

Coordination, Collaboration and Cooperation: Interdisciplinary Perspectives

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Humans may interact with each other over multiple complementary timescales. Humans, for instance, show fast low-level *coordination* processes of behavioral matching and interactional synchrony, as well as mid-range *collaborative* processes and *cooperative* processes over longer periods of time. Joint actions, for example, involve turn-taking (e.g., Levinson, 2006) and the alignment of linguistic resources during dialogue (e.g., Fusaroli et. al., 2012; Pickering & Garrod, 2004), the inter-animation of coordinated individuals' behaviors and motor plans (Knoblich, Butterfill & Sebanz, 2011), and gaze coordination during conversations (Richardson, Dale & Kirkham, 2007). Importantly, high levels of coordination in humans also appear to facilitate collaborative and cooperative behaviour. Research on collaborative learning, for instance, has shown that sequential gaze alignment may improve collaborative and cooperative efforts (e.g., Jermann, Mullins, Nüssli & Dillenbourg, 2011).

To date, however, little is known about the exact way in which coordination,

collaboration and cooperation are linked to each other. Even less is known on their evolutionary and developmental origins. From an evolutionary point of view, for instance, much work has been done on primate cooperation (see Melis & Semmann, 2010). However, little is known on the way coordination affects the emergence of cooperative strategies (e.g. Petit, Desportes & Thierry, 1992; Hirata & Fuwa, 2007). Interestingly, there is also little consensus on the definition of coordination, collaboration and cooperation across different disciplines.

In January 2014, a two-day workshop was held at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, to explore how coordination, collaboration and cooperation are studied and approached across different disciplines. The workshop was funded by a grant from the German Research Foundation (DFG) to the editors of this special issue. The workshop held in Leipzig brought together diverse perspectives on coordination, collaboration and cooperation from scholars across disparate disciplines, who were largely unaware of each other's research before the workshop took place. Given its trans-disciplinarity, the workshop benefited from contributions from primatologists, developmental and cognitive psychologists, learning scientists, sociologists, computer scientists and linguistics. Apart from Amici's review article on the evolution and development of human cooperation, Bietti and Sutton's review article on time-scales and joint remembering, and Cienki's general commentary, early versions of all other articles in this Special Issue were presented at this workshop.

This Special Issue represents a first step towards fostering dialogue across disciplines. Whenever possible, it strives to reach some common ground about how to use the terms coordination, cooperation and collaboration, and fosters interdisciplinary research to better understand how coordination, cooperation and collaboration interact in a variety of animal species and in a wide range of social and material contexts. If coordination, collaboration and

cooperation are omnipresent and multi-layered in interactions, for instance, which is their relative impact in human-human interactions? Can researchers control coordination processes during collaboration and cooperation? Or can they manipulate collaborative and cooperative processes in order to analyze their impact on coordination? Are these processes the same across different species, and across development? The answers to these questions are not simple and pose important challenges for those researchers interested in how these different but complementary levels of human and animal experience impact together on social interactions. By bringing together contributions from multiple disciplinary perspectives on coordination, collaboration and cooperation, the primary goal of this special issue is to provide a better understanding of (i) the low-level processes driving coordination mechanisms, (ii) the way these low-level processes affect mid-range collaborative processes in a wide range of cognitive tasks (e.g. problem-solving, decision-making, collaborative learning and joint remembering), and (iii) the way they affect longer-term cooperative behavior in humans and other animals. This Special Issue comprises several original contributions, including research articles with original empirical analyses and review articles summarizing major findings with different disciplinary approaches.

The special issue begins with Albiach-Serrano providing a brilliant review of cooperative studies in non-human primates. In particular, she thoroughly reviews experimental studies conducted under controlled conditions to better understand how non-human primates choose partners, interact and switch roles with each other, and share resources during cooperative interactions. The results of these studies are largely contradictory, partly because of important methodological difficulties inherent to empirical research. Apart from discussing the main weaknesses of previous studies on primate cooperation, Albiach-Serrano sets up an original agenda to address these issues and proposes

concrete solutions to some of the procedural problems highlighted in her review.

Second, Bräuer analyzes the cognitive and motivational components required for prosocial behaviour (i.e., a special form of cooperation) to happen. In particular, she reviews recent studies conducted in dogs to better understand whether dogs have the cognitive ability to be prosocial (i.e., they recognize others' goals and know how to fulfil them), as well as the motivational skills (i.e., they are spontaneously prosocial). Overall, dogs clearly appear to show prosocial behavior under certain conditions. Comparisons with human and non-human primates further allow the author proposing convincing evolutionary hypotheses as to why dogs, human and non-human primates may differ in their way to be prosocial.

Third, Amici presents a comprehensive review of recent studies on the development and evolution of cooperative behavior in humans, with a special attention to important aspects of inter-cultural variation in collaborative and cooperative behavior. The vast literature covered in this chapter is aimed to provide readers with a first orientation through the abundant studies that have been done on human cooperation. After presenting the different evolutionary scenarios in which cooperation may have emerged, she extensively reviews studies on infants and children cooperation to determine when the cognitive and motivational skills first emerge during human development.

Fourth, Bietti and Sutton provide a novel approach to joint remembering in social interactions, by exploring the ways in which remembering with other people relies on the complementarity of multiple timescales. Such timescales range from faster, lower-level coordination processes of behavioral matching and interactional synchrony to cultural processes and practices operating within distributed socio-cognitive networks over evolutionary and historical time. Bietti and Sutton relate these timescales to the concepts of coordination, collaboration, cooperation and culture. In their conclusion, they argue that joint remembering is a complex phenomenon unfolding over multiple inter-animating timescales.

Fifth, Baker presents what a model of collaboration refers to within the fields of collaborative learning (CL) and computer-supported collaborative learning (CSCL) in the learning sciences. His intention is to foster trans-disciplinary dialogue and cross-fertilization across social, cognitive and behavioral sciences. The model of collaboration that Baker puts forward is based on cognitive-linguistic processes of co-elaboration of problem solutions and their conceptual underpinnings, focusing particularly on interactive processes by which learning outcomes are produced. Baker discusses how his use of the concepts of collaboration and cooperation in the learning sciences ties in with other approaches applying similar terms, but often referring to different phenomena.

Sixth, Cowley and Steffensen argue that human individuals and groups rely on temporalities to discern and create structures, artefacts, institutions, social roles and even language. Drawing on recent work on cognition, language and time, they argue that coordination goes far beyond just being the driving force structuring language and social interaction. Cowley and Steffensen claim that coordination supports all modes of expressing one's being alive and with which humans pass on awareness, remember actions and events, and project themselves into possible futures.

Seventh, Bjørndahl, Fusaroli, Østergaarda and Tylén analyze the interactional dynamics animating outcomes of collective creative processes. Their qualitative microanalysis of coordination processes during collective LEGO constructions in semi-structured group interactions shows that interactional styles (inclusive, instructional and integrative) play a crucial role in shaping collaborative outcomes in LEGO models. The authors describe each of those interactional styles and explain which of the three interactional styles creates the conditions for more innovation and the construction of more creative LEGO models.

Eighth, Aranguren successfully combines naturalistic data collection and the physical description of facial behaviors (i.e., how one's face may respond) to examine the ways in which the passengers of the Delhi metro coordinate non-verbal signals in order to repair or prevent repetition of density-induced territorial intrusions. By coordinating non-verbal signals passengers are able to engage in structured interactional patterns that enable them to collaborate and solve unwanted intrusions of personal space in the metro in a micro timescale of milliseconds.

Lastly, Cienki distils the relevant and common themes that have been discussed throughout the Special Issue. He successfully integrates the various trans-disciplinary works on coordination, collaboration and cooperation (what he calls the three Cs) of the individual articles, and relates them to the concepts of intentionality, consciousness, role perspective, mental models and mental simulation. Cienki further argues that investigations into the three Cs constitute fertile ground for a successful interaction of behavioral and cognitive sciences. In order for this to occur, however, scholars working on the three Cs should take into consideration that a trans-disciplinary vernacular definition of the Cs is still needed to achieve common ground and bridge disciplinary barriers.

To conclude, we are confident that this Special Issue will benefit researchers from very different areas, providing innovative stimuli to develop a more interdisciplinary and comprehensive approach to the topic of coordination, collaboration and cooperation. We are especially confident that this Special Issue will benefit primatologists and comparative psychologists, by providing them with the opportunity to learn the newest methods in the study of coordination of multi-modal behaviors and new original techniques to be used on species other than humans. Also learning scientists might be able to gain a broader perspective thanks to the new approaches presented in this special issue. Finally, by fostering interdisciplinary dialogue and multi-disciplinary research perspectives, this Special Issue

might open up to original research approaches in the near future, bringing together the main strengths of both behavioral and cognitive sciences.

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