



Automatic and controlled attentional orienting in the elderly: A dual-process view of the positivity effect

G. Gronchi, S. Righi*, L. Pierguidi, F. Giovannelli, I. Murasecco, M.P. Viggiano

Psychology Section, Department of Neuroscience, Psychology, Drug Research and Child's Health, University of Florence, Italy

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ABSTRACT

The positivity effect in the elderly consists of an attentional preference for positive information as well as avoidance of negative information. Extant theories predict either that the positivity effect depends on controlled attentional processes (socio-emotional selectivity theory), or on an automatic gating selection mechanism (dynamic integration theory). This study examined the role of automatic and controlled attention in the positivity effect. Two dot-probe tasks (with the duration of the stimuli lasting 100 ms and 500 ms, respectively) were employed to compare the attentional bias of 35 elderly people to that of 35 young adults. The stimuli used were expressive faces displaying neutral, disgusted, fearful, and happy expressions. In comparison to young people, the elderly allocated more attention to happy faces at 100 ms and they tended to avoid fearful faces at 500 ms. The findings are not predicted by either theory taken alone, but support the hypothesis that the positivity effect in the elderly is driven by two different processes: an automatic attention bias toward positive stimuli, and a controlled mechanism that diverts attention away from negative stimuli.

1. Introduction

Adaptive and flexible behavior depending on context is a hallmark of human adult cognition (Gronchi & Provenzi, 2017; Gronchi & Strambini, 2017; Kumano, Suda, & Uka, 2016; Pierguidi et al., 2016; Righi, Gronchi, Marzi, Rebai, & Viggiano, 2015; Van den Stock, Righart, & De Gelder, 2007). Conversely, cognitive aging has been conceived as characterized by an intractable and rigid decline of performance (Harada, Love, & Triebel, 2013; Hedden & Gabrieli, 2004). However, recent research has emphasized both the flexibility of cognitive processes and the enhancement of abilities related to emotion-cognition interaction in older adults (Charles & Carstensen, 2013), as demonstrated by the positivity effect. The positivity effect is an age-related trend that favors positive over negative stimuli in cognitive processing (Carstensen & Mikels, 2005; Reed & Carstensen, 2012). This effect is revealed in a variety of memory domains (Comblain, D'Argembeau, & Van der Linden, 2005; Mather & Carstensen, 2003; Scheibe & Carstensen, 2010; Spaniol, Voss, & Grady, 2008), including working memory (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005), short-term memory (Charles, Mather, & Carstensen, 2003), autobiographical memory (Kennedy, Mather, & Carstensen, 2004; Schlagman, Schulz, & Kvavilashvili, 2006), and false memories (Fernandes, Ross, Wiegand, & Schryer, 2008).

There are two models of cognitive-affective aging that may explain the positivity effect: the socio-emotional selectivity theory (SST; e.g., Carstensen, Isaacowitz, & Charles, 1999; Carstensen & Mikels, 2005; Mikels et al., 2005) and the dynamic integration theory (DIT; Labouvie-Vief, 2003, 2005, 2009; Labouvie-Vief, Grünh, & Mouras, 2009). The SST (Mather & Carstensen, 2003) is a lifespan theory of motivation which assumes that the core constellation of goals changes throughout adulthood as a function of future time horizons. Since older adults have a decreased future time perspective, they consciously emphasize goals of well-being and emotional stability (Carstensen, Mikels, & Mather, 2006). According to the idea that the positivity effect involves deliberate cognitive strategies, the more recent extension of SST (although not central to the original model) is that positivity effects are the result of controlled attentional processes (Reed & Carstensen, 2012).

Alternatively, the DIT (Labouvie-Vief, 2003) is an integrative model of emotional development aimed at explaining the pattern of both gains and losses in cognitive affective functioning across the lifespan. According to DIT, the positivity effect is related to affect optimization, which is an automatic process associated with declining cognitive resources in aging (e.g., Labouvie-Vief, 2003). The DIT states that due to their age-related limitation in cognitive resources, older adults have difficulties in managing the cognitive-affective complexity. Hence, an adaptive attentional mechanism would automatically preserve

* Corresponding author at: Psychology Section, Department of Neuroscience, Psychology, Drug Research and Child's Health, University of Florence, via di San Salvi 12, 50135 Firenze, Italy.

E-mail address: stefania.righi@unifi.it (S. Righi).

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cognitive processing by gating out emotional stimuli, especially when distress and threat-related.

In both theories, attentional mechanisms have been invoked as the main causes of the positivity effect. Both SST and DIT predict age-related differences in the processing of emotional material whereby the processing of negative information declines, whereas that of positive information is stable or improves with age (Carstensen et al., 1999; Labouvie-Vief, 2003). However, different predictions may be derived from the role that attention plays in each theory. SST assumes that the positivity effect depends on late (controlled) attentional processes, whereas according to DIT, such an effect involves early (automatic) attentional processes. Much effort has been devoted to investigating attentional orienting in late adulthood; this has generally produced mixed results and focused mainly on late (controlled) attentional processes. According to some authors (Charles et al., 2003; Ready, Weinberger, & Jones, 2007; Shamaskin, Mikels, & Reed, 2010), age-related differences in attentional orienting are driven by the greater attention paid by younger people to negative material. Also, older adults showed an attentional facilitation for positive (vs. negative) material (Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b; Mather & Knight, 2006). There is also evidence that older participants divert attention away from negatively valenced materials (Mather & Carstensen, 2003; Mather & Knight, 2006; Orgeta, 2011). However, in many cases, a difference in emotional attention between younger and older adults was not observed (Demeyer & De Raedt, 2013; Hahn, Carlson, Singer, & Gronlund, 2006; Leclerc & Kensinger, 2008; Mather & Knight, 2006; Murphy & Isaacowitz, 2008). Generally, the majority of this research has been aimed at confirming the SST predictions of a conscious and voluntary attentional shift toward positive, and/or away from negative, material. This issue has been investigated mainly by using the dot probe task, which involves the presentation of a pair of stimuli for a fixed period of time, followed by the appearance of a visual probe in one of the two stimulus locations. Participants then have to perform a task involving the probe (i.e. identification or localization) and the distribution of spatial attention between the initially presented stimulus pair is inferred by comparing the speed of manual responses to the probe at each of the stimulus locations (following Navon & Margalit, 1983; Posner, Snyder, & Davidson, 1980). Since the focus of research in elderly people was on the SST and consequently on controlled (overt) top-down processes (which require conscious attention), attentional orienting has been mainly investigated through dot-probe tasks with long (from 500 ms) duration of stimuli (Isaacowitz, Allard, Murphy, & Schlangel, 2009).

The few works that have explored attentional mechanisms have employed eye tracking procedures and dot-probe tasks with long stimuli presentations (2000 ms) (Allard & Isaacowitz, 2008; Isaacowitz et al., 2006a, 2006b). Older adults directed their gaze toward happy and away from angry or sad faces, but relatively late after stimulus presentation (from 500 ms) (Isaacowitz et al., 2006a, 2006b). Hence, it has been concluded that positivity bias requires an overt controlled (top-down) attentional orienting (Isaacowitz et al., 2006a, 2006b; Reed & Carstensen, 2012). Crucially, such previous studies investigated the timeline of overt gaze patterns, but did not directly explore automatic (bottom-up) stimulus-driven attentional orienting, which is only evident with stimuli presentation at around 100 ms (Cooper & Langton, 2006; Koster, Verschuere, Crombez, & Van Damme, 2005). So, the critical issue of determining at what stage of attentional processing the positivity bias has an impact has yet to be explored.

Here, we aim to investigate the key role of automatic and controlled attentional mechanisms in the positivity effect. The primary concern is to establish which model of cognitive-affective aging—SST or DIT—better predicts the observed positivity bias in older adults. To explore this issue, we used two dot-probe procedures that varied for the duration of the stimuli (100 ms and 500 ms durations) (Cooper & Langton, 2006). The dot-probe has been employed in previous research on attentional bias in the elderly by using only long stimulus durations

(1000 ms) (Mather & Carstensen, 2003). The dot-probe task involves the presentation of a pair of stimuli for a fixed time period, followed by the appearance of a visual probe in one of the two stimulus locations. Our stimuli were faces with neutral, positive (happy), negative (disgusted), and negative threat-related (fearful) expressions. Participants are required to localize the probe. By varying the time between the onset of the stimuli and the appearance of the probe, one can assess both the automatic covert attention and the controlled overt attention (Cooper & Langton, 2006).

Considering the main models of cognitive-affective aging, different predictions can be made: (i) according to the SST (Baltes & Carstensen, 2003; Isaacowitz et al., 2009; Reed & Carstensen, 2012), the positivity effect should be elicited by controlled (overt) top-down processes that require conscious attention and should only be observed with long stimuli presentations (at 500 ms); (ii) following the DIT (Carstensen et al., 1999; Labouvie-Vief, 2003), which implies that an automatic affect optimization has been finalized to preserve the cognitive processing, we can suppose an early avoidance of negative stimuli, especially when threat related. Hence, older adults should divert their attention away from fearful expressions from as early as 100 ms.

2. Method

2.1. Participants

Thirty-five young (17 male), and 35 elderly (18 male) healthy adults participated in the experiment. All participants had normal or corrected-to-normal vision and had not suffered from any neurological diseases. The groups were comparable for anxiety (State-Trait Anxiety Inventory – STAI) and depression (Beck Depression Inventory – BDI) (Table 1). Demographic and test data are reported in Table 1. Ethical approval was obtained.

2.2. Materials

Sixteen face identities (8 female) were taken from the Karolinska Directed Emotional Faces (KDEF) database (Lundqvist, Flykt, & Öhman, 1998). For each identity, the photographs (totaling 64 faces) comprised neutral, disgusted, fearful, and happy expressions. Faces were presented in a grey rectangular frame that measured 8.5 cm by 5.5 cm on the screen. A neutral face was paired with the same identity displaying one of four emotional expressions: angry, fearful, happy, or neutral. The face-pairs were presented on a black background, with one face on the left and the other face on the right, separated by 6 cm.

2.3. Procedure

Two dot-probe tasks with different stimuli durations (SOA) of 100 ms (short duration) and 500 ms (long duration) were run under *E-Prime* in counterbalanced order across participants. For both the dot-probe tasks the same instructions were given. Participants were told that the task was to identify whether the dots were presented on the left or on the right and that, as such, the faces had nothing to do with the task and so should be ignored. Participants had to press one key (v)

Table 1
Demographic and test data for young and elderly participants.

	Age-range (years)	Mean age (SD)	STAI- trait	STAI-state	BDI
Young	20–30	27.26 (3.28)	36.66 (5.97)	33.54 (7.35)	6.61 (3.44)
Elderly	70–89	77.11 (6.84)	36.12 (7.63)	34.66 (7.70)	7.06 (4.45)
t-student (<i>p</i> value)		–38.40 (<i><</i> 0.001)	0.33 (0.74)	–0.62 (0.54)	–0.48 (0.63)

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