Threat Perception in Mild Cognitive Impairment and Early Dementia

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Mild cognitive impairment (MCI) and dementia affect many aspects of emotion processing. Even though the ability to detect threat is a particularly important aspect of emotion processing, no study to date has assessed threat perception in either of these groups. The purpose of the present study was to test whether individuals with MCI \( n = 38 \) and mild dementia \( n = 34 \) have difficulty differentiating between faces and situations normatively judged to be either high or low in threat relative to age-matched controls \( n = 34 \). To achieve this aim, all participants completed 2 danger rating tasks that involved viewing and rating high- and low-danger images. It was also assessed whether threat perception was related to cognitive functioning and emotion recognition. The results indicated that all 3 groups were accurately, and comparably, able to differentiate high from low-danger faces. However, the dementia group had difficulties differentiating high from low-danger situations, which reflected a bias to overattribute the level of threat posed by normatively judged nontaxing situations. This difficulty was related to more general cognitive decline.

Key Words: Dementia—Emotion—Social cognition.
four community-dwelling elders meet criteria for cognitive impairment that is not dementia (Unverzagt et al., 2001). Thus, although evidence continues to be debated as to whether MCI represents a prodrome of dementia, MCI is an increasingly prevalent theoretical and diagnostic syndrome in its own right, and it is important to delineate the extent to which threat perception is impaired in this group.

Individuals who meet criteria for MCI present with cognitive and brain changes that are generally intermediate between individuals with dementia and nonclinical controls (Petersen, 2007). Preliminary evidence suggests that at least some aspects of emotion processing may be similarly affected, such as basic emotion recognition (Spoletini et al., 2008; Teng, Po, & Cummings, 2007). Consequently, it may be anticipated that a qualitatively similar profile of threat perception difficulties will be observed in the MCI and dementia groups, although the magnitude of these difficulties should be smaller for those with MCI. The second aim is to test this possibility.

The final exploratory aim is to clarify whether any observed difficulties in threat perception are related to more general cognitive impairment and emotion recognition.

**METHODS**

**Participants**

One hundred and six community-dwelling adults participated, 34 of whom met Diagnostic and Statistical Manual of Mental Disorder (DSM-IV) criteria for dementia, 38 of whom met the modified criteria for MCI (Petersen, 2007), and 34 of whom were demographically matched controls without cognitive impairment. All participants had an informant with whom they had at least weekly contact and adequate eyesight, hearing, and English language ability. Subjects were excluded if they had a previous diagnosis of psychiatric or neurological illness.

The three groups did not differ significantly in age ($M = 79.4, SD = 6.12; M = 78.7, SD = 4.53; M = 77.2, SD = 4.30,$ respectively; $F(2, 103) = 1.65, p = .196, \eta^2_p = 0.03$), years of education ($M = 11.4, SD = 3.57; M = 11.6, SD = 3.58; M = 11.6, SD = 3.56,$ respectively; $F(2, 103) = 0.03, p = .969, \eta^2_p < .01$), or gender (47%, 50%, and 44% male, respectively; $\chi^2(2, N = 106) = 0.25, p = .883; \phi = .05$).

The majority of participants (>90%) were recruited from a large epidemiological study of aging, which commenced 2 years prior to the current study. The second source of recruitment was from a Memory Disorders Clinic, many of whom were newly diagnosed with dementia at the time of recruitment. In total, nine participants were recruited from the Clinic to supplement the recruitment from the epidemiological study. This was largely because the epidemiological study excluded dementia at baseline, so at the 2-year time point, this study was conducted, dementia cases tended to be few and mild. One participant recruited from the Clinic was excluded due to not being able to complete the testing. Of the remaining eight, one was a control, two were diagnosed with MCI, and five were diagnosed with dementia.

All participants from both sources had an extended clinical and neuropsychological evaluation in the 2 months prior to recruitment, and informants were interviewed regarding participants’ activities of daily living and instrumental activities of daily living. All participants in the control group had Mini Mental State Exam (MMSE) scores of 27 or higher and did not have an impairment of 1.5 SDs below the age-based norm for a battery of standardized neuropsychological tests that indexed memory, language, and executive function. MCI and dementia were diagnosed by consensus conference of the memory clinic or epidemiological study. Two of the authors (H.B. and P.S.) are the joint consultant psychiatrists in both these conferences, the same neuropsychologist oversees both, and the test batteries used are identical. The same criteria are applied in both situations.

MMSE scores indicated that dementia participants were in the mild stage of the illness, consistent with the majority of this group being fewer than 2 years postdiagnosis ($M = 26.0, SD = 3.58$ for the dementia group; $M = 27.9, SD = 1.52$ for the MCI group; and $M = 28.6, SD = 1.44$ for the control group).

**Materials and Procedure**

Ethics approval was obtained from South Eastern Sydney Illawara Area Health Service. The following measures were administered in counterbalanced order:

**Danger rating task—Faces.**—These were 20 black and white photographs of people’s faces taken from a larger stimuli set for which Ruffman and colleagues (2006) obtained normative judgments from younger and older adults to identify the 10 faces that were most approachable, and the 10 faces that were most unapproachable. The typical low-danger individual was young, female, and smiling, whereas the typical high-danger individual was middle-aged, male, and not smiling. The bias linking a smiling female with low danger and an unsmiling male with high danger provides the stimuli with ecological validity.

**Danger rating task—Situations.**—The pictures for the situation task were also black and white photos and were selected by Ruffman and colleagues (2006) from a larger set of pictures. The pictures included different activities (e.g., rally car driving vs. swimming), different animals (e.g., tiger vs. kittens), and different environmental conditions (e.g., storm clouds vs. nonstorm clouds). Human faces were not present in the photos depicting situations. The 10 high-danger situations and the 10 low-danger situations were again selected based on normative judgments of both older and younger adults (see Ruffman et al.).
Face and situation photos were presented as separate tasks. Presentation of individual photos within each task was randomized, with participants asked to rate each photo on a scale from 1 (not at all dangerous) to 7 (very dangerous).

Cognitive function.—In addition to including the MMSE to provide a gross index of cognitive function, two measures of executive functioning were included. These were verbal fluency (using the probes: F, A, and S and animals) and the Trail Making Test (Trails). For each fluency probe, participants were given 1 min to orally produce as many exemplars as possible. The dependent measure was the total number of correct responses summed across the phonemic and semantic fluency probes, which were intercorrelated \( r = .37 \). To minimize the impact of visual search and processing speed on the Trails, the difference score between Part A and Part B was divided by the comparable score from Part A, and this ratio used as the second measure of executive control.

Emotion recognition.—Participants were presented with a sequence of 36 photographs from the black and white Ekman and Friesen (1976) Pictures of Facial Affect, six each of anger, happiness, fear, disgust, sadness, and surprise. For each face, participants had to identify which of the six emotion labels best described the face.

Results

Danger Rating Tasks

Figure 1A and 1B shows danger ratings for control, MCI, and dementia participants on the two danger rating tasks. The faces data were analyzed with a 3 (group: older, MCI, dementia) \( \times \) 2 (danger level: high, low) analysis of variance (ANOVA), with danger ratings as the dependent variable. These analyses indicated a main effect of danger level, \( F(1, 103) = 596.20, p < .001, \eta_p^2 = .85 \), which reflected higher danger ratings on high-danger than low-danger faces. However, there was no main effect of group, \( F(2, 103) = 0.45, p = .64, \eta_p^2 = .01 \), and no interaction between danger level and group, \( F(2, 103) = 0.48, p = .62, \eta_p^2 = .01 \).

The situations data were similarly analyzed with a 3 (group: older, MCI, dementia) \( \times \) 2 (danger level: high, low) ANOVA, with danger ratings as the dependent variable. Again, there was a main effect of danger level, \( F(1, 103) = 1865.64, p < .001, \eta_p^2 = .95 \), which reflected higher danger ratings on high-danger than low-danger situations, and no main effect of group, \( F(2, 103) = 0.25, p = .78, \eta_p^2 = .01 \). However, there was an interaction between danger level and group, \( F(2, 103) = 6.91, p = .002, \eta_p^2 = .12 \).

To analyze the interaction between group and danger type, tests of simple effects were conducted. For low-danger situations, but not high-danger situations, group was a significant main effect: low-danger situations, \( F(2, 103) = 3.29, p = .041 \); high-danger situations, \( F(2, 103) = 0.869, p = .422 \). The three groups, therefore, only differed with respect to their ratings in the low-danger situations. Tukey tests of this simple main effect revealed that the dementia group reported significantly higher danger ratings to the low-danger situations relative to the control group \( p = .031 \), but did not differ from the MCI group \( p = .389 \). The MCI and control groups also did not differ \( p = .389 \).

Another way of analyzing these data is by deriving difference scores that represent the discrepancy between ratings to (a) high- and low-danger faces and (b) high- and low-danger situations. The larger these difference scores, the better the participant is able to differentiate between high- and low-danger faces and situations, respectively. For example, participants rated high-danger stimuli as lower in danger than low-danger stimuli. The discrepancy analyses include a negative value for this participant. Exclusion of this participant does not in any way alter the conclusions. Analyses of variance on these difference scores confirmed the previous findings of no between-group difference between high- and low-danger faces, \( F(2, 103) = 0.48, p = .620 \), but a between-group effect for high- and low-danger situations, \( F(2, 103) = 6.91, p = .002 \). Tukey tests of this simple main effect revealed that the dementia group was less able to differentiate between high- and low-danger situations relative to the control group \( p = .031 \), but did not differ from the MCI group \( p = .389 \). The MCI and control groups also did not differ \( p = .389 \).
high- and low-danger situations relative to the control group ($p = .001$) and showed a trend to have increased difficulty relative to the MCI group ($p = .098$). The MCI and control groups did not differ ($p = .201$).

**Emotion Recognition**

Emotion recognition data were analyzed with a $3 \times 6$ ANOVA with the between-subjects variable of group (control, MCI, dementia), and the within-subjects variable of emotion (anger, disgust, fear, sadness, surprise, happiness). There was a main effect of group, $F(2, 103) = 16.38, p < .001, \eta^2_p = .24$, and emotion, $F(5, 515) = 162.07, p < .001$, $\eta^2_p = .61$, but no interaction, $F(10, 515) = 0.75, p = .679, \eta^2_p = .01$. To follow-up the main effect of group, Tukey tests indicated that the dementia group ($M = 24.3, SD = 2.71$) was impaired relative to both the control ($M = 28.6, SD = 2.71; p < .001$) and the MCI group ($M = 26.9, SD = 3.02; p = .002$). There was also a trend for the MCI group to be more impaired than the control group ($p = .062$). Tests of simple effects revealed that emotion type was a simple main effect within each group: control, $F(5, 165) = 57.4, p < .01$; MCI, $F(5, 185) = 54.6, p < .01$; and dementia, $F(5, 165) = 54.3, p < .01$. In terms of the pattern of these effects, all three groups had the same order with respect to the lowest to highest percentage of recognized emotions: fear, anger, disgust, sadness, surprise, and happiness. This difficulty order was almost identical to that identified by Henry et al. (2008) for older controls and participants with Alzheimer’s disease.

**Correlates of Threat Perception**

The measures of cognitive function (MMSE, Trails, and Verbal fluency) and emotion recognition were correlated with the difference scores between high- and low-danger faces and between high- and low-danger situations. Neither of the correlations in the control group attained significance nor were any of the correlations with the ability to differentiate high- and low-danger faces significant. However, the ability to differentiate high- and low-danger situations was related to Trails and emotion recognition in the MCI group ($r_s = .42$ and .48, respectively) and to MMSE scores in the dementia group ($r = .34$; all $p_s < .05$).

**Discussion**

The present results indicate that individuals with MCI and in the very early stages of dementia do not differ in their ability to detect threat or nefarious intent in the facial expressions of others relative to age-matched controls. However, those with dementia are less able to differentiate high- and low-threat situations relative to age-matched controls, with this difficulty appearing to predominantly reflect a bias to overattribute the level of threat posed by normatively judged nonthreatening situations. The finding of a significant correlation between these danger ratings and performance with the MMSE in the dementia group suggest that this difficulty may at least partially reflect a more general decline in cognitive function. However, equally, this correlation is consistent with the possibility that higher threat ratings for low-danger situations in the dementia group do not reflect a deficit at all, but instead an accurate assessment of relative risk. Specifically, with declining cognitive abilities normatively judged low-danger situations may in fact be more dangerous for those with dementia (whereas high-danger situations are dangerous irrespective of cognitive status). However, further research is needed to assess how emotion recognition relates to threat perception, which was only related to one aspect of threat perception, in one of the three groups.

These data contrast with the pattern of age effects identified in previous research using the same danger rating tasks. As noted, in a study of the effects of normal adult aging, Ruffman and colleagues (2006) found differences in the way older and younger adults rate threat in faces, but not situations, and this was attributed to greater amygdala involvement in the processing of threatening facial (as opposed to threatening nonfacial) information, as well as age-related change in other components of the “social brain.” The present data imply that although these brain regions are more affected in dementia than in normal adult aging (for a review, see Ruffman, Henry, Livingstone, & Phillips, 2008), this does not appear to incur “costs” by way of facial threat perception.

It is, however, important that future studies test whether the detection of gender influences the decisions being made. As noted, the typical low-danger individual was young, female, and smiling, whereas the typical high-danger individual was middle-aged, male, and not smiling. Although the bias linking a smiling female with low danger and an unsmiling male with high danger provided the stimuli with ecological validity, it also introduced a confound between threat and gender detection. An appropriate control comparison would be to require participants to rate threat for younger female and older male faces who have neutral facial expressions. Inclusion of such a control condition would be important in future research to more clearly assess detection of threat that is independent of gender.

Another important issue that could not be addressed in the present study is the extent to which threat perception differs as a function of dementia subtype. In the present study, information relating to specific diagnoses was not available. However, it would be of considerable interest to assess how threat perception is affected in dementias that vary with respect to their relative impact on the key structures thought to be implicated in this aspect of emotional processing. In particular, frontotemporal lobar degeneration is associated with marked tissue loss in frontal and temporal structures. Relative to other dementia subtypes, this group is characterized by greater impairments in virtually all facets of social and emotional processing (Wittenberg et al.,...
2008). Consequently, it may be anticipated that this dementia group will present with particularly early and severe deficits in threat perception, but this possibility remains to be directly tested.

In conclusion, all three groups were accurately, and comparably, able to differentiate high from low-danger faces, but those with dementia had difficulties differentiating high from low-danger situations. These difficulties appeared to predominantly reflect a trend to overattribute the level of threat posed by normatively judged nontreating situations. Furthermore, although these data indicate that the ability to detect threat or nefarious intent in the facial expressions of others is preserved in the early stages of dementia, the more advanced stages are characterized by global cognitive and functional decline. It is, therefore, important to clarify at what point in the illness difficulties detecting facial threat emerge, and how this relates to other functional parameters. A more nuanced understanding of the temporal progression and correlates of threat perception difficulties in abnormal aging is not only of considerable theoretical interest, but has practical implications for the safety and well-being of our most vulnerable older adult populations.

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References


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