Consciousness and Cognition xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Implicit motivation improves executive functions of older adults

Shira Cohen-Zimerman[a,*], Ran R. Hassin[a,b]

[a] Psychology Department, The Hebrew University, Jerusalem, Israel
[b] The Center for the Study of Rationality, The Hebrew University, Jerusalem, Israel

ARTICLE INFO

Keywords:
Cognitive aging
Age differences
Motivation
Executive functions
Task engagement

ABSTRACT

It is widely accepted that while controlled processes (e.g., working memory and executive functions) decline with age, implicit (automatic) processes are not affected by age. In this paper we challenge this view by arguing that high-level automatic processes (e.g., recruiting motivation) decline with age, and that this decline plays an unappreciated role in cognitive aging. Specifically, we hypothesized that due to their decline, automatic motivational processes are less likely to be spontaneously activated in old age; thus, implicit external activation of them should have stronger effects on older (vs. younger) adults. In two experiments we used different methods of implicitly activating motivation, and measured executive functions of younger and older adults using the Wisconsin Card Sorting Test. In both experiments, implicit modulation of motivation resulted in improved executive functioning for older adults. The framework we propose is general and offers a new look at various aspects of cognitive aging.

1. Introduction

Advancing our understanding of cognitive aging is a key theoretical challenge for the cognitive and brain sciences. Like the study of every special population, studying older adults holds two promises. First, improved understanding of cognitive aging will reflect back on our theories and understanding of human cognition more generally. Second, it will help us better cope with the social and monetary challenges associated with aging, that are expected to dramatically increase in the coming decades (Kinsella & Wan, 2009; Ortman, Velkoff, & Hogan, 2014; Vincent & Velkoff, 2010).

A dominant view of cognitive aging holds that consciously controlled processes decline with age (Craik & Salthouse, 2008; Gazzaley, Cooney, Rissman, & D'Esposito, 2005; Hasher, Lustig, & Zacks, 2007; Park et al., 2002; Sorel & Pennequin, 2008), whereas implicit, automatic processes do not (Chauvel et al., 2012; Hoyer & Verhaeghen, 2006; Jennings & Jacoby, 1993; Peters, Hess, Västfjäll, & Auman, 2007; Queen & Hess, 2010). Here we challenge this view on theoretical grounds, and report findings that suggest that aging-related cognitive deficits can result from decline in implicit processes.

Crucial to our argument is the distinction between low-level automatic processes such as perception and associative memory, and high-level automatic processes, such as executive functions, goal pursuit, and rule-based computations over abstract symbols (Hassin, Uleman, & Bargh, 2005). This distinction is based on the accumulation of evidence in cognitive and social psychology, as well as in cognitive and social neurosciences. This evidence suggests that even high-level functions that were historically associated with conscious awareness can occur automatically, outside of conscious awareness (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Capa, Bouquet, Dreher, & Dufour, 2013; Custers & Aarts, 2010; Hassin & Sklar, 2014; Hassin, 2013; Lau & Passingham, 2007;

* Corresponding author at: Cognitive Neuroscience Laboratory, Shirley Ryan AbilityLab, 355 E Erie St., Chicago, IL 60611, USA.
E-mail address: scohenzime@sralab.org (S. Cohen-Zimerman).

https://doi.org/10.1016/j.concog.2018.06.007
Received 19 December 2017; Received in revised form 13 May 2018; Accepted 6 June 2018
1053-8100/

Please cite this article as: Cohen-Zimerman, S., Consciousness and Cognition (2018), https://doi.org/10.1016/j.concog.2018.06.007

Sklar et al., 2012; Soto & Silvanto, 2014; Soto, Mäntylä, & Silvanto, 2011; van Gaal, Ridderinkhof, van den Wildenberg, & Lamme, 2009).[1] While accepting the view that low-level automatic processes are relatively immune to aging (e.g., Park, 2000), we suggest that high-level automatic processes may decline with age.

The rationale behind the current proposal is simple. Non-conscious, automatic high-level cognitive processes such as goal pursuit and inhibition are functionally similar to the parallel conscious processes of goal pursuit and inhibition (Hassin & Sklar, 2014; Hassin, 2013). There is also evidence to suggest that they occur in roughly the same brain areas (Lau & Passingham, 2007; Pessiglione et al., 2007; Ursu, Clark, Aizenstein, Stenger, & Carter, 2009; van Gaal & Lamme, 2012; van Gaal, Scholte, Lamme, Fahrenfort, & Ridderinkhof, 2011). Conscious high-level functions are known to be affected by age-related biological changes in relevant brain areas (i.e., frontal lobes, among other brain areas which are affected by aging), and tend to deteriorate with age (Head, Snyder, Girton, Morris, & Buckner, 2005; Nyberg & Salami, 2010; Raz, 2000). Given the similarities described above, it is reasonable to hypothesize that high-level automatic processes would deteriorate with age similarly to their conscious counterparts. Put in more technical terms, the principle of parsimony suggests that we should hypothesize no differences between the two types of processes.

1.1. The aging of executive functions

As we succinctly alluded to above, the prevalent understanding of cognitive changes in old age is based on the widely adopted distinction between two separate processing systems: one that is deliberate, slow, effortful, and mostly conscious, and one that is automatic, quick, effortless, and mostly unconscious (Craik & Bialystok, 2006a; Morewedge & Kahneman, 2010). The distinction between two processing systems appears in the literature in various forms (for reviews see Chaiken & Trope, 1999; Evans & Stanovich, 2013; Sherman, Gawrsonski, & Trope, 2014; however, see Keren & Schul, 2009, for a critical review), and for ease of communication we will henceforth refer to them as automatic vs. controlled.[2] Aging, holds the modal view, leads to a slow decline of controlled processes, whereas automatic processes remain relatively intact (Campbell, Zimerman, Healey, Lee, & Hasher, 2012; Craik & Bialystok, 2006a; Hess, Waters, & Bolstad, 2000; Liu & Park, 2004).

Since executive functions (EFs) are tightly associated with controlled processes, the modal view predicts that they decline with age. And indeed, a large and growing body of research finds evidence for age-related deficits in EFs. These include working memory capacity (Bopp & Verhaeghen, 2005), planning (Sorel & Pennequin, 2008), response inhibition (Troyer, Leach, & Strauss, 2006), and task management (Craik & Bialystok, 2006b; for a reviews see Park & Reuter-Lorenz, 2009; Phillips & Henry, 2008; Salthouse, Atkinson, & Berish, 2003). The changes in EFs are associated with underlying neurobiological developments, namely, the disproportionate age-related loss of frontal brain volume (Head et al., 2005; Raz, 2000).

The decline in EFs is assumed to underlie age-related difficulties in various domains such as memory (Clarys, Bugaiska, Tapia, & Baudouin, 2009), understandings of others' beliefs and intentions (Phillips et al., 2011), social biases (Krendl, Heatherton, & Kensinger, 2009), and daily activities such as managing money (Vaughan & Giovanello, 2010) or even walking (Holtzer, Wang, Lipton, & Verghese, 2012). Specifically, it is widely accepted that age related decline in EFs impairs cognitive flexibility (Rhodes, 2004), the main outcome variable on which we focus here (However, see Verhaeghen, 2011 for a different perspective on age-related changes in a subset of EFs).

1.2. Motivation and executive functions

Conscious EFs are difficult and effortful functions. Performing them, therefore, depends on how much one is willing to invest; namely, on one's motivation (Heitz, Schrock, Payne, & Engle, 2008; Krawczyk, Gazzaley, & D'Esposito, 2007). Motivation – in real-life situations as well as in laboratory tests – can be recruited either in a deliberate and controlled manner or automatically, in response to internal and environmental cues. To take an example, recent studies that tested younger adults' EFs found improvement in performance as a function of monetary incentives, both consciously (Savine, Beck, Edwards, Chiew, & Braver, 2010) and subliminally presented (Capa, Bustin, Cleeremans, & Hansenne, 2011).

In daily life the difference between controlled and automatic motivation would be the difference between having to remind yourself that picking up your granddaughter from daycare is a good idea for everyone involved, and simply wanting to do it after seeing a picture of your granddaughter on your desk, respectively. In recent years many studies tested – and found evidence for – the idea that motivation and goal pursuit can be primed and then operate outside of conscious awareness (for reviews see Custers & Aarts, 2010; Dijksterhuis & Aarts, 2010; Hassin, 2013).

Recent research focused on the associations between age, motivation and cognition. A prominent example is the well-established selection, optimization, and compensation (SOC) theory of successful aging (Baltes & Baltes, 1990). According to this theory, older adults optimize their performance by selecting motivationally relevant, attainable goals, and by doing so they successfully compensate for their deficits. A more recent example is the selective engagement theory (SET; Hess, 2014), which argues that explicit intrinsic motivation to do well in a difficult cognitive task decrease with age, as the costs associated with engaging in such cognitive activity increases (Hess & Smith, 2016; Queen & Hess, 2017). Moreover, it has been suggested that older adults become less interested

[1] While some replication failures question specific parts of this literature (see Hesselmann & Moors, 2015), the overwhelming evidence seems to suggest that high-level priming works, although it is weaker than previously thought (Goldstein & Hassin, 2017)

[2] The dual process/system metaphor is likely to be too coarse for many fine-grained analyses of cognition (Kahneman, 2011). We use it as an approximation that allows easier communication.