

Interactional Coordination and Alignment: Gestures in Indoor Cycling Courses

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Abstract

Interactions provide opportunities for coordination that can be enacted via gestures. Interactions in a sports setting (in our case indoor cycling classes) provide opportunities and demands for coordination that go beyond typical face-to-face interaction. In this paper, we investigate how a trainer motivates the trainees and with a focus on the methods that are applied. The approach presented here conceptualizes “gestures” as an interactional phenomenon rather than the mere utilization of specific body parts. Our analysis shows that pedaling in indoor cycling courses can be understood “gestures” getting interactional functions.

Index Terms: gesture, interaction, multimodal actions

1. Introduction

In general, research on the topic of “motivation” is undertaken by psychologists focusing on the individual level. However, motivation is also an interactive phenomenon. Such interactional motivation processes can be studied especially well in fitness courses, such as indoor cycling, which involve a trainer and several trainees. Indoor cycling is a form of exercise with classes focusing on strength, endurance and high intensity that involve using a stationary exercise bicycle with a weighted flywheel in a classroom setting and loud music. Due to the exercise, the participants’ hand, arms and legs are engaged in the physical task and therefore not available for communicational purposes such as gesturing. Thus, this scenario poses a challenge for traditional gesture analysis that predominantly focuses on the communicative aspects of hand and arm movements [1].

In cycling classes the beat of the music and the participants’ coordinating pedaling play a fundamental role for the analysis of gestures in this setting. In order to signal the pedaling rhythm and to support the trainees’ coordination, the trainer introduces a set of resources such as music with a steady beat. Video recordings from such classes show that - in addition to this beat - some trainees need more support. In such cases, the trainer provides gestures: He starts pedaling himself to the rhythm of the beat (i) and he verbalizes his actions (ii). Thus, under specific conditions, part of the action is endowed with gesture-like qualities. Such a setting and practical task is interesting for gesture research: It suggests that the concept of “gesture” might not best be conceived of as an a priori defined construct that involves a number of well-describable semantic, semiotic or visual features. Instead, gestures appear as being constructed on-line, in the course of the action and fulfill a certain *interactive* goal. In this view, leg movements in indoor cycling classes may be conceived of gestures, if the participants’ involved in the interaction understand them as such. The present paper aims at illustration (1) how the trainer establishes leg movements as gestures in a multimodal way and (2) how the meaning of leg movements is changed by the interpretation of the actors.

These questions and conceptual issues arise from an interdisciplinary project founded by the German Aerospace Center which aims at developing of a robot system that should

motivate astronauts to increase the effectiveness of their daily fitness training. This is particularly important, because of the loss of muscular tissue due to long exposition to zero-gravity conditions, astronauts need to do sports for at least two hours a day. However, due to high workload this is not always possible. In the scope of the project, we investigate if a robot system may fill the role of a fitness trainer, when adequate modules for interaction and motivation are realized.

At a basis and inspiration for the design of the human-robot-interaction we investigate how human fitness trainers motivate their trainees during the training. The coordination of pedaling and the music’s beat is one of the trainer methods.

2. Background

Previous research has often described gesture as a phenomenon that accompanies speech and which manifests itself in hand and arm movements. Whereas McNeill recognizes that gestures accompany speech as holistic and non-conventionalized, Kendon also covers conventionalized gestures with the concept of recurrent gesture. These are found in similar forms in specific contexts, but did not achieve lexical status. The concept of gesture in classical gesture research seems to be a non-dynamical construct describing specific movements of the hands and arms related to accordingly produced speech. Thus it is often conceived as isolated from interaction. The focus is thus on the producer of gesture. In this sense research has shown that and how gestures allow the speaker to economically describe spatial scenarios [7], location plans [8, 9] as well as abstract relations like functional hierarchies in the compound of sentences [10] in the gestural modality in gesture space.

Next to this classic conception of gesture research ethnomethodology and conversation analysis brought a holistic conception of non-verbal communication, which describes verbal and non-verbal communicative phenomena as diverse, equally valued resources of communication. In the last years concepts were suggested which tie to traditional concepts of gesture but view gestures in an interactive context as a holistic collaborative production [3]. In particular Goodwin’s concept of an “ecology of sign systems” [12] has been influential. Instead of channels of behavior Goodwin speaks of „semiotic fields“. These include syntactic structure, prosody, body posture, gestures which are embedded in a particular situation, state of participants, material structures in the environment. This combination of different signs plays a fundamental role in the constitution of interaction. The current combination of relevant resources is continuously changing during the interaction, so that specific „contextual configurations“ emerge. By use of the concept of „ecology“ Goodwin refers to the fact that different signaling systems may adopt different functions in the course of the interaction: „The term ecology is used to note the way in which these separate systems function as differentiated, interdependent components of a larger whole that can adapt to changing circumstances.“ [15]. His analysis on interaction expands the classic notion of gestures. He provides a framework for the collaborative constructions of meaning. Goodwin also shows that resources currently not available are replaced with other, available resources [12]. This dynamic

notion is relevant for the interactional setting investigated in this paper as it provides a framework to systematically describe the phenomenon that when certain communicational resources are not available (e.g., hands, arms, legs when cycling) their function might be taken up by other resources. Furthermore Streeck [13] suggests that certain gestures arise from everyday manual actions. This provides a basis to also think of pedaling on a bike as becoming - under certain conditions - a gesture.

The ethnomethodological tradition describes gesture as no definite concept of movements. Gesture is viewed as an interpretative category of interaction. This means that, in principle, every body movement could become a gesture, if the actors treat it as such. Starting with this consideration a differentiation between observable body gestures (facial expression, posture, body movement) and audible body gestures (articulation, prosody) [3]. Dausendschön-Gay and Krafft describe two functional areas of body gestures. The first functional area is assigned to face-to-face-situations following the assumption that as long as humans are in the same room, they behave. Through the intensity of gestural behavior they mark their status as being participants of this situation. Therefore the body gesture becomes a basic function of human interaction. The second function describes the processing of a form of an expression. The focus here also is on body gestures in relation to the joint production and assurance of comprehension. Gesture therefore describes no fixed concept or inventory of hand movements, but an interactive effort of all actors of an interaction to assure comprehension, which can be manifest in every body movement.

3. Study Design and Data

In order to investigate interactive strategies of motivation we are conducting a set of studies (09/2010 – ongoing) investigating the interaction between trainer and trainees in indoor cycling courses. These start from investigating authentic indoor cycling classes as they are carried out in the everyday life in fitness centres (corpus 1) and include – in a second step – a semi-experimental design to manipulate certain parameters and transfer the setting to the requirements of the envisioned human-robot-interaction (HRI) in the SocioRob-project (corpus 2).

Corpus 1 investigates every day group interaction in spinning courses as they occur in fitness centres. These group interactions comprise a trainer and several trainees (between x and y participants). Three different trainers are recorded in order to be able to abstract from potential personal differences in the communication strategies exhibited by diverse trainers.

Corpus 2 constitutes a semi-experimental design and reproduces the situation of a personal training (1:1). As – in the future – our robot system is supposed to interact with one individual trainee at a given time, we need to understand the particular differences between the group and the individual situation. This HRI adapted setting compares effects of the training situation (group vs. personal training) and investigates effects of different training methods and situations respectively. The setting contains one trainer and one trainee, with five consecutive training sessions per trainer and participant. Within these five sessions three training courses are recorded which only differ from a normal session in the number of participants. The goal of the sessions three and four is to manipulate two independent variables (availability of trainer bicycle, rhythm and music respectively), which are motivated by context of Human-Robot-Interaction: in session 4 only the trainee uses a bicycle which enforces the trainer to design the training on basis of different interactive resources.

4. Method

In a first Study data of three trainers in every day group situations was acquired. The data material covers video and audio material of approx. 180 minutes. In Study B (personal training) data of five training sessions with a total of 300 minutes was recorded with two video cameras so far.

Our analytic approach is qualitative being based upon Conversation Analysis [14]. Conversation Analysis describes the structure, orderliness and sequential patterns of interaction and the micro-coordination between the actors. This mixed approach enables to start with explorative, in-depth qualitative analysis of a small collection of cases drawing on ethnomethodology and conversation analysis to detect analytical issues and phenomena.

In a first step we produced a transcript of the trainer’s and trainee’s speech and body movement. Not only does the collected data show that annotation of activities (drinking, removal of sweat) is necessary, but also each pedaling is important to analyse. Pedaling and its frequency in relation to the rhythm of the music is relevant in all the collected data on the level of interaction. A systematic annotation of pedaling by the trainer as well as by the participant and the annotation of the rhythm of the music is required (Fig.1).

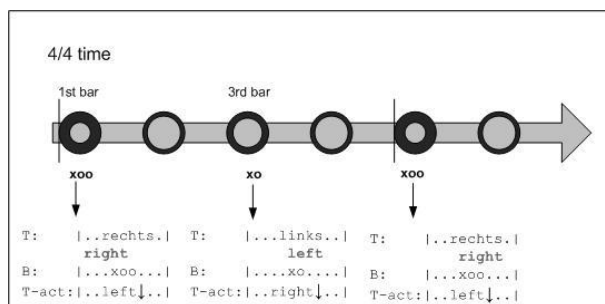


Fig.1: Annotation of multimodal actions to the beat

Figure 1 displays the pattern of intonation (i.e., the beat: 4/4 times) in relation to the multimodal acts of the trainer. On the first bar (noted here in an additional tier B as: xoo) the trainer says: “rechts” (right in German). Simultaneously to the exclamation “rechts” he pedals with the left foot. Consequently speech and act of the trainer are not congruent, but adapted to the perspective of the exercising participants.

5. Alignment and Coordination

5.1. Rhythm as resource for interactional coordination

Coordination plays a fundamental role in interaction in general as well as in fitness interaction like in indoor cycling classes. During indoor cycling the athletes not only coordinate their behavior to the trainer and other athletes but also to the beat of the music. Thus, this setting requires coordination of all persons involved. To do so, the trainer has a variety of resources at his/her disposal, such as the beat of the music, the simultaneous paddling and verbal utterances.

Let us consider the following fragment taken from one of the authentic group spinning courses (corpus 1, about 32 sec.): At the beginning of this exercise the trainer establishes the beat of the music as a shared attention in a multimodal way and therefore makes it relevant on the level of interaction. Not only the verbalization “just listen” (I.01) but also the timely related pointing gesture towards the ceiling which points to the

music in a metaphorical way, he establishes the relevance of the rhythm in this part of the exercise.

24:31.150

01 T: <<all> GEnau hinhörn? > (-)
listen carefully
 02 T-act: |.....iconic gesture.....|
 03 GANZ GANZ einfach
very very simple

Through his pointing the trainer suggests the music as a focus of shared attention to the participants. Then, consecutively, he delivers a turn on every beat XO and XOO (once right once left; 1.04), which refers to the rhythm of the pedaling. This method provides an orienting device for the participants' to synchronize their pedaling with those of the group and the rhythm easier. At the beginning of an exercise those verbal-rhythmic turns are repeated on every relevant beat XO and XOO, but are semantically and syntactically simplified during the progress of the exercise.

In the beginning the specification of the treading foot to each relevant beat XO and XOO by the trainer can be recognized, i.e. his left foot is treading on beat XO and his right foot on beat XOO. Verbal rhythmic advices are also verbalized simultaneously (l. 04, 05).

04 T: <<all> einmal rechts> ↑EINmal links (-)
one right one left
 05 B: |.....xo.....| |.....xoo.....|
 06 T-act: |.....left↓.....| |.....right↓.....|
 *Fig.2 *Fig.3

Making the display of the tread action relevant for the co-participants is also revealed in a particular the change of perspective: The trainer treads with the left foot, but verbalizes the right one, because of the training situation which is also defined by the alignment of the persons in the room. Spinning training is a classic sport, which is mediated in the training situation by a front alignment of trainer to participant(s) so that the trainees can directly align with and imitate what they observe.



Fig.2: "one right"



Fig.3: "one left"

These verbal-rhythmic devices change systematically during the progression of the exercise. While the trainer mediate every movement of pedaling to the participants at the begin of the session, he constitutes the rhythm only through *one side* of treading during the progression of the exercise (right right right right, 1.07) until he finally uses any exchangeable word (hop, 1.12).

[...] 25:00.800

07 T: <<all> RECHTS- RECHTS- RECHTS-
right right right

08 B: |.....xo.....| |.....xo.....| |.....xo.....|
 09 T-act: |.....left↓.....| |.....left↓.....| |.....left↓.....|
 RECHTS- RECHTS- >
right right
 10 B: |.....xo.....| |.....xo.....|
 11 T-act: |.....left↓.....| |.....left↓.....|

[...]
 12 T: HOPP HOPP
hop hop
 13 B: |..xo..| |..xo..|
 14 T-act: |left↓| |left↓|

During this systematic reduction of announcements the trainer permanently observes the group which mostly obeys the tact standard prior established.

5.2. Pedaling: An interactionally relevant gesture

The coordination of pedaling and beat poses a practical problem to the participants. In the case of non-coordination the difficulty involved in this task becomes apparent. In such a case, the trainer has to intervene, and subsequently repair strategies can be observed that go along with a change of the trainer's gaze orientation.

In the process of the sequence it becomes clear that these verbal-rhythmic devices are not only understood as addressed to the entire group, but also as personally addressed towards one participant. While the trainer pays no attention to gaze organization in the beginning and watches all participants equally often with an equal duration in the average, he starts to watch participant S2 more often later in the exercise and restricts his field of gaze until eye contact is finally established. This focusing is carried out because participant S2 does not pedal synchronously to the rhythm of the music and to the homogenous pedaling of the group (s. Fig.4).

With continued practice (and an according difficulty increase) there is an increased demand for coordination. Participants now not only have to pedal to the beat but furthermore need to pedal standing up versus sitting down in a certain rhythm. S2 is the participant who has difficulties with this new task, which becomes particularly visible in the data comparing her body movement with that of her neighbors (as suggested in fig. 4).

[...] 25:45.100

Trainee S2 isn't pedaling in rhythm *Fig.4

15 T: up (.) UP (-)
 16 B: |..xo..| |..xo..|
 17 T-act: |left↓| |left↓|
 18 S-act: |right ↓| |right ↓|



Fig.4: Trainee is not pedaling in rhythm

During the instruction "yeah yeah yeah (.) stay in rhythm" (l. 18) eye contact between trainer and participant takes place. The fact the participant adjusts her tread rhythm immediately after the trainer's turn shows her interpreting herself as the addresser of his advice.

18 T: <<cresc> ja: jaja ja:> (-) <<ff> bleibt im rhythmus?>
 yeah yeah yeah stay (plr.) in rhythm
 19 T: |@S2|
 29 S: |.....@T.....|

(3.0) Trainee S2 is pedaling in rhythm *Fig.5



Fig. 5: Trainee S2 is pedaling in rhythm

In this phase the trainer uses a repair mechanism through a change in his gaze organization. Because of the trainer's eye-contact the trainee feels addressed by his announcement and synchronizes her movements to the group's homogenous pedaling rhythm of the group (Fig.5).

5.3. Body movement: An interactionally relevant gesture

If repair is not possible via gaze organization, the trainer employs other strategies.

After a couple of beats the participant S2's pedaling rhythm again is not synchronous to the music and hence not to the groups' rhythm. The trainer reacts upon it by focusing the trainee again and repeating his verbal-rhythmic advices (one more right (.) left, l. 20).

Trainee S2 is pedaling in rhythm, but losing it
 20 T: noch EINE (-) <<p> RECHTS (.) LINKS.
 one more right left
 21 B: |.....xo.....| |...xoo...|
 22 T-act: |.....right ↓.....| |..right↓|
 23 S-act: |.....right ↓.....| |...left↓.....|
 24 T-gaz: |@S2|

However, the trainee is still not able to align her movements during the following bars. (Fig.6).



Fig.6: Trainee S2 is losing rhythm

As a reaction the trainer gets off his bike. Once standing he turns towards the group and constitutes the rhythm verbally once again. It is interesting to observe that he now uses his hands as a means to indicate the pedaling rhythm. This way, he manages to realize an optical indicator even though he is not sitting on the bike pedaling (l.25, l.27). Since this gesture achieves the same effect as the pedaling it provides an additional functional argument - including the participant's perspective - that the action of pedaling itself can constitute a gesture.

Trainee isn't pedaling in rhythm
 Trainer is leaving his bike

25 T: RECHTs. (.) LINKs.
 right left
 26 B: |.....xo.....| |...xoo...|
 27 T: |.fist left..| |fist right|
 *Fig.7 *Fig.8



Fig. 7: "right"



Fig.8: "left"

The trainer then walks towards the trainee who is not synchronized. Arriving at the trainee he adjusts the resistance of her bike. At the same time he constitutes the rhythm via "right (.) left" (l. 30) once more. After a few beats the trainee is able to synchronize to the rhythm indicated by the trainer (l. 32).

Trainer walks towards Trainee S2

28 T: Rechts. (.) Links
 right left
 29 B: |...xo..| |.xoo.|

Trainer manipulates Trainees adjustabler resistor, is leaving S2

30 T: RECHTs. (.) LINKs. (.) Genau.
 right left correct
 31 B: |.....xo.....| |...xoo...|
 32 S2: |..right ↓| |.right↓|

Depending on their state of participation the other trainees may utilize the trainer's additional advice for trainee S2 as an offer for self correction purposes. After adjusting the resistance he steps back again in order to gain an overview of the whole group (s. Fig.9). By actively intervening the trainer managed to establish a homogenous rhythmic synchronization. After observing the group for about six seconds he remarks "better better" (l.33). This remark displays an explicit praise and reveals the relevance of a homogenous pedaling rhythm.

Trainer is watching the group for about 6 seconds. All trainees are pedaling correctly respecting the rhythm.

33 T: << BESSer. BESSer.>
better better

34 B: |...x00...| |...x0...| |...x00...| |...x0...|
35 S2: |..left↓..| |right↓| |..left↓..| |right↓|

*Fig.9



Fig.9: Trainer is observing the group

The analysis shows that the ascribing of the gestural status to a multimodal action takes place on an interactional level. Therefore, the gesture can be considered as the result of an effort all actors of the face-to-face-interaction are involved in. In conclusion this means that the multimodal action of pedaling will achieve gestural status if an actor in the interaction ascribe this status to it and treat it as a gesture.

5.4. Production of Meaning: Replacement of pedaling gesture

As a first step, we presented results from the qualitative analysis taking a close look at the way a trainer is doing a indoor cycling course. The analysis shows that the coordination to music is an essential element of spinning. Those coordination activities do not merely take place on a macro level (e.g. the coincidence of low bpm count low cadence) but we can furthermore observe local coordination activities. The trainer constitutes the desired pedaling rhythm with the help of the music's beat. If a trainee is not able to pedal in the established rhythm, specific repair strategies initiated by the trainer can be observed. We noted that the trainer mobilized other resources (e.g., he used his hands) if he had no bike to demonstrate the rhythm. To investigate such strategies more systematically, we conducted a second study in which we varied whether personal trainers had versus did not have a bike at their disposal.

Let us consider the following fragment: In this situation we can see that the trainer is not only pedaling. He coordinates his pedaling moves to the music's rhythm. On a beat xo he pedals with his left foot. This observation can be made throughout the whole data. This mere coincidence of body movement and beat would not be referred to as a gesture yet. It is the fact that the trainer takes part in a social situation, a face-to-face-interaction, which puts this phenomenon into a different context. Additionally in this face-to-face-interaction the trainer makes a verbal announcement ("step") while pedaling to the relevant beat.

Fragment 1

01 T: TRITT- TRITT-
step step
02 B: |...xo.....| |...x00..| |...xo.....|

03 T-act: |...left ↓..| |right ↓| |..left ↓..|
*Fig. 10 *Fig.11 *Fig.12

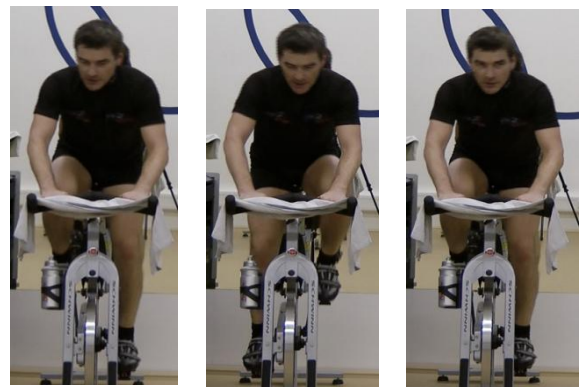


Fig.10: 34:24.40 Fig.11: 34:25.102 Fig.12: 34:26.35

The importance of the pedaling display through the trainer's pedaling shows the following fragment: in this situation the same trainer does not have a bike. We can observe that he tries to replace the marked leg actions through his arms and hands. So he can recoup a missing interactive resource through another one.

Fragment 2

01 T: TRITT- TRITT-
step step
02 B: |...xo.....| |...x00..| |...xo.....|
03 T-act: |...left ↓..| |right ↓| |..left ↓..|
*Fig. 13 *Fig.14 *Fig.15



Fig.13: 30:04.40 Fig.14: 30:05.12 Fig.15: 30:05.92

This analysis leads to the conclusion that pedaling to the music's beat together with the trainer's verbal-rhythmic devices, constituting the rhythm, that make the pedaling movement a multimodal action and ascribe the status of an interactionally relevant gesture to it.

6. Results and Implications

In this paper, we have presented the first results of the analysis of a study aiming at identifying interactive strategies for motivation.

We observed that the pedaling movement combined with the simultaneous announcement of the foot to pedal with constitutes an offer for coordination that can have a motivational impact on the trainees. On an interactional level we could observe that the actors in this sports interaction ascribe a gestural status to the pedaling movements of trainer as well as the trainees. The relevance of this communicated gesture becomes describable on an interactional level especially when

an athlete is not able to carry the pedaling movement demanded to the beat into execution: The trainer gets off his spinning bike and adjusts the resistance of the trainee's bike. At the same time he gives verbal-rhythmic advice to the other trainees as well but this time it is not realized via his pedaling moves but through other communicational resources: his hands.

This observation leads to two conclusions:

- 1) The gestural status of a body movement does not depend on the utilization of specific body parts. Only if the body movement takes place in a social situation and results in a multimodal action it may be described as a gesture. The mere pedaling e.g. is not a gesture. It is the social situation - the interaction - in combination with the synchronicity of the pedaling to the music's beat together with the trainer's verbal-rhythmic advice, constituting the rhythm, that make the pedaling movement a multimodal action and ascribe the status of a gesture to it.
- 2) The ascribing of the gestural status to a multimodal action takes place on an interactional level. Therefore, the gesture can be considered as the result of an effort all actors of the face-to-face-interaction are involved in. In conclusion this means that the multimodal action of pedaling will achieve gestural status only if all actors in the interaction ascribe this status to it and treat it as a gesture.

So, what is gesture? Gesture is not limited to extremities such as arms and hands. Every kind of multimodal action can achieve the status of a gesture and accomplish the functions associated with this status [13, 3, 11]. With indoor cycling this especially holds true for the pedaling moves. Since the trainer establishes the pedaling moves multimodally they can be seen as multimodal actions. This form of multimodality (body movement, speech, music's beats) [12] shows that for the analysis of gesture not only speech has to be taken into account but also external factors such as music which have an influence on interaction and hence become part of it. The interaction and its associated interactive negotiation processes are essential for the definition of the term gesture. Gesture is what actors in an interaction treat as such. Interactive negotiation processes not only take place between trainer and trainee but also among the trainees. We can often observe that a trainee who is not able to synchronize to the pedaling rhythm not exclusively utilizes the trainer's movements for orientation but also their neighbors' movements as well as their interpretation of the audible beat. Further research examining this phenomenon has to be undertaken. The role of the beat in the accompanying music and its function as an external time base must be the subject of further analysis as well. We expect to gain eminently insightful information by the analysis of training courses where the trainer did not have music as an auxiliary means.

What does that mean for a robot system that is supposed to act as a fitness trainer both everyday situations and in the aerospace mission? A robot system would need to monitor the coordination efficacy of the participants (i.e., it needs to realize when pedaling is versus is not in congruency with the beat) in order to fulfill the role of an indoor cycling trainer. However, before such a system could be help of the athlete, it would need to successfully coordinate itself. To do so, it would need to recognize the beat and coordinate its movement accordingly.

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