

The influence of affordance on object-directed actions: A neuropsychological study

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Background & Objectives

Limb apraxia is a higher-order motor deficit often observed after a stroke, comprising deficits in skilled movements despite intact primary motor, cognitive and sensory faculties (Leiguarda & Marsden, 2000). Traditional theories of apraxia categorise patients according to the type of errors they make, following a **two-system model of action** (Catani & Ffytche, 2005).

Patients with **ideational apraxia** have deficits in conceptualising appropriate movements, and show deficits in object use, whilst those with **ideomotor apraxia** have deficits in implementing these movements and show deficits in imitation. Traditional tests of apraxia have been criticised for being qualitative and failing to fully account for patients' deficits.

The present study describes the case of **patient MH**, who exhibited ideomotor apraxic symptoms in gesture imitation tests. We tested him on a task involving actions towards a simple handled object (BNS conference, 2014), using conditions that stressed the **affordance** for action, the **end comfort** of the action (Rosenbaum et al., 1992) and the **action** itself (lift vs. turn).

Our aim was to assess the impact of these factors on motor preparation and execution in apraxia.

Case Description

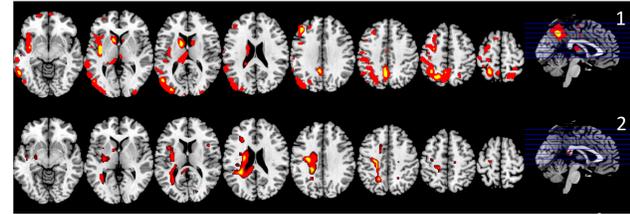
Patient MH

- 62 year-old right-handed male
- Ischaemic stroke in 2011

Cognitive profile

MoCA (18/30)

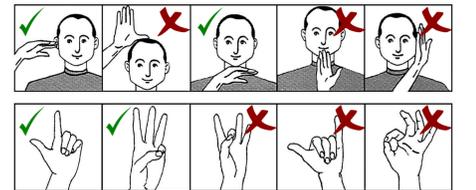
- Intact executive functions
- Visuospatial/constructional deficits



1. Grey matter lesion (vs 201 controls), Red=uncorrected, yellow = FWE corrected at .05
2. White matter lesion (vs 201 controls), Red=uncorrected, yellow = FWE corrected at .05

Ideomotor deficits as assessed by:

- Birmingham Cognitive Screen (BCoS) gesture imitation tasks (13/20)
- Goldenberg's test of imitation of meaningless gestures (24/40)



(Goldenberg, Laimgruber & Hermsdo, 2001)

No ideational apraxia (BCoS 'Multi-step object use' and 'Single object use' tasks)

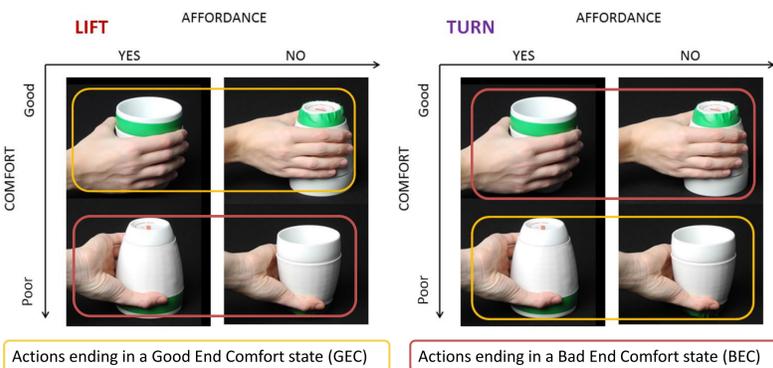
Methods & Procedure

Task:

- Action:** verbal instructions to **LIFT** or **TURN** the cup
- Grasp:** either **STRAIGHT** or **INVERTED**; the type of grasp was indicated by a **green line** on the cup
- Cup Start Orientation:** either **UPRIGHT** or **UPSIDE DOWN**

This yielded **8 possible combinations** of Action, Cup Orientation and Grasp.

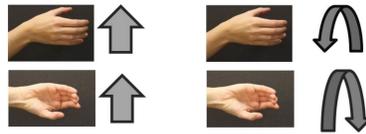
-An **Affordance** was defined as an action to the functional (open) part of the cup.
-**Good End Comfort (GEC)** and **Bad End Comfort (BEC)** positions were defined by pronation of the hand at the end of the action.



Actions ending in a Good End Comfort state (GEC)

Actions ending in a Bad End Comfort state (BEC)

Action and Grasp combinations:

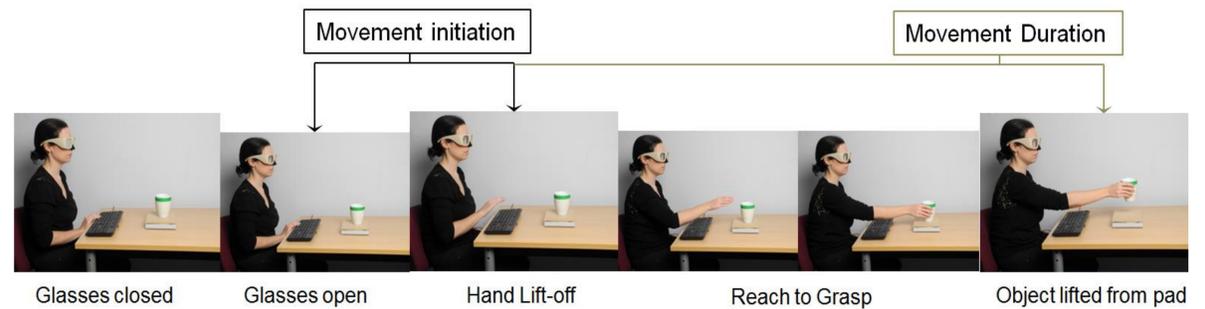


Analyses:

Factors used in the analyses: Affordance, End Comfort, Action

- Log-linear regression with backward elimination** to find the best fitting model to the data for our error analysis on MH's performance
- Crawford's modified t-test** (Crawford, Garthwaite & Porter, 2010) to compare MH's reaction times (RTs) for correct trials with those of a control sample (n = 18)
- Univariate ANOVA on MH's RTs** with three between-subjects factors to investigate any main effects

Timings of interest:

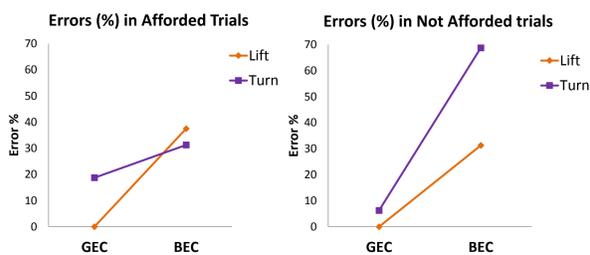


Results

ERROR ANALYSES

Log-linear regression:

The final model that best explained the patient's errors included two factors which separately interacted with **Accuracy: Action and End Comfort**.



REACTION TIMES (RTs) ANALYSES

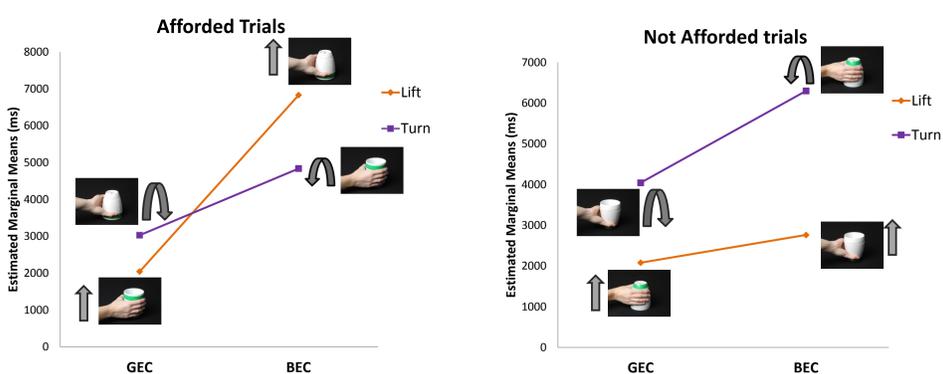
1) Crawford's t-tests:

- Movement Initiation RTs:** No significant difference was found between MH and healthy controls
- Movement Duration RTs:** MH's RTs were significantly delayed compared to healthy controls in all conditions

2) Univariate ANOVA on Movement Duration RTs:

- Significant main effects of **Action** ($F(1, 93) = 5.754, p=.019$); **End Comfort** ($F(1, 93) = 25.85, p<.0001$)
- A significant 3- way interaction:

Affordance*Action*End Comfort



Conclusion

This study revealed deficits during performance of simple actions to a handled object in a patient with ideomotor apraxia, despite adequate performance on traditional tasks of apraxia involving object use.

When performing a task requiring actions toward a cup, MH showed distinct effects of **action** and **end state comfort**. For an afforded action, lifting was very problematic when it ended in a BEC state; on the other hand, for a non-afforded action turning was problematic when it ended in a BEC state. These results are consistent with an **interaction between action, end comfort and affordance**. Actions are problematic when the initial grasp mismatches the usual grasp to the object for the action, and it ends in a BEC state.

Our findings demonstrate that assessing apraxic deficits using traditional batteries of tasks may be misleading in terms of the deficits patients may display in real life. The data support recent proposals that apraxia may be the result of deficits in planning actions under visual control ('affordance competition' hypothesis; Cisek, 2007; Rounis & Humphreys, 2015). Further studies using this type of paradigms and involving objective, rather than subjective, characterisation of deficits will aid our understanding of this complex disorder, and in particular how patients' deficits translate to deficits in every day activities (Bickerton et al., 2012).

References

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