predictor of trait resilience ($p < .05$) and cognitive flexibility was a marginally significant predictor ($p = .06$).

predicted level of trait resilience is one of the first demonstrations of a positive relation between executive control and measures of trait resilience in an adult population. The finding that general cognitive flexibility, when processing non-affec tive material, is a central process underlying resilience is consistent with Fredrickson's (2001) broaden-and-build theory and confirms the link suggested in the literature between cognitive flexibility and resilience.

More importantly, we demonstrated that performance in a novel task-switching paradigm developed to measure flexible affective processing significantly predicted level of trait resilience even when controlling for general cognitive flexibility. The affective task-switching paradigm involved switching back and forth between categorising valenced emotional words according to an affective rule (positive or negative) or a non-affective rule (adjective or noun). Thus, flexible affective processing proved to be a process that is separate from general cognitive flexibility; both tasks independently predicted trait resilience.

Our results also showed that affective switching costs in the inconsistent block, but not in the consistent block, were associated with trait resilience. Hence, trait resilience was related to the task-switching costs that were cognitively taxing, not to the task-switching costs that were comparatively easy. In retrospect, it makes sense that performance on the more difficult, inconsistent block is the best measure of flexible affective processing, because these trials test the limits of this ability. Task-switching costs in the consistent block predicted trait resilience only when it was entered into the regression along with task-switching costs in the inconsistent block and presumably by suppressing the variance in inconsistent task-switching costs that was irrelevant for the prediction of resilience (e.g., related to an unspecific slowing after the switch of the task set).

Individual differences in working memory capacity were unrelated to trait resilience, suggesting that a high level of trait resilience is not merely the result of better general executive functioning. Rather, trait resilience is tied to specific processes related to flexibility. Importantly, there were no correlations between the experimental tasks and measures positively associated with trait resilience (extroversion and BAS subscales) or negatively correlated with trait resilience (neuroticism). This finding suggests that cognitive flexibility and flexible affective processing are specifically related to trait resilience and do not just correspond to adaptive emotional traits in general.

Our results also suggest which component of the flexible affective processing task might be most critical for trait resilience, though this point is somewhat speculative. As described in the introduction, cognitive flexibility involves two central components of executive control: shifting between tasks sets and inhibition of irrelevant task sets (Miyake et al., 2000). It can be argued that these components of our cognitive flexibility task with affective stimuli were involved to different degrees in task-switching within inconsistent and consistent blocks. Whereas both blocks of the flexible affective processing task involved the activation of a new task set, only task-switches in inconsistent blocks also required the inhibition of the incompatible reactions associated with the irrelevant task set. Thus, it seems that the executive function that is responsible for task-switching costs in the consistent block and inconsistent block (i.e., activation of a new task set) is less crucial for trait resilience than is the executive function uniquely required for task-switching in the inconsistent block (i.e., inhibition of responses associated with the irrelevant task set). Inhibition, rather than activation of the new task set, seems to be the executive control component that is crucially involved in trait resilience.

Limitations and future directions

While the present study provides strong support for the notion that flexible affective processing is important for trait resilience, the presented results require replication and extension. Although we started to explore the underlying components of flexible affective processing that drive the relationship between this ability and trait resilience, future studies should use paradigms that allow for a clearer distinction between inhibition and shifting processes (e.g., Whitmer & Banich, 2007). Furthermore, we measured flexible affective processing with one type of stimulus modality (i.e., affective words). Future research is necessary to demonstrate that this construct extends to other types of affective information and, in particular, to information that elicits stronger emotional reactions (e.g., photographic images).

Importantly, the current study only measured resilience using a self-report trait measure and did not measure actual resilience following a traumatic event. Although preliminary research has shown that trait resilience is associated with actual adaptation to stressful events (e.g., Fredrickson et al., 2003), this association is not well established. Thus, our results speak to the underlying processes of trait resilience, in particular, and not real-life resilient responding. We believe that establishing a link between our new measure of flexible affective processing and trait resilience is an important first step to demonstrate the validity of this cognitive measure. Future research, however, should investigate whether these flexibility processes predict actual recovery from stressful negative life events.

Future research should also explore mediating factors that link flexible affective processing and resilience. In particular, studies should investigate whether flexible affective processing underlies the ability to flexibly regulate emotions according to different situational demands. Consistent with this idea, Bonanno et al. (2004) recently provided evidence for a link between flexibility in ER and resilience. The authors found that the ability to flexibly suppress and enhance emotional expressions in response to emotional pictures predicted lower levels of distress among undergraduates in New York City one and a half years after the 9/11 terrorist attacks. Thus, flexible ER might mediate the relation between flexible affective processing and (trait) resilience.

Furthermore, executive functions, such as cognitive flexibility, are thought to promote effective ER (Zelazo & Cunningham, 2007); however, traditional cognitive flexibility tasks are non-affective in nature and thus may fail to capture important aspects of cognitive mechanisms underlying ER. Flexible affective processing tasks include an affective component and may provide us with a unique perspective on ER processes. Furthermore, flexible affective processing may promote the use of specific ER strategies, such as cognitive reappraisal, which, by definition, requires the ability to flexibly process emotional information to bring about less (or more) emotion and which is also associated with positive psychological outcomes (John & Gross, 2004).

Conclusion

Our results show a direct link between cognitive flexibility and trait resilience in adults. This study is also the first that introduces a paradigm to operationalise and measure the construct of flexible affective processing, the ability to flexibly switch back and forth between processing affective and non-affective qualities of affective stimuli, and to show that flexible affective processing predicts level of trait resilience even when controlling for general cognitive flexibility and working memory capacity. The current study is among the first to explore the specific cognitive abilities that may underlie trait resilience.

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