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The relationship of age to prepulse inhibition and habituation of the acoustic startle response

Joel Ellwanger *, Mark A. Geyer, David L. Braff

Department of Psychiatry, University of California, San Diego, USA

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Abstract

Prepulse inhibition (PPI) of the startle response reflects an early stage of information processing that is abnormal in schizophrenia and certain other specific neuropsychiatric disorders that are distinguished by the inability to inhibit redundant or relatively irrelevant sensory, cognitive, or motor information. The goal of the present study was to characterize the effect of normal aging on PPI and habituation of the startle response and to examine the hypothesis that normal aging is characterized by a global decline in inhibitory function. Ninety-seven non-psychiatric controls (age range 18–88) were tested for startle eyeblink response using electromyogram (EMG) recording. Startle magnitude decreased and startle latency increased with aging. PPI demonstrated an inverted U-shaped function with age (greatest PPI at intermediate ages) while there was no significant effect of age on startle habituation. The results do not support the theory that aging is associated with a general decline in inhibitory function and contrast with previous studies that have compared only extreme age groups and have found no effects of age on PPI.

Keywords: Age; Startle; Prepulse inhibition; Habituation; Attention

* Corresponding author. Present address: Department of Psychology, California State University, Los Angeles, 5151 State University Drive, Los Angeles, CA 90032-8227, USA. Tel.: +1-323-343-2266; fax: +1-323-343-2281.

E-mail address: joel.ellwanger@calstatela.edu (J. Ellwanger).

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1. Introduction

The startle reflex is a constellation of responses to a sudden intense stimulus that is most often operationalized in humans by electromyogram (EMG) measurement of the eyeblink component of the reflex. Human research using the startle response has grown exponentially in the last 30 years (Braff et al., 2001; Filion et al., 1998). One important reason for this interest in the startle response is that it shows several forms of behavioral plasticity that are functionally significant, have a well delineated neural substrate, and are related to fundamental aspects of information processing. The goal of the present study was to examine the effect of normal human aging on startle response plasticity.

The rationale for exploring the relationship between age and the startle response was 2-fold. First, measures of startle reactivity and plasticity are increasingly being used as measures of cognitive and affective processes in both clinical (e.g. see Cadenhead and Braff, 1999) and normal (e.g. see Bradley et al., 1999) populations. For a cognitive psychophysiological measure to be most useful, in a clinical or non-clinical context, it is important to understand the sources of variation that can affect the measure (e.g. Polich, 1993). When these sources are understood and controlled, startle response measures will have much greater utility as indices of cognitive function or as markers for psychiatric disorders. Age is known to be an important source of subject variability affecting cognitive psychophysiological measures such as the P300 and N400 event-related potentials (ERPs; Polich, 1993; Kutas and Iragui, 2000). Because age affects so many other behavioral and psychophysiological indices of information processing, it is a natural candidate to examine as a potential source of variability affecting the startle response.

A second reason for examining the age-startle relationship is to test the idea, common to several theories of cognitive aging, that increasing age is related to a global loss of inhibitory function (Woodruff-Pak, 1997). As measures of startle plasticity are direct physiological indices of inhibition, they provide a novel method to test the universality of central nervous system-modulated inhibitory decline with aging.

One of the most frequently studied forms of startle plasticity is prepulse inhibition (PPI). PPI is the reduction in startle amplitude that occurs when a startling stimulus is preceded (30–500 ms) by a weak prestimulus. Graham (1975) proposed that PPI reflects the activation of an automatic process that serves to protect the cognitive processing of the prestimulus. This hypothesis has been expanded upon in human and animal studies by Braff, Geyer, Swerdlow, and colleagues (Braff et al., 1978, 1992, 1999, 2001; Geyer and Braff, 1987) who proposed that PPI is an operational measure of gating, which refers to a general reduction in the processing of and distraction by irrelevant or repetitive stimuli. Supporting this position, PPI is deficient in psychiatric disorders that are characterized by a deficient inhibition of irrelevant sensory, motor, or cognitive information, including schizophrenia (Braff et al., 1978, 1992), obsessive compulsive disorder (Swerdlow et al., 1993b), and Huntington's disease (Braff et al., 2001; Swerdlow et al., 1995).