



Cognitive control adjustments in healthy older and younger adults: Conflict adaptation, the error-related negativity (ERN), and evidence of generalized decline with age



Michael J. Larson^{a,b,*}, Peter E. Clayson^{a,c}, Cierra M. Keith^d, Isaac J. Hunt^a, Dawson W. Hedges^{a,b}, Brent L. Nielsen^e, Vaughn R.A. Call^f

^a Department of Psychology, Brigham Young University, Provo, UT, United States

^b Neuroscience Center, Brigham Young University, Provo, UT, United States

^c Department of Psychology, University of California-Los Angeles, Los Angeles, CA, United States

^d Department of Psychology, St. Louis University, St. Louis, MO, United States

^e Department of Microbiology and Molecular Biology, Brigham Young University, Provo, UT, United States

^f Department of Sociology, Brigham Young University, Provo, UT, United States

ARTICLE INFO

Article history:

Received 31 January 2015

Received in revised form

31 December 2015

Accepted 17 January 2016

Available online 21 January 2016

Keywords:

Aging

Older adult

Cognitive control

Conflict adaptation

Congruency sequence effects

Event-related potential

N2

Anterior cingulate (ACC)

Error-related negativity (ERN)

Error positivity (Pe)

Post-error slowing

ABSTRACT

Older adults display alterations in neural reflections of conflict-related processing. We examined response times (RTs), error rates, and event-related potential (ERP; N2 and P3 components) indices of conflict adaptation (i.e., congruency sequence effects) a cognitive control process wherein previous-trial congruency influences current-trial performance, along with post-error slowing, correct-related negativity (CRN), error-related negativity (ERN) and error positivity (Pe) amplitudes in 65 healthy older adults and 94 healthy younger adults. Older adults showed generalized slowing, had decreased post-error slowing, and committed more errors than younger adults. Both older and younger adults showed conflict adaptation effects; magnitude of conflict adaptation did not differ by age. N2 amplitudes were similar between groups; younger, but not older, adults showed conflict adaptation effects for P3 component amplitudes. CRN and Pe, but not ERN, amplitudes differed between groups. Data support generalized declines in cognitive control processes in older adults without specific deficits in conflict adaptation.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

The ability to dynamically adjust performance in response to errors, conflict, or a frequently changing environment is an important aspect of goal-directed behavior. Studies suggest possible age-related declines both in the ability to detect poor performance and in the ability to make important performance adjustments (Lucci, Bechicci, Spinelli, Taddei, & Di Russo, 2013; Trewartha, Penhune, & Li, 2011); however, results are limited and somewhat

inconsistent. Furthermore, the neural correlates of age-related decline in cognitive control adjustment processes remain poorly understood.

Cognitive control refers to the “ability to guide thought and action in accord with internal intentions” (Cohen, Botvinick, & Carter, 2000, p. 421). Conflict adaptation is a crucial aspect of cognitive control, and involves the ability to detect conflict and recruit additional cognitive resources in order to make appropriate adjustments in performance (Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; Cohen et al., 2000; Kerns et al., 2004). The “conflict adaptation”, “sequential trial”, or “congruency sequence effect” (CSE) (we will refer to these effects as conflict adaptation effects throughout the manuscript for simplicity, although we note there is controversy regarding the precise mechanisms and theories underlying these effects) is seen in tasks involving response conflict, such as the

* Corresponding author at: Department of Psychology and Neuroscience Center, Brigham Young University, 244 TLRB, Provo, UT 84602, United States. Fax: +1 1 801 422 0163.

E-mail address: michael.larson@byu.edu (M.J. Larson).

Stroop task, Simon task, or the Eriksen flanker task, and refers to the phenomenon wherein previous-trial congruency affects current-trial performance (Botvinick et al., 1999; Clayson & Larson, 2011a; Duthoo, Abrahamse, Braem, Boehler, & Notebaert, 2014; Gratton, Coles, & Donchin, 1992; Kerns et al., 2004; Larson, Kaufman, & Perlstein, 2009). Conflict created by competing stimulus information from the previous trial leads to cognitive control adjustments to reduce conflict and improve performance on the subsequent trial (Botvinick, Carter, Braver, Barch, & Cohen, 2001). Changes in cognitive control as a result of conflict can lead to behavioral adjustment in response times (RTs). These adjustments include faster RTs for incongruent trials preceded by an incongruent trial (il) when compared with incongruent trials preceded by congruent trials (cl), as well as faster RTs for congruent trials preceded by congruent trials (cC) relative to congruent trials preceded by incongruent trials (iC) (Botvinick et al., 2001; Gratton et al., 1992; Kerns et al., 2004; Larson, Clayson, & Clawson, 2014). Regarding neural mechanisms, conflict monitoring theory states that the presence of conflict activates the anterior cingulate cortex (ACC), which is associated with monitoring performance and error identification (Botvinick et al., 2001). The resulting recruitment of additional cognitive resources and adjustments in performance are then mediated by the dorso-lateral prefrontal cortex (dlPFC; Botvinick et al., 2001).

Cognitive control theory is not the only possible explanation for conflict adaptation effects. One proposed alternative theory suggests that conflict adaptation effects are due to repetition priming (e.g., Logan, Schneider, & Bundesen, 2007; Mayr, Awh, & Laurey, 2003). For instance, Mayr et al. (2003) found behavioral conflict adaptation effects only exist for trial groups that included exact stimulus–response (S–R) repetitions (consecutive stimuli requiring identical responses). Effects were no longer observed with the elimination of such repetitions, consistent with the prediction that effects can be accounted for by repetition priming. However, Clayson and Larson (2011b) found that N2 and P3 amplitudes showed conflict adaptation effects even when S–R repetitions were removed, suggesting that repetition does not fully account for adaptation effects. Recent additional studies removing all priming, episodic memory, and stimulus feature repetition trials also show conflict adaptation (Duthoo et al., 2014; Schmidt & Weissman, 2014; Weissman, Jiang, & Egner, 2014). Thus, it appears that there is a strong contribution of cognitive control/attentional control to conflict adaptation that cannot be explained solely by priming or feature repetitions.

The neural processes of conflict adaptation are reflected in the conflict N2 component of an event-related potential (ERP). The N2 is a frontal negative ERP deflection that peaks at approximately 250–350 ms, representing the detection of conflict between competing stimuli. The N2 increases in amplitude with increased conflict in the presented stimulus (Folstein & Van Petten, 2008; van Veen & Carter, 2002). Furthermore, il trials are associated with attenuated N2 amplitude when compared with cl trials (Clayson & Larson, 2011a, 2011b; Larson et al., 2014). These changes in N2 amplitude can be explained by the increase in cognitive control following high conflict. An incongruent trial that requires more cognitive resources to accurately respond will be associated with a subsequent increase in control, resulting in less conflict on the subsequent incongruent trial (il trials) and decreased N2 amplitude (Larson et al., 2014). Congruent trials do not require the same increase in control; as such, cl trials tend to be associated with higher levels of conflict and increased N2 amplitudes. Source localization techniques have identified that the neural generator of the N2 is the ACC (van Veen & Carter, 2002). As conflict is detected and adjustments in performance are needed, attentional resource allocation may be reflected by the central-parietal component referred to as the P3 component. The P3 is a positively deflected event that peaks at approximately 300 ms. P3 amplitude is significantly

more positive for cl trials compared to il trials (Clayson & Larson, 2011a). Clayson and Larson (2011a) inferred that the N2 likely signals the increase in cognitive control, whereas the P3 seems sensitive to recruitment of control following conflict. Notably, behavioral and N2 conflict adaptation effects are associated with attention/executive functioning and verbal fluency abilities—areas that often decline with old age (Clayson & Larson, 2012).

The current state of the research is mixed regarding whether aging impairs the ability to detect conflict and adjust performance. Some studies support age-related declines in conflict adaptation (Lucci et al., 2013; Trewartha et al., 2011), but other studies suggest that conflict adaptation remains intact in healthy older adults (Puccioni & Vallesi, 2012; West & Moore, 2005), with two studies showing mixed findings within the same samples depending on the task (Lemaire & Hinault, 2014; Monti, Weintraub, & Egner, 2010). For example, Trewartha et al. (2011) attempted to isolate conflict adaptation from conflict detection in a key-press task that minimized the need for conflict detection and decreased task complexity with embedded conflicting responses within repeated pairs of key-presses. They found that older adults were able to perform as well as younger adults on the first conflict trial, but they were not able to increase performance with repeated exposure to conflict, unlike younger adults.

Lucci et al. (2013) utilized a go/no-go task to examine behavioral and electrophysiological correlates of conflict detection. Whereas older adults were slower than younger and middle-aged adults, no significant between-group differences in accuracy were supported. This is consistent with the speed-accuracy trade-off theory of aging, which states that older adults tend to place more emphasis on accuracy at the expense of speed (Lucci et al., 2013; Salthouse, 1979). However, older adults engaged in additional and different neural recruitment for the tasks than younger adults. The no-go N2 peak shifted from frontal to parietal regions in middle-aged and older adults, and was accompanied by a positive prefrontal activity not observed in younger adults—suggesting that older adults exhibited compensatory recruitment of additional resources in prefrontal regions. Additionally, P3 amplitude and latency were increased in middle-aged and older adults for trials that required a different response with respect to the previous trial (increased conflict).

Other studies present results contradictory to these age-related declines in conflict adaptation. For instance, West and Moore (2005) failed to find significant age-related changes in conflict adaptation effects observed in a Stroop task, as behavioral data did not support differences between older and younger adults. The absence of behavioral between-group differences might be attributed to small sample size; however, there were age-related differences in electrophysiological correlates of conflict processing, particularly in the anterior frontal region. Younger adults exhibited a sustained modulation in the anterior frontal region that reflected greater negativity for incongruent trials than congruent trials. This modulation was absent in older adults, and the P3 was attenuated in older adults relative to younger adults (West & Moore, 2005). Thus, these results are somewhat confusing and contradictory between behavioral and ERP findings.

Puccioni and Vallesi (2012) showed a speed accuracy trade-off in the Stroop task, finding older adults to be slower but equally accurate when compared with younger adults. Notably, response slowing was negatively correlated with intelligence, education, and cognitive reserve. Furthermore, the Stroop effect (differing RTs between congruent and incongruent conditions) was negatively correlated with verbal IQ for older adults only. Interindividual variability in education and intelligence may therefore be an important factor in the preservation of cognitive function with age (Puccioni & Vallesi, 2012).

In a study using a flanker task, Wild-Wall, Falkenstein, and Hohnsbein (2008) found that despite typical age-related slowing,

Download English Version:

<https://daneshyari.com/en/article/920726>

Download Persian Version:

<https://daneshyari.com/article/920726>

[Daneshyari.com](https://daneshyari.com)