Action perception predicts action performance

Heather R. Bailey[a,*], **Christopher A. Kurby**[b], **Tania Giovannetti**[c], and **Jeffrey M. Zacks**[a]
[a]

qualitative reports are important for diagnosis, they cannot distinguish the cognitive mechanisms underlying the functional deficit (Schwartz, Segal, Veramonti, Ferraro, & Buxbaum, 2002). Further, their subjective nature calls into question their accuracy, particularly in the earliest stages of dementia (see Gold, 2012 for a review).

Direct measurements of everyday action performance are a valuable complement to subjective reports, and have provided further evidence for action impairments in AD. The *Naturalistic Action Test* (NAT) was created to simulate the complex nature of real-world activities of daily living by requiring participants to complete naturalistic actions (Schwartz et al., 2002), and performance is correlated with subjective reports of daily living (Giovannetti, Libon, Buxbaum, & Schwartz, 2002; Schwartz et al., 2002). Naturalistic actions are everyday tasks that often require using objects to complete a series of steps in order to achieve a goal. One advantage of the NAT is that it explicitly assays differ2.07 pesn

representations (or scripts) of learned actions may help us predict what other people will do and they may guide our own preparations to perform an action (e.g., Barbey, Krueger, &

activity is remembered, could that ability be related to how well one performs everyday tasks? And if perception and action are related, which neural mechanisms mediate this relationship? We evaluated whether the integrity of several brain regions thought to be involved in event segmentation also was related to NAT performance. Finally, we examined whether cognitive variables were related to different aspects of action performance. Specifically, we examined working memory, semantic memory, and script knowledge given their relationships with action representations in individuals with Alzheimer's disease (e.g., Allain et al., 2008; Giovannetti et al., 2008; Grafman et al., 1991).

1.2. Current study

To address these questions, we asked cognitively healthy older adults and those with mild or mild AD to watch and segment three movies of everyday activities into events. Then they completed the NAT, which involved performing activities that were different from those in the movie. The participants also underwent structural MRI scans. The two main goals of the current study were to evaluate (1) whether segmenting an activity during perception is related to performing an activity and, if so, (2) which brain regions mediate the action perception and action performance relationship.

2. Method

This study was conducted as a part of a larger investigation of event segmentation in healthy

2.2. Materials

2.2.1. Segmentation—Participants watched four movies: one practice movie and three
249 s). Fig.Tf depicantstill framviifromeeach of thond(exlregmenlur movi.ee)T 60 214 Td(Participants watcheanhes

was not immediately relevant or necessary to the task was performed (e.g., eating the bologna or pack., eatiBnchbox iny to thschoolbag). See Giolevnetti et al.ed 2002) erf ahe stepsntovolveinto eachf NAthr Gieverydayctionviones: shopp., ef ahgcedlrnes, gti e, e wadyef a workBud cogoe, eouteao eat. TheseAthr Gitionvionesorthscoolsen from atiBnt an NA15itionviones

2.3. Procedure

0.28, and a significant group × error type interaction, $F(4,148) = 7.63$, $p < 0.001$, $\eta^2 = 0.12$. Planned *t*-test comparisons indicated that the CDR 1 group had the highest number of errors ($M = 65.53$, $SE = 8.25$), followed by the CDR 0.5 group ($M = 29.05$, $SE = 3.98$), and then the CDR 0 group ($M = 17.50$, $SE = 2.78$). This group difference was significant for omission errors, $F(2,74) = 22.71$, $p < 0.001$, and for commission errors, $F(2,74) = 4.57$, $p = 0.013$, but not for action additions, $F(2,74) = 2.28$, $p = 0.11$.

Because the total number of errors differed significantly between CDR groups, we computed their errors as proportion scores to better evaluate the pattern of errors by group. For each participant, we calculated the proportion of the total errors that were omissions, commissions, and action additions (see Fig. 6). A one-way MANOVA revealed a significant multivariate main effect of CDR group, Wilks' $\sigma = 0.807$, *F*

3.4. Regional brain volume

without the association, the object's function or the actor's intention may be difficult to comprehend. Further, losing the association (e.g., sandwich in the lunchbox) during action production may cause an individual to lose track of which step was executed leading to

The current pattern of results supports the Omission-Commission model (Giovannetti et al., 2012), which proposes that omission and commission errors are distinct everyday action impairments. We found that omissions were predicted by segmentation ability; commissions were not. Importantly, this study was the first to systematically evaluate which brain regions were associated with each error type. MTL volume predicted omissions, DLPFC predicted commissions, and ACC predicted action additions.

4.2. Conclusion

Segmentation of everyday activities is related to the performance of different activities in

Buxbaum LJ, Schwartz MF, Montgomery M. Ideational apraxia and naturalistic action. Cognitive

Kiehl KA, Liddle PF, Hopfinger JB. Error processing and the rostral anterior cingulate: An event-

Schwartz MF. Cognitive neuropsychology of everyday action and planning. Cognitive

Fig. 2.
Schematic for how the objects were arranged for the NAT Task 3.

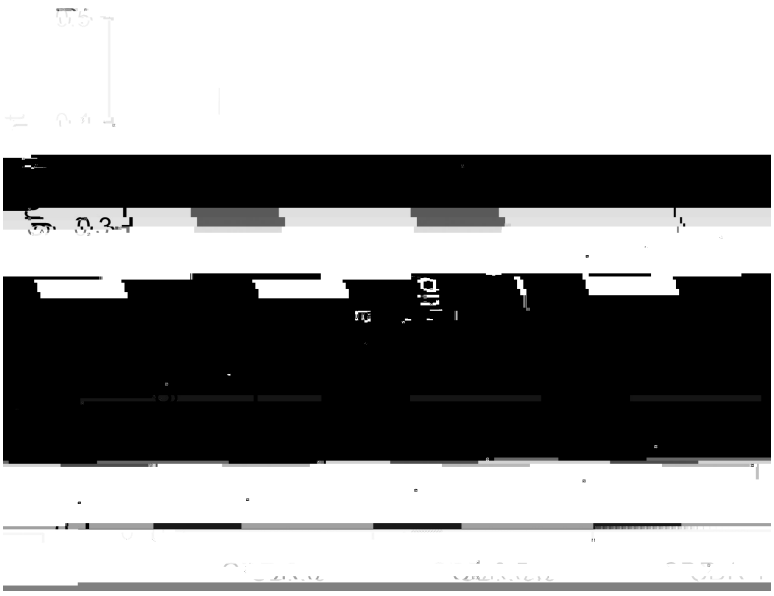
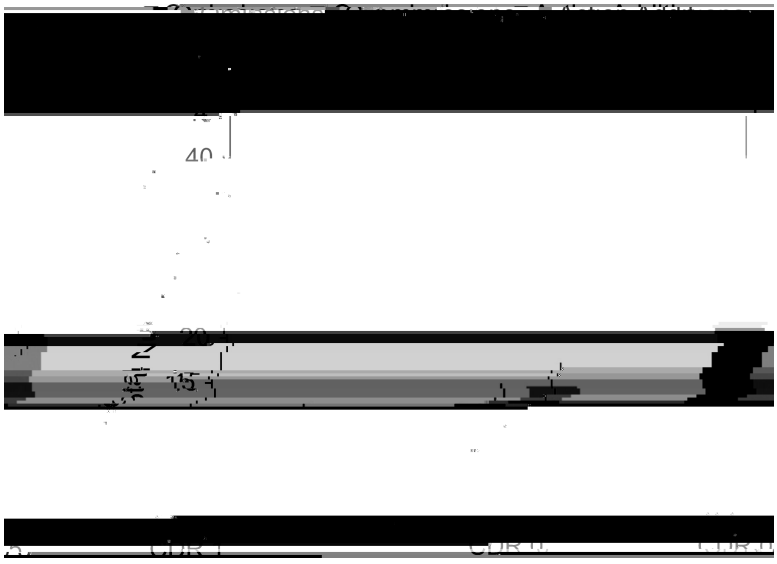


Fig. 3.
Segmentation agreement scores by CDR group. Error bars are standard errors of the mean.

Fig. 4.
NAT scores ranging from 0–6 by CDR group. Error bars are standard errors of the mean.



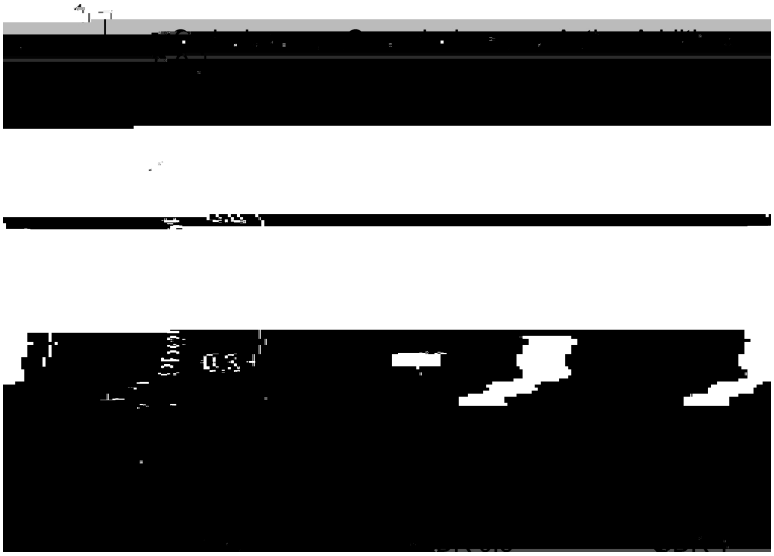


Fig. 7.
Scatter plot for the relationship between segmentation agreement and NAT scores.

Fig. 8.
Scatter plots for the relationships between segmentation agreement and (a) omission errors, (b) commission errors, and (c) action additions.

Table 3

Correlations between NAT and cognitive variables.

Table 4

Regression analyses predicting NAT score and error types.

Table 5

Correlations between NAT performance and structural MRI volumetric estimates (n = 55).

Region of Interest	NAT score	Omissions	Commissions