**Discussion**

The present research confirmed adults' fast belief-tracking ability as manifested in certain anticipatory gaze response patterns. In the FB condition, just before the agent was about to select an action, participants looked in anticipation towards the empty box. Correspondingly, in the TB condition, just before the agent was about to select an action, participants looked in anticipation towards the full box. These results dovetail with those studies showing that eye gaze can reveal adults’ ability to quickly and correctly anticipate the action of a person who has a false or a true belief about the location of an object (e.g., Grainger, Henry, Naughtin, Comino, & Dux, 2018; Schneider, Slaughter, Becker, & Dux, 2014).

Our analyses of adults' mediolateral balance shifts—sampled at an early time point in the event sequence when there were no overt cues to suggest which box the agent would move towards—revealed, for the first time, spontaneous representation of belief-based actions by the subjects in response to the agent’s predicament. In the FB condition, adults leaned towards the empty box; and in the TB condition, they towards the full box in the TB condition. These results are in line with the prediction that motorically-grounded action expectations can be influenced by belief-tracking.

These findings revealing participants' motorically-grounded expectations of the agent's action being modulated by the workings of a fast belief-tracking system are noteworthy for several reasons.

· Remind the reader that research in the motor area has focused on situations where the action is going to successfully achieved by the agent.

· Then say that as per our interactive task, there are social situations where the agent will have a false-belief of an object's whereabouts as well as which action is needed.

· Research on motor processing suggests that an onlooker’s motor system generates expectations taking into account facts about the actual environment (some relevant study). Butterfill & Apperly (2016): Such motor processes occur not only when a subject is observing an actual environment but also when she or he is imagining it (see also Jeannerod, 2006) and B&A suggest that, during action observation, the onlooker’s motor system are not tied to the actual environment but can also generate behavioural expectations based on non-actual environments and, in particular, expectations which track the agent’s beliefs. Our findings could be seen as supporting this suggestion. Alternatively, it may be that belief-tracking processes guide subjects in spontaneously predicting the agent’s future actions nonmotorically, and these predictions then trigger motor activity. On such a view, belief-tracking and motor processes would not be integrated in the way Butterfill & Apperly envisage. In order to decide between these competing ideas further research is necessary. For instance, if belief-tracking and motor processes are tightly integrated, temporarily impairing one should have an effect on the other: thus, if subjects’ abilities to represent actions motorically were impaired (perhaps by using TMS (\*REF) or by bodily constraining them (\*REF)), we may find that their fast belief-tracking abilities are correspondingly reduced.

Adults’ final helping actions were unlike those which have been reported for children in a similar helping task (Buttemann *et al*. [16]). Adults were not more likely to help open the now-full box in the FB condition than in the TB condition. The majority of adults helped to open the now-empty box in both conditions. When we asked them why they chose this box, adults generally referred to facts about the agent or to her abilities rather than to her mental states.

Why did the final helping response not reflect belief information that the eye gaze and leaning responses was picked up by the adults? One possibility is that adults had the agent’s mental state in mind all along but took the view it was normatively irrelevant to their choice of action. This possibility is consistent with the observation that no adults expressed the view that their choice of final helping action was mistaken when subsequently asked why they had acted as they did. Alternatively, it may be that adults are poor at reflecting on the agent’s belief in the course of socially interacting with her, despite the occurrence of fast belief-belief tracking. Much as adults have been shown not always to take another’s visual perspective into account when interacting with her (\*Keysar et al), so also they may cut corners by ignoring another’s belief. Importantly, our results indicate that they could be doing this even when their eye gaze and leaning indicate that they have tracked the belief: if so, there may be a dissociation in adults’ performance analogous to that sometimes observed in young children (e.g. Clements & Perner, 1994; Low & Watts, 2013). Our results do not distinguish between these different reasons for why, despite showing sensitivity to belief in eye gaze and leaning, the adults did not do so in their final helping actions.

Why are adults’ responses different from children’s, at least in this respect? One possibility is that children and adults have different views about what one should do. Adults may generally think it is best to do as expected, whereas children may be more disposed to act in another’s best interests. Alternatively, it may be that children’s actions are less reflective than adults. The fast belief-tracking processes which influence adults’ leaning also occur in children but dominate their actions for longer; in adults, those fast-belief tracking processes are overshadowed by a more reflective process which, however, can be slow to incorporate information about beliefs (and other mental states, and perspective) in reaching decisions about what to do, especially when they are involved in a social interaction with the agent.

***Unexpected payoffs***

[1] Some failed replications of the finding that eye gaze can reflect belief tracking (\*refs) have led to the suggestion that eye gaze measures may be altogether ill-suited to measuring action anticipation (\*Southgate). To get clearer about the validity of eye gaze as reflecting belief tracking, we considered that to date, anticipatory looking behaviour toward locations of belief attribution has been demonstrated only in relatively passive computer-based tasks. This restriction invites the charge that apparent false belief effects in eye gaze are merely artefacts which do not reflect abilities important for everyday social interactions. On the other hand, if eye gaze can really be used to measure belief tracking, it should be possible to find real-time situations in which subjects’ eyes reveal what they take another to believe. Our results extend documentation of rapid mental-state tracking to a real-time interactive helping scenario. This gives weight to the idea that eye gaze is a valid cue to belief tracking, and supports claims that human beings' fast belief-tracking is a vital social sense for monitoring of others' action preparations (Apperly & Butterfill, 2009; Kovacs et al., 2010).

[2] If fast belief-tracking can only affect our eyes in tasks that involve, relatively passive looking expectations for example, its function will remain mysterious. Since our own physical movements also foreshadow other people’s belief-like state, our findings would suggest that the fast belief-tracking system, by way of its connections with the motor system, can have functional consequences for action understanding.

**Introduction**

There is some initial plausibility to the conjecture: van der Wel *et al.* [5] found that information about someone else's belief systematically perturbed the motor processes underpinning the trajectory of adults' own hand movements on a computer mouse-tracking task. We sought to uncover further evidence of whether observers' proactive belief tracking could modulate the pre-reflective role played by the motor system in the understanding of others' actions. Whereas van der Wel et al measured interference effects, we sought evidence that subjects will spontaneously represent the belief-based actions of an agent in the course of interacting with her.