Neuroscience Letters 557 (2013) 143–147

Contents lists available at ScienceDirect

Neuroscience Letters

journal homepage: www.elsevier.com/locate/neulet

Individual contributions to (re-)stabilizing interpersonal movement coordination

C. (Lieke) E. Peper[a,*,1], John F. Stins[a], Harjo J. de Poel[b]

[a] Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, The Netherlands
[b] Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, The Netherlands

HIGHLIGHTS

- While two persons coordinated their rhythmic arm movements one of the arms was briefly perturbed.
- Both participants adapted their movements to re-establish the shared coordination pattern.
- Interpersonal coordinative stability resulted from symmetrical bidirectional coupling.
- The symmetry in coupling strength was not affected by the coordination pattern performed.
- The applied methodology can be used to examine sources of asymmetry in interpersonal interactions.

ARTICLE INFO

Article history:
Received 28 August 2013
Accepted 12 October 2013

Keywords:
Interpersonal coordination
Movement stability
Social interaction
Synchronization
Coordination dynamics
Joint action

ABSTRACT

Interpersonal movement coordination is characterized by stable coordination patterns. We examined the extent to which the two individuals within a dyad contributed to the stabilization of a shared coordination pattern. Within each dyad, the two participants coordinated rhythmic movements of their right lower arms in either in-phase or antiphase. We analyzed the responses to precisely controlled mechanical perturbations to one of the arms that disrupted the coordination pattern. Return to the original coordination pattern did not only involve phase adaptations in the perturbed arm, but in the unperturbed arm as well. Hence, the coupling between the companions was bidirectional and subserved the coordinative stability. Moreover, for both coordination patterns the interpersonal coupling was near symmetrical, with both actors (perturbed and unperturbed) contributing to the same extents to the restabilization of the coordination between them. The applied methodology provides a new entry point to examine asymmetries in interpersonal coupling, due to, for instance, social impairments, differences in social competence, or particular task setting.

© 2013 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

When interacting with one another, people tend to synchronize or copy each other's movements. This tendency appears to be associated with pro-social attitudes and behavior [8,9,11,14,30] and to be influenced by the social setting (e.g., stronger synchronization when involved in a collaborative task [11,27]). Conversely, moving in synchrony seems to foster cooperative ability [29,32]. Because this nonverbal interpersonal movement coordination can be affected in pathologies such as premature birth [5], autism [6,13] and schizophrenia [31], more detailed understanding of the underlying dynamics and mechanisms may potentially provide vital information for future movement-based clinical assessments or therapies (cf. [31]).

Apart from spontaneous synchronization tendencies, the interactions between persons within a dyad have been examined extensively for intended coordination. Interestingly, the observed coordination dynamics showed striking qualitative similarities to those of bimanual coordination within a single individual [19,21,22,26]. In particular, it was demonstrated that when two individuals coordinate the rhythmic movements of one of their limbs with one another, the in-phase and antiphase coordination patterns (i.e., synchronous movements in identical or opposite directions, respectively) could be stably performed. Furthermore, a gradual increase in movement frequency resulted in an abrupt transition from the less stable antiphase pattern to the more stable in-phase pattern [22]. Such transitions between stable states are a key characteristic of a nonlinear system of coupled oscillators [7], indicating that the attraction to stable coordination patterns and

* Corresponding author at: Faculty of Human Movement Sciences, VU University Amsterdam, Van der Boechorststraat 9, 1081 BT Amsterdam, The Netherlands. Tel.: +31 20 5988539.
E-mail addresses: l.peper@vu.nl, c.e.peper@vu.nl (C.E. Peper).
[1] http://www.move.vu.nl/members/lieke-peper/.

0304-3940/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.neulet.2013.10.031

the transitions between them were due to interactions between the rhythmic movements of the individuals [22].

Attraction to stable coordination patterns (in particular, the in-phase and antiphase patterns) has been convincingly demonstrated by means of various analysis methods and dependent variables, such as mean relative phasing and its variability [16,20,24–26,28], critical frequency [22], cross recurrence analysis [19,27], cross-spectral coherence [11,20,24,25], and power spectral overlap [16]. Although these results are clearly in agreement with the assumption of a bilaterally coupled system (with both persons influencing each other), these analyses cannot reveal the extent to which each of the individuals contributes to the coordinative stability. In principle it is even possible that the observed coordination dynamics result from a unilaterally coupled system, with only one person adapting to the movements of the other. In the present study we examined interpersonal coupling in a head-on fashion, using a perturbation paradigm and accompanying analysis that were originally developed to determine the degree to which the left and right hand contributed to the stability of bimanual within-person coordination [3,4].

Using this method we determined whether, and to what extent, both persons adapted their movements in response to a mechanical perturbation of one person's arm. We were particularly interested to what extent the other (unperturbed) person would adjust his or her arm movements, thereby contributing to the return to the stable coordination pattern. Whereas phase adjustments in the perturbed arm's movements may result from both its own orbital (limit cycle) stability [2,10] and its coupling to the other person's movements, adjustments in the movements of the unperturbed arm are a direct result of its coupling to the perturbed arm's movements. Hence, by applying perturbations to one oscillating arm and examining the degree to which the (unperturbed) companion contributes to the subsequent phase adjustments, we can unravel how two individuals contribute to the adaptations in movement phasing that are necessary to re-establish the original coordination pattern.

2. Materials and methods

2.1. Participants

Twelve young adults (2 male, 10 female; age range: 19–23) participated in the experiment. Eleven participants were right-handed (laterality quotient [LQ] range: 71–100, based on a Dutch version of the Edinburgh handedness inventory [15]), and one was left-handed (LQ = −78). Twelve dyads were formed, with each participant figuring in two different dyads. All participants gave their informed consent prior to the experiment. The protocol was approved by the departmental ethics committee.

2.2. Apparatus

Participants were seated in pairs, with the right elbows opposite to each other (distance between their torsos: ca. 1.3 m; Fig. 1). Each right lower arm was positioned in a manipulandum that allowed rotation about the elbow in the horizontal plane only. Each manipulandum was mounted on a vertical rotation axis and could be adjusted so as to locate the participant's epicondylus medialis above this axis. Angular position was registered using hybrid potentiometers (Sakae, type 22HHPS-10, accuracy 0.2°, sample frequency: 300 Hz). Using a Digital Actuator Controller and a torque motor (developed by Fokker aerospace) the movements of either arm could be arrested instantaneously, by sudden application of 60 Nm friction. Movement frequency was prescribed by means of an auditory metronome, presenting two beeps per movement cycle (alternatingly 100-Hz and 200-Hz tones; tone duration: 50 ms).

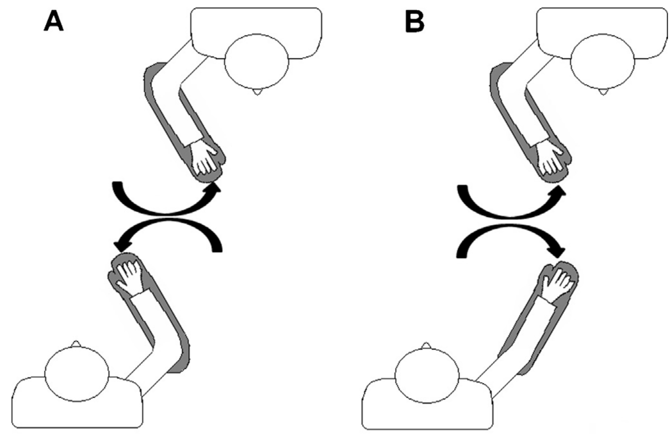

Fig. 1. Schematic representation of the experimental set-up and tasks. (A) Antiphase coordination and (B) in-phase coordination.

2.3. Procedure

Prior to the experiment, a practice period was administered. First, each participant practiced individually by moving the arm at the prescribed frequency (1.25 Hz), with the instruction to synchronize peak extension with one tone and peak flexion with the other. Next, the participants practiced as a pair (dyad). Both in-phase (simultaneous movements in the same direction) and antiphase coordination (simultaneous movements in opposite directions) of their arm movements were practiced (see Fig. 1), first without perturbation and subsequently with a perturbation of either arm (two trials: one perturbation per participant). The instruction was to restore the original coordination pattern as quickly as possible without pausing the movements. During these trials auditory pacing was presented at the start of the trial. Once the pattern was stably performed at the prescribed frequency, the experimenter waited for three more movement cycles and then terminated the pacing signal. The participants were instructed to continue their rhythmic movements in the same coordination pattern and at the same frequency.

In the experiment proper, the same perturbation paradigm was employed, involving a synchronization period (auditory pacing at 1.25 Hz) followed by a 30 s continuation period. During the continuation period a perturbation could be delivered to either arm (i.e., either participant). The order in which these perturbations were administered to the two arms was randomized. The perturbations were executed at the moment of peak extension and lasted a quarter cycle, resulting in a phase shift of 90° (for more details, see [3,18]). The timing of the perturbation was randomly distributed between the 12th and the 20th movement cycle of the continuation period. Again the instruction was to re-establish the original coordination pattern as quickly as possible, without pausing the movements. To further secure unpredictability of the perturbations, dummy trials without perturbation were also presented. The two coordination patterns (in-phase and antiphase) were performed in two separate blocks that were counterbalanced over the dyads. Within each block the three perturbation conditions (perturbation of participant 1, perturbation of participant 2, and no perturbation) were all presented 4 times, in a random order. Hence, each dyad performed $2 \times 3 \times 4 = 24$ trials in total. These trials were conducted in a single session of about 30 min. The time interval between the two measurement sessions per participant (each participant was engaged in two dyads, see Section 2.1) varied between 45 min and 2 days.

Download English Version:

https://daneshyari.com/en/article/6282636

Download Persian Version:

https://daneshyari.com/article/6282636

Daneshyari.com