

Age-related differences in brain activation during emotional face processing

Faith M. Gunning-Dixon*, Ruben C. Gur, Alexis C. Perkins,
Lee Schroeder, Travis Turner, Bruce I. Turetsky, Robin M. Chan,
James W. Loughhead, David C. Alsop, Joseph Maldjian, Raquel E. Gur

Department of Psychiatry and Radiology, Section of Neuropsychiatry, University of Pennsylvania, Philadelphia, PA 19104, USA

Received 5 July 2001; received in revised form 25 April 2002; accepted 5 June 2002

Abstract

Advancing age is associated with significant declines on neurobehavioral tasks that demand substantial mental effort. Functional imaging studies of mental abilities indicate that older adults faced with cognitive challenges tend to activate more regions, particularly frontal, than their younger counterparts, and that this recruitment of additional regions may reflect an attempt to compensate for inefficiency in cortical networks. The neural basis of emotion processing in aging has received little attention, and the goal of the present study was to use functional magnetic resonance imaging (fMRI) to examine the influence of age on facial emotion processing and activation in cortical and limbic regions. Participants (eight old and eight young adults) viewed facial displays of happiness, sadness, anger, fear, disgust, and neutrality in alternating blocks of emotion and age discrimination. We predicted that in response to an emotion discrimination task, older adults would demonstrate increased use of frontal regions relative to younger adults, perhaps combined with diminished use of regions recruited by younger adults, such as temporo-limbic regions. During the emotion discrimination task, young participants activated, visual, frontal and limbic regions, whereas older participants activated parietal, temporal and frontal regions. A direct comparison between emotion and age discrimination revealed that while younger adults activated the amygdala and surrounding temporo-limbic regions, older adults activated left frontal regions. The results of this study suggest that older adults may rely on different cortical networks to perceive emotional facial expressions than do their younger counterparts.

© 2002 Elsevier Science Inc. All rights reserved.

Keywords: Aging; Brain; Facial emotion processing; Functional neuroimaging; fMRI

1. Introduction

Advancing age is associated with significant declines on neurobehavioral tasks that demand substantial mental effort, rely heavily on processing speed, and are characterized by novelty and complexity of the stimuli [36]. Functional neuroimaging techniques, such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), provide roughly ‘real-time’ representation of brain hemodynamic response, and thus enable the *in vivo* study of neural mechanisms underlying mental processes. Several studies have used functional neuroimaging paradigms to study the neural basis of age-related changes in mental abil-

ities. These investigations have examined episodic memory [10–12,26,33,46,48,67], working memory [32,51,64,66], attention [5,39,47], and executive functioning [71]. Generally, the evidence suggests that older adults tend to activate more regions than their younger counterparts. This recruitment of additional cortical regions may reflect an attempt to compensate for cortical networks that have become less efficient in advanced age. Furthermore, functional imaging data suggest that older adults recruit frontal regions when faced with effortful tasks [25,61]. This effect too can be considered compensatory, in view of evidence for age-associated reduction in frontal lobe volume (e.g. [16,40,61,62]).

Whereas much of aging research has focused on the neurobiologic substrates of cognition, the neural underpinnings of emotion processing in aging have received little attention. Lesion studies aimed at identifying the neural substrates of emotion have implicated the limbic system, particularly the amygdala, as well as cortical areas including

* Corresponding author. Present address: Department of Psychology, Hillside Hospital, 217 Kaufman Building, 75-59, 263rd Street, Glen Oaks, NY 11004, USA. Tel.: +1-718-470-8382; fax: +1-718-962-7717.

E-mail address: fdixon@lij.edu (F.M. Gunning-Dixon).

the orbitofrontal, dorsolateral prefrontal, parietal, and temporal cortices [1,2,4,13,17,18,21,34,45,65]. Functional neuroimaging studies have used diverse paradigms to examine emotion processing, including emotion discrimination [29,30,41], mood induction [24,59,68–70], fear conditioning [44,52], prosodic identification [9], reward and punishment conditions [42,57,80] and viewing of emotionally provocative stimuli [7,14,37,43,58,63]. Generally, these studies support the lesion findings that limbic regions, particularly the amygdala, and certain prefrontal regions are consistently involved in emotion processing [29–31,53–55,72].

Facial expression has been considered a salient component of emotional behavior [19], and the ability to identify and distinguish facial emotion is an important component of emotion processing. The preponderance of data from fMRI studies of activation patterns associated with perception of facial expression in young healthy adults indicate activation of limbic regions, particularly the amygdala, in response to emotional faces [30,31,68,72]. However, inferior frontal regions seem also to be involved in facial emotion discrimination. For example, Sprengelmeyer et al., evaluated activation patterns associated with performance of gender discrimination of faces expressing disgust, fear and anger compared with neutral expressions. They detected left inferior frontal activation for all three emotions, with different patterns for each emotion in other cortical and subcortical regions [72]. Interestingly, it appears that activation of the amygdala may be dependent upon the relevance of the facial emotion itself to the task at hand. For instance, in the aforementioned study, where emotional faces were used but the task required gender discrimination, amygdala activation was not observed [72]. Similarly, Gur et al. [30] observed activation in inferior frontal regions, regardless of the type of facial emotion task, but amygdala and hippocampal activation was modulated by the task relevance of the emotional aspects of the face.

Although the effect of aging on emotion processing has received limited attention, there is evidence to suggest that some deficits, such as “lesser expressivity” are present in older adults [27,49]. There is also evidence that older adults are more vulnerable than young adults to adverse effects of negative emotional states on memory [20] and other cognitive abilities [56]. Behavioral studies of emotional perception indicate that older adults may perceive emotions less accurately than younger adults. For example, older adults appear to process lexical emotional stimuli less accurately than their younger counterparts [28]. Furthermore, results of a study that required facial expression identification indicate that older adults, when required to identify negative affect, are less accurate than young adults [50].

To our knowledge, only one study has used functional neuroimaging to study emotion processing in older adults. Paradiso et al. [58], used PET to study brain activation in healthy elderly individuals during a mood induction task. Participants watched video clips intended to evoke positive or negative emotions while regional cerebral blood flow

was measured. During all conditions, participants activated visual cortices, orbital and medial frontal cortices, and the fusiform gyrus. In the happy condition only, subjects activated the anterior cingulate and entorhinal cortex, while in the disgust condition only, subjects activated the medial thalamus. However, the conclusions about the effect of aging on emotion processing are limited due to the fact that this study looked only at older adults.

The goal of the present study was to examine the influence of age on activation of limbic and cortical regions during facial emotion processing. Regional activation during an emotion-discrimination task was compared to activation during passive baseline and an active control condition requiring discrimination of non-emotional aspects of the same faces. Based on previous studies of emotion discrimination in young, healthy individuals, we expected young participants to show activation in limbic regions (amygdala, hippocampus, parahippocampal gyrus), fusiform cortex, occipital regions, and inferior frontal cortex. The bulk of the functional imaging data suggest that older adults, perhaps in an attempt to compensate for diminished function in other brain regions, tend to recruit frontal regions when faced with effortful tasks (see [10,25,61] for review). Thus, we predicted that, due to the decreased efficiency in temporo-limbic regions associated with advancing age, older adults would demonstrate increased use of frontal relative to limbic regions, compared to the younger adults.

2. Material and methods

2.1. Participants

Participants were healthy individuals recruited through advertisements in the local newspapers and in collaboration with the Penn Passcard Program for Healthy Living of the Institute on Aging at the University of Pennsylvania. Participants underwent medical screening to exclude individuals with a history of any illnesses affecting brain function. Specifically, participants were screened for history of neurological and/or psychiatric conditions, head trauma with loss of consciousness, uncontrolled hypertension, diabetes mellitus, kidney disease, chronic obstructive pulmonary disease, and cancer affecting the central nervous system. Data from 16 participants were included in the present study, balanced for gender between age group. The age of the young participants (4 men and 4 women) ranged from 19 to 29 years, $M = 25.8$, $S.D. = 3.1$. The age of the older participants (4 men and 4 women) ranged from 57 to 79 years, $M = 72.3$, $S.D. = 7.6$. Results from six of the young individuals were reported in a previous study [30]. Groups did not differ on years of education: young, $M = 16.4$, $S.D. = 2.7$ (range 12–20); old, $M = 17.0$, $S.D. = 1.8$ (range 14–20), $t < 1$, ns. Written informed consent was obtained from each participant after the nature and possible consequences of the study were explained.

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات