Dorsal–ventral integration in the recognition of 3D structure-from-motion stimuli in Mild Cognitive Impairment

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INTRODUCTION

In structure-from-motion stimuli (SFM), 3D shape can only be extracted from dot moving patterns by integrating motion cues over time. Recent studies have shown that integration of visual information across dorsal and ventral visual streams is needed for the perception of 3D SFM objects [1]. In a previous study, our group has found that 3D motion integration is specifically impaired in Mild Cognitive Impairment (MCI), indicating that parietal function may become affected early in the course of the disease.

OBJECTIVE

In the present study, we investigated whether the ability to recognize 3D SFM objects is impaired in MCI.

METHODS

Participants: A group of MCI patients (n=25) and a healthy control groups (n=22) were included. MCI and old adults groups were matched for chronological-age (p>0.05). Patients were recruited from the Neurology Department of Coimbra University Hospital, where diagnosis was achieved through gold standard neurological and neuropsychological assessment, following Petersen's [3] classification criteria for MCI. All the participants had normal or corrected-to-normal vision. Older healthy volunteers had no history of neurological disorders and were submitted to neuropsychological screening to exclude cognitive impairment.

	Control group (N= 22)		MCI (N= 25)	
	Mean	(SE)	Mean	(SE)
Chronological Age (years)	62.23	(1.99)	66.13	(1.59)
Education Level (years)	10.63	(0.99)	6.91	(0.85)
Gender (m:f)	12 : 10		9 : 16	

Procedures: Two tasks were included in which participants had to discriminate 3D SFM objects from 3D SFM meaningless objects. In the first task, participants were asked to discriminate 3D SFM chairs from 3D SFM scrambled chairs. In the second task, the stimuli to discriminate were 3D SFM faces and 3D SFM scrambled faces. The first task using chair stimuli was therefore used as a control task, at near ceiling level of performance, to make sure that subjects understood the task requirements. On both chair and face task, stimuli duration and depth were manipulated at three levels (duration: 100ms, 160ms, 980ms; depth: flat, intermediate and full depth), resulting in a 4 x 3 x 3 design with 10 trials per condition.

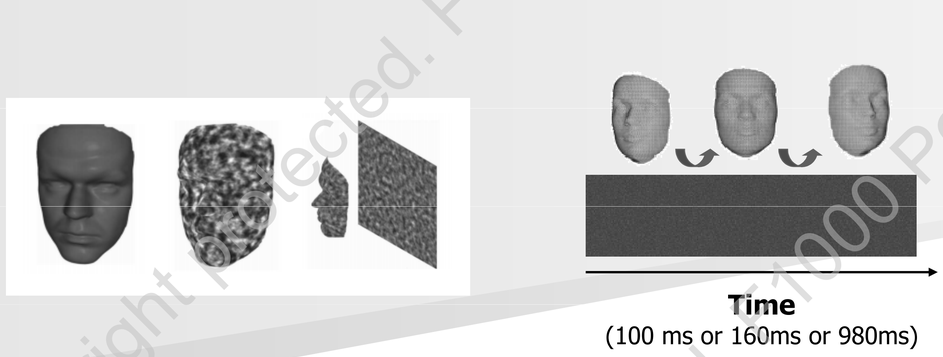

Fig. 1. Representation of the SFM face stimuli used in the experiment.

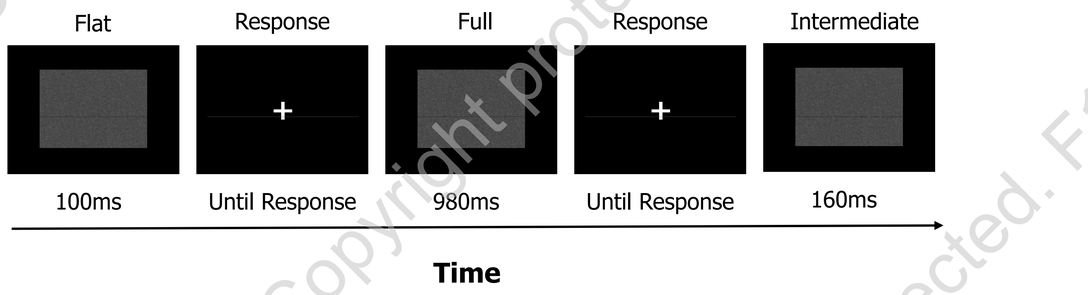

Fig. 2. Example of the experimental design involving the three stimuli durations and the three depth levels.

RESULTS

Repeated measure ANOVA, regarding the **Face** stimuli, revealed significant main effects for Depth (p<0,001) and Duration (p<0,001) suggesting that performance changes depending on the different Duration and Depth levels of the stimuli. A significant main effect for Group (p<0,05) was also found.

Independent sample T-tests revealed significant differences for the intermediate Duration (160 ms), for Full and Intermediate Depth levels (p<0,001; p<0,05 respectively) and for the slowest Duration (980 ms), for Full and Flat Depth levels (p<0,05; p<0,05 respectively).

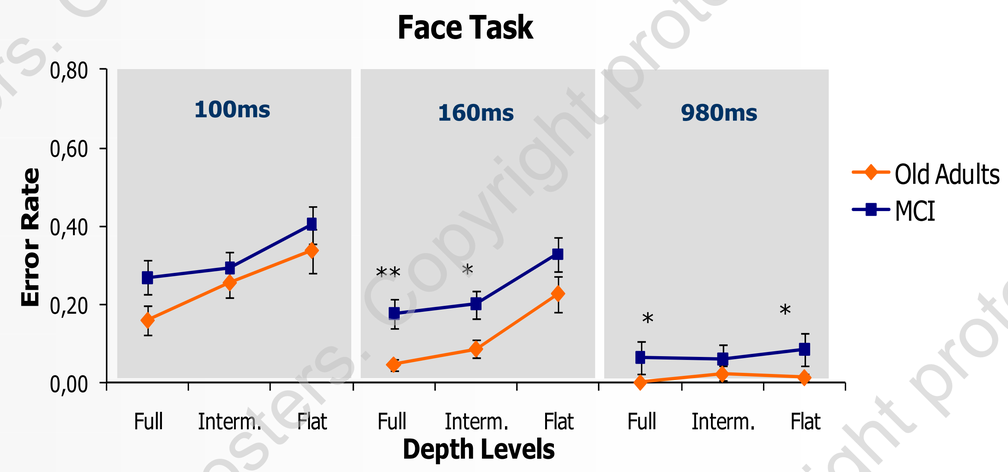

Fig. 3. Error rate of MCI patients compared to old adults considering the three depth levels and the three stimuli durations. Data were expressed as mean ± standard error (SE). * p<0.05; ** p<0,001

D-prime (d') analysis (zHit – zFalse Alarm) corroborated the main effects for depth, duration and group described above.

For **Scrambled Faces**, significant effects for Depth and Duration were also found (p<0,001), suggesting that performance is dependent of the different stimuli Duration and Depth levels. No significant effect for Group was found (maybe due to lack of statistical power and response bias in this condition).

No differences were found considering the **Chairs** stimuli confirming that this control condition ensured task comprehension.

DISCUSSION

Our results demonstrate evidence of an impairment in the integration of dorsal and ventral pathways in the recognition of faces in MCI. In the Face Recognition, only the Intermediate Duration (160 ms) enables a distinction regarding the comparison between MCI and Control Subjects. This was found for both Full and Intermediate Depth levels, suggesting that more difficult conditions (Flat depth level) are not optimal for discrimination at this duration. However for the longest Duration (980 ms) we found that MCI and Control Subjects performed differently in both Full and Flat Depth levels.

We conclude that pathological ageing (MCI) is related to deterioration in extracting object information from combined short lived motion and depth cues processed in the visual dorsal stream, leading us to believe that an impairment of the dorsal-ventral integration already exists at this early stage of pathological ageing.

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