**Research Networking Programmes**

## Short Visit Grant ☒ or Exchange Visit Grant ☐

*(please tick the relevant box)*

# Scientific Report

**Scientific report (one single document in WORD or PDF file) should be submitted online within one month of the event. It should not exceed eight A4 pages.**

***Proposal Title:***
Joint action, self-other distinction and response inhibition in toddlers.

***Application Reference N°:*** 5945

## 1) Purpose of the visit

The aim of my visit at the Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen (NL), was to set up a joint project on the development of the ability to coordinate with others in a non-imitative fashion during social interactions. My PhD project, developed at Sapienza University of Rome (IT) under Prof Salvatore Maria Aglioti's supervision, is based on the notion that we live our whole life dipped into an interactive social environment where we observe and act together with others. In this regard, the hypothesis of a direct matching between action observation and action execution (AO-AE) within one system (Rizzolatti and Sinigaglia 2010) has recently been widely challenged, since the AO-AE network seems to be also involved when we need to adapt to others' movements in a complementary (i.e. non-imitative) fashion (Newman-Norlund et al. 2007). However, the neurocognitive bases of social interaction are still poorly understood. In my project I aim to build a more coherent model of the role of simulation within the AO-AE network during social interaction.

In Rome, I developed a novel scenario to study face-to-face dyadic interactions requiring participants to both synchronise and reciprocally adapt their reach-to-grasp movements to achieve a common goal. So far, I demonstrated that simulation of the partner's movement is task-dependent (Sacheli et al. 2013) and modulated by the interpersonal relationship linking co-agents (Sacheli et al. 2012). Moreover, we used the same scenario to investigate the different contribution of the parietal and frontal nodes of the AO-AE network during joint-action by means of Transcranial Magnetic Stimulation.

However, the ability to efficiently coordinate with others' actions is not present from birth and the contribution of the AO-AE network might change over the course of life.

The Action and Neurocognition (ANC) group at the Donders Institute held by Prof Harol Bekkering possesses strong expertise in studying the role of action monitoring and motor simulation during social interaction (Bekkering et al. 2009, Ondobaka et al. 2012) and of motor resonance in imitation and social learning (Bekkering et al 2000, Paulus et al 2011, 2012). Moreover, it strictly cooperates with the Baby Research on Action, Interaction and Neurocognition (Baby BRAIN) Group, Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, interested in investigating the developmental mechanisms and neurocognitive changes underlying early social-cognitive development. In particular, in a recent study they investigated the development of children's ability to interact with others (Meyer et al. 2010), demonstrating that between two and three years of age children become proficient in coordinating with an adult partner during a turn-taking motor game. This might be either due to the fact in younger children higher-level action monitoring is not fully developed or to younger children's inability to integrate the partner's movements within their own action planning.

## 2) Description of the work carried out during the visit

The aim of my visit was to extend previous findings on the development of interpersonal coordination skills by investigating the different contribution of action planning/monitoring in children's ability to engage in non-imitative joint-actions with a partner. Capitalizing on the experience I acquired working with adults, I developed together with researchers from both the ANC and the BabyBRAIN groups a new experimental set-up to study 2 ½- and 3-year-old children ability not only to imitate but also to complement a partner's movements.

More precisely, the aim of this new experiment is to compare children's performance on two dyadic tasks, one purely requiring motor coordination at the movement level (Task 1, "Executive functions task") and the other requiring motor coordination in order to cooperatively achieve a common goal (Task 2, "Common goal task"). Both tasks require the participant to perform button presses choosing between two possible options, adapting their own movements to the experimenter's ones according to different instructions. Each button-press is associated with an outcome on the screen: a sequence of images will be displayed, showing a bear "being dressed" as a consequence of the experimenter' and participant's joint-action (see Figure 1 in the Appendix).

Figure 1. PANEL A. The experimental set-up. The child sits on the parent's lap in front of the experimenter who plays as interactive partner. Both the child and the partner have two buttons in front of them, one large button requiring a whole-hand press (a) and one small button requiring a finger press (b). The experimenter always starts the interaction and the child needs to responds performing congruent/incongruent movements according to task instructions (see main text). Both the experimenter and the child are required to perform the movements with their right hand. PANEL B. Each time the experimenter presses a button, the screen shows the bear "receiving" an article of clothing, e.g. a shirt; if the child correctly performs the response, the dressing action is complemented, e.g. the bear also receives the trousers.

During Task 1 ("Executive functions task"), the participant is required to perform, in different blocks, the same (congruent) or opposite (incongruent) movement with respect to the experimenter's one, e.g. in the incongruent condition, if the experimenter performs a whole-hand press on the big button participant is required to perform a finger press on the small button, and vice-versa. During Task 2 ("Common goal task"), the participant is required to complement the experimenter's action helping him/her "to dress the bear". In different blocks, unbeknownst to participants, the association between the experimenter's movements and outcomes (e.g. article of clothing "given" to the bear as a consequence of a small/big button press) is inverted, leading the participant performing congruent/incongruent movements with respect to the experimenter's one in order to complement the dressing action. In order to control for the impact of attentional factor, in all conditions images of the bear are always shown on the screen and participant's correct responses result in the bear being correctly dressing.

We expect children to be able to solve the Common-goal tasks earlier than the Executive function task. Thus, we might show that face-to-face motor interactions are situations that, thanks to their social relevance, do not necessarily require complex action monitoring. Indeed, they might rely on the purely motor ability to form action plans representing a common goal.

**3) Description of the main results obtained**

During my visit, I started up the experimental paradigm, programmed and tested the script to run the experiment and built up and piloted the experimental set-up (see Figure 2 in the Appendix) in order to achieve the best configuration to test toddlers' motor abilities during social interaction.

Figure 2. Three-year-old child being tested during the pilot experiment. The experimenter's confederate is showing the child how to perform the finger press on the small button (left) and the whole-hand press on the big button. Permission to show this picture has been provided.

The work done seems extremely promising; we now plan to collect data from three age-groups of participants, namely 2 ½- and 3-year-old children and a control group of adults.

**4) Future collaboration with host institution (if applicable)**

In case results from this first behavioural study met expectations, future collaborations will allow performing follow-up studies with neuroimaging techniques (fNIRS and fMRI) to investigate the involvement of the AO-AE network vs. prefrontal areas during the task.

***5)*** **Projected publications / articles resulting or to result from the grant *(ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)***

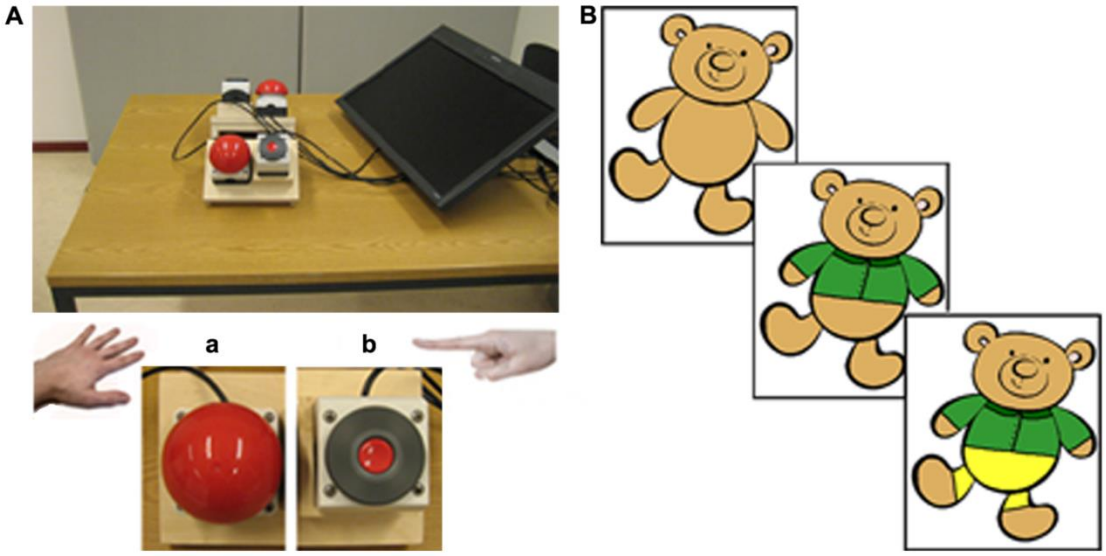
Hopefully, the behavioural study we are running now thanks to the Short Visit Grant support and the neuroimaging studies which will capitalise on its results will lead to joint publications with the host institution in peer-reviewed journals within 12 months.

**6) Other comments (if any)**

In addition to the empirical work, during my visit I took part to several meetings organized by both ANC and BabyBRAIN groups and acquired knowledge on the one hand on new approaches to the study of perception and action and on the other hand on theories, techniques and experimental paradigms suitable for studying social-cognitive development in children. Moreover, I had the chance to learn how research on infants and children is performed at the Baby Research Center of the Radboud University Nijmegen and to participate to the meetings of the Baby Research Center group where researchers investigating social-cognitive development, language acquisition and communication monthly meet and exchange ideas. Finally, I also took part to the 2nd Baby Brain & Cognition Meeting (Nijmegen, 23rd of September 2013) where seminal experts discussed recent studies relevant to social-cognitive development.

In conclusion, I consider my visit at the Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, a turning-point opportunity for me and my scientific future. I reckon that here I had the chance to be part of a lively scientific community, interacting with researchers possessing strong expertise in studying on the one hand the cognitive bases of action, perception and social interaction and on the other hand the development of motor cognition. This has been an extremely valuable opportunity to learn how to conduct research on children under a neurocognitive viewpoint and to acquire new perspectives to push further with proper experiments the findings I achieved so far . I believe this will be also beneficial to establish future collaborations.

## APPENDIX

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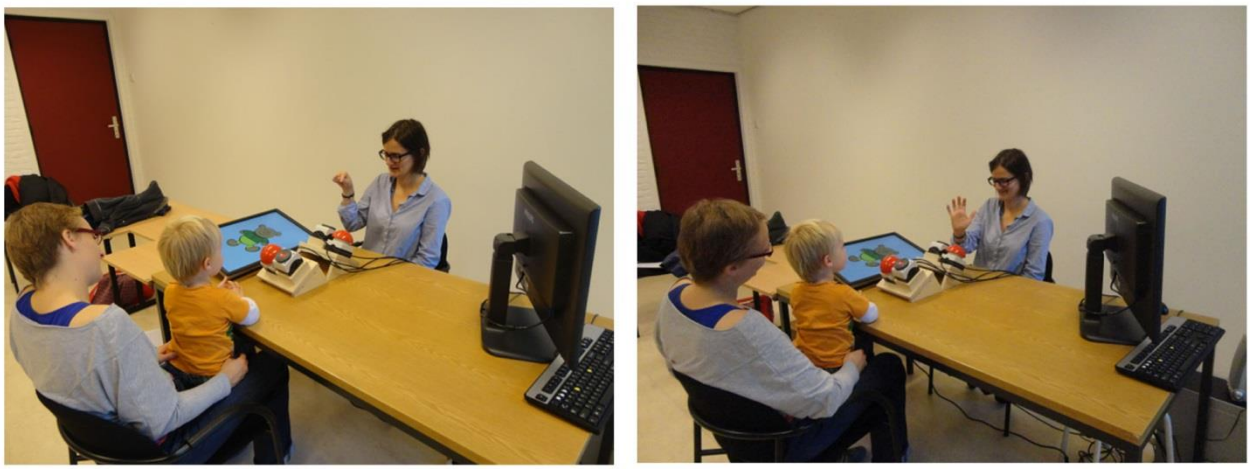

Figure 2. Three-year-old child being tested during the pilot experiment. The experimenter's confederate is showing the child how to perform the finger press on the small button (left) and the whole-hand press on the big button. Permission to show this picture has been provided.