

Self-recognition in the Perception of Actions Performed in Synchrony with Music

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This study investigated self-recognition in point-light displays depicting actions performed in synchrony with music. Participants were recorded executing three different actions (dancing, walking, and clapping) and were subsequently required to identify the agent (self versus other) from point-light displays with or without the accompanying music. Results indicate that while recognition accuracy was better than chance for all actions, it was best for the relatively complex dance actions. The presence of music did not affect accuracy, suggesting that self-recognition was based on information about personal movement kinematics rather than individual differences in synchrony between movements and music.

Key words: action perception; movement kinematics; self-recognition; synchronization; point-light displays

Introduction

Music is a prime area for the study of human action and interaction. The synchronization of body movements with music is a common activity, even for people without formal training, whether they are dancing, marching, or simply clapping in time during a concert. These forms of synchronization require the tight coupling of perceptual and motor processes. Consistent with the notion of such coupling, evidence is mounting that there are strong links between action execution and action perception¹ and that common neural substrates underlie these links.²

The relationship between perception and action has been examined in a number of studies of self-recognition. Specifically, it has been shown that, in a variety of contexts, perceptual sensitivity to human bodily action is highest when the observer is the agent of the action. Self-recognition has been investigated

mainly by focusing on either visual or auditory modalities. As far as the visual modality is concerned, self-recognition has been addressed previously by observation of hand gestures,³ drawing movement trajectories,⁴ and various full body movements.⁵ For the latter, it has been shown that observers can distinguish between their own and others' actions (e.g., dancing) when depicted as point-light displays that only make available kinematic information from the head and the main joints of the body. With regard to the auditory modality, self-recognition has been investigated by having individuals listen to the sounds of their own or others' clapping⁶ and by having piano players discriminate between their own and others' musical performances.⁷ Thus, visual and auditory cues to agent identity are provided by the idiosyncratic ways in which individuals move on account of personal biomechanical constraints and past experience and training.

Claims that the perception of agent identity is grounded in motor processes, specifically, "motor resonance" or a covert form of action simulation,⁸ are supported by the results of studies that require overt coordination with self- versus other-generated stimuli.^{9,10} For

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example, in the music domain, it was found that pianists were not only able to recognize their own performances, but were also able to synchronize better when playing duets with their own previous recordings than with another pianist's recordings.¹⁰

The current study investigates self-recognition in the context of point-light displays of actions performed by non-musicians in synchrony with music. The actions that were employed are representative of three ecologically valid behaviors that vary in complexity, or, more specifically, in the degrees of freedom that constrain movement kinematics: dancing, walking, and clapping in time with music. On the basis of the results of research conducted outside the music domain,⁵ we expected that self-other discrimination would improve with decreasing constraints on movement, and, therefore, that self-recognition should be most accurate for dancing and least accurate for clapping.

The main aim of the study, however, was to examine whether the dynamics of relationship between an individual's movements and the music provide informative cues for self-recognition. Individuals differ in the way in which they synchronize with external signals even in the context of simple tasks, such as finger tapping in time with a metronome.¹¹ By testing self-recognition with point-light action displays presented with or without the original music, we tested the hypothesis that the availability of information about synchrony between movements and music improves recognition relative to information about movement kinematics alone. Furthermore, the presence of music may boost performance especially for relatively constrained actions (walking and clapping).

Methods

Fourteen adults (eight females; mean age = 24.2 years) participated in two experimental sessions, separated by 1–2 months. In the first

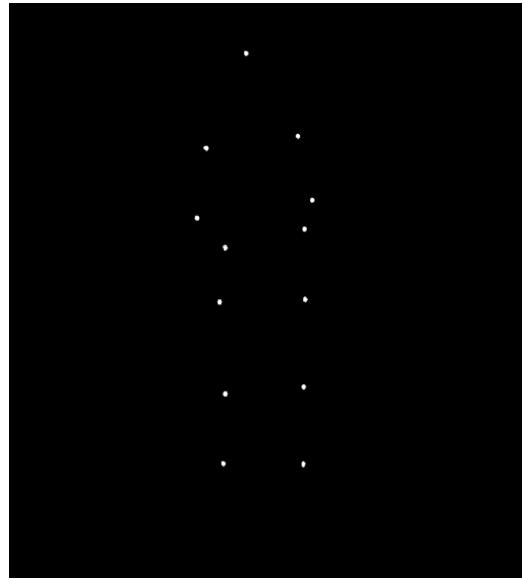


Figure 1. Point-light depiction of an agent with 13 markers attached at the head and the main joints of the body.

session, individual participants were invited to execute three different actions (dancing, walking, and clapping) in synchrony with the beat of three musical excerpts from different genres (“drum and bass” dance, folk, and jazz). The duration of the excerpts was 60–70 s. The performances were recorded by using a Vicon (Oxford, UK) motion-capture system. Thirteen reflective markers were attached to the participants' bodies, at the head and at the main joints (Fig. 1). For the clapping action, one extra marker was attached on the proximal phalanx of each index finger. The time intervals separating claps and walking steps were indicated by an experimenter and were the same for all participants. The actions had the same starting positions (and paths in the case of walking), which were clearly indicated by white tape on the floor. The orders of the excerpts and of the actions were counterbalanced.

In the second session, the same participants were invited back to watch 5-s point-light movies depicting excerpts of their own performances and those of another participant (matched pairs). Participants were matched according to gender and physical body

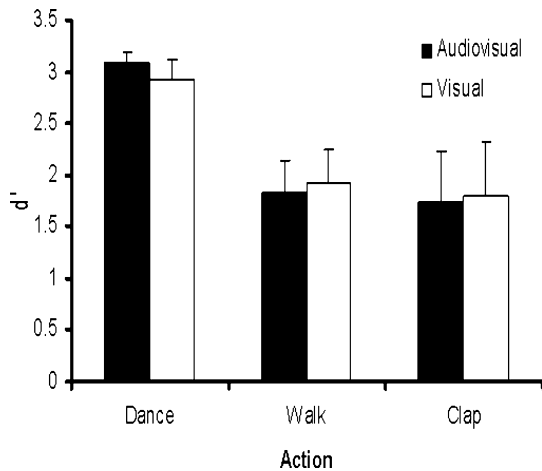


Figure 2. Average d' scores in the two modality conditions for the three actions.

proportions. The point-light movies displayed the performances of the three different actions as white dots on black background, in frontal viewpoint, with or without the accompanying music (audiovisual versus visual condition). Participants watched in total 144 point-light movies presented on a computer monitor in random order (36 “self” and 36 “other” movies repeated across two blocks). The task was to indicate by key press whether the depicted agent was the self or another person.

Results

Self-other discrimination was assessed by computing d' , a measure that takes response bias into account by subtracting z-transformed false-alarm rates (“self” judgments for “other” displays) from hit rates (correct “self” responses) (see Ref. 12). The results are shown in Figure 2, where high d' scores indicate accurate self-other discrimination. Recognition accuracy was significantly better than chance for all actions: dance, $t(13) = 22.60$, $P < 0.001$; walk, $t(13) = 6.25$, $P < 0.001$; and clap, $t(13) = 3.54$, $P < 0.01$.

A 3×2 repeated-measures analysis of variance (ANOVA) was conducted on d' scores to test our hypotheses about the effects of

Action (dancing versus walking versus clapping) and Modality (audiovisual versus visual) on self-recognition. This analysis revealed a statistically significant main effect of Action, $F(2,26) = 3.36$, $P = 0.05$. Paired t -tests revealed that the difference in performance between the dancing and walking conditions was significant, $t(13) = 3.91$, $P < 0.01$, while the difference between the walking and clapping conditions was not significant, $t(13) < 1$, n.s. The main effect of Modality was not significant in the ANOVA, indicating the lack of reliable differences in self-recognition across audiovisual and visual conditions, $F(1,13) < 1$, n.s. The interaction between Action and Modality was likewise not significant, $F(2,26) < 1$, n.s.

Conclusions

The findings of this study extend research on the role of perception-action links in self-recognition to the domain of actions performed in synchrony with music. Our results indicate that the kinematic information contained in relatively complex full body movements (i.e., dancing) provide clear cues for recognizing the identity of an agent, although agents can be distinguished even in the case of simple actions, such as clapping (cf. Ref. 5).

We also found that the availability of information about synchrony between movements and music in audiovisual displays did not improve recognition accuracy even for the simplest actions. Thus, information about the temporal relationship between agents' movements and the music evidently made no compelling contribution to the perception of agent identity. This suggests that self-recognition was based predominantly on personal movement kinematics, with individual differences in synchrony between movements and sounds conferring no discernable benefit. It remains to be seen whether such multimodal (audiovisual) cues are informative in more interactive contexts, such as dancing dyads and ensemble music making.

To conclude, the finding that self-recognition depended predominantly on motor cues is

consistent with embodied cognitive accounts claiming that action observation triggers covert simulation in the observer's motor system. The strength of this form of motor resonance may depend on the nature of the action, with relatively unconstrained movements being particularly potent because of richness in information about personal styles of action execution. In contexts involving musical interaction, the tight coupling of perception and action that enables self-recognition may facilitate interpersonal coordination by allowing the relationship between one's own actions and those of others to be accurately gauged.

Acknowledgments

The authors wish to thank Jan Bergmann for programming and technical assistance, Kerstin Träger for technical support, and Regine Steinke and Juliane Zeiss for their help with data collection.

Conflicts of Interest

The authors declare no conflicts of interest.

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