# Action discrimination based on auditory kinematics

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***Summary*— The aim of this study was to explore if artificial movement acoustics based on kinematic parameters can be decoded by naïve listeners. Results show that this was the case even though participants were completely uninformed about the utilized kinematic-acoustic mapping structure. Participants were able to solidly differentiate sound sequences of six everyday upper-limb actions independent of the sound sequences' mapping structure.**

## INTRODUCTION

Auditory information can enhance and modulate perceptual as well as motor processes in a multifaceted manner [1]. Movement sonification as one of the most recent approaches expanding auditory movement information also to usually mute phases of movement was developed as a new method of auditory augmentation [2]. Despite general evidence on the effectiveness of movement sonification in different fields of applied research several questions regarding the configuration of information rich sound sequences in the field of gross human motor behavior still remain open. Such questions may contain (a) the selection of suitable movement features, (b) effective kinematic-acoustical mapping patterns and (c) the number of regarded sonification parameters. In this study we wanted to explore the informational content of an artificial kinematic-acoustical mapping in terms of a kinematic movement sonification using an intermodal discrimination paradigm.

## METHOD

In a repeated measure design we analyzed discrimination rates of six similar everyday upper limb actions to evaluate the effectiveness of seven different kinds of kinematic-acoustical mappings as well as short term learning effects. The position information of the right metacarpophalangeal joint during the six upper-limb actions – 1) drawing a circle, 2) stirring in a pot, 3) pouring water from one glass to another, 4) drinking a glass of water, 5) rasping one's nails and, 6) brushing one's teeth – were calculated based on inertial motion sensor data and transferred into seven different kinematic-acoustical mappings resulting in 42 sound sequences. Sound sequences were randomly presented to participants in seven blocks. Each block had a different kinematic-acoustical mapping and consisted of 18 sound sequences. The seven mappings consisted of four sound parameters representing four kinematic parameters which were either apparent in each mapping or not.

$N$ = 28 participants were instructed visually by watching video sequences of the upper-limb actions. Neither an auditory instruction, nor information about the parameter mapping was given to the participants. 126 sound sequences were presented to the participants whereas no feedback on discrimination was given.

## RESULTS

Data indicate an instantaneous comprehensibility of the sonification feature used in this study as well as short term learning benefits (see Fig. 1). No differences between different kinematic-acoustic mappings became evident thus indicating a high efficiency for intermodal pattern discrimination for the acoustically coded velocity distribution of the actions.

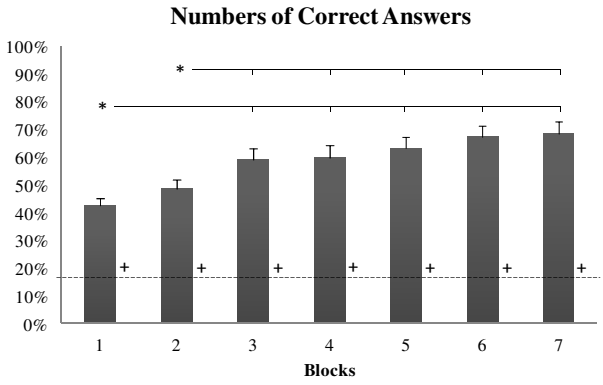


**Figure 1** Participant's numbers of correct answers (mean ± SE) of the seven blocks of the sound sequences presented (indepentent of kinematic-acoustical mapping) *indicates significant differences according to Tukey HSD post-hoc test, $^{+}$indicates significant difference to chance level (dashed line).

## DISCUSSION

Taken together movement information related to continuous kinematic parameters can be transformed into the auditory domain and pattern based action discrimination is apparently not restricted to the visual modality. This feature of movement sonification might be used to supplement and/or substitute visual motion perception in sports and motor rehabilitation.

## REFERENCES

[1] A.R. Seitz, R. Kim, and L. Shams, "Sound facilitates visual learning," Curr Biol, vol. 16, pp. 1422-1427, 2006

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