“WA-UM-EI”

How a choreographer can use sonification to communicate with dancers during rehearsals

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Abstract

A sonification is a nonverbal speech act and might sound like “wa-UM-eii”, or “wooosh!” The purpose of this study was to investigate a choreographer’s use of sonification in dance instructions, to see if there are different types of sonifications and if the use of these might differ with a change in context. Video material capturing the rehearsals of a noted dance company was analyzed using a cognitive ethnography-based approach. Nine different types of sonifications were identified and described according to purpose, and a context-based analysis showed that certain kinds of sonifications occurred more frequently in some contexts than others. The results suggest that sonification used in dance instruction can serve multiple different purposes – the three main purposes described here are these: to communicate the quality of a movement, to facilitate communication between choreographer and dancers, and to coordinate the dancers as a group.
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1. Introduction

A sonification is in this study defined as a non-verbal speech act that is not a recognizable word. It can sound like this: “wa-UM-ei”, or this: “niaaaa-HA”. It can be the sound you use when trying to describe what falling from that cliff felt like (“waaaaaaah!”), how noisy it was when a lawn mower woke you up last Sunday morning (“RRRRRRR”) or how your friend best should hit the badminton ball (“think “PAOW!””).

Most people should be able to recall using such “sound effects” every now and then. They seem to appear spontaneously and we seem to understand each other intuitively. Why is this? Are there perhaps universal laws at play? Some studies have investigated the relationship between gesture and sound – how certain sounds invite to certain gestures (Godoy 2006, 2010). Others have sought to investigate similar relationships between shape and sound (the shape here being illustrated by either a body movement or a drawn figure/line). A few studies have focused on sonification in relation to movement perception (Effenberg 2004, 2005, 2007). The Theoretical Background-chapter will give a more in-depth presentation on these studies.

This study will focus on sonification as it takes place in one specific context – dance rehearsals. This context is well suited for studying sonification from a cognitive science perspective. The choreographer and the dancers are constantly interacting, and the effects of the choreographer’s sonifications often manifest themselves in visible ways – by changes in the way the dancers move.

In a dance rehearsal context the communication between the choreographer and the dancers is of highest importance. The choreographer must communicate his ideas to the dancers – ideas that are of a physical nature, on how he wants the dancers to move their bodies.

By studying sonification from a cognitive science perspective we might gain better insight on how they are used and what purpose they play in the interaction between people. This knowledge in turn can be used to improve instruction and learning in other contexts, such as in rehabilitation training, when developing tools for working with abstract concepts, or when using sound to illustrate data.

1.1 Background

The video data used in this study was collected by Professor David Kirsh and his students, University of California, San Diego, with the intention to study dance from a cognitive science perspective. The investigation was designed to result "...in a singular document of the process that will be available to others and analyzed for years to come." (Kirsh, 2009). A couple of papers have since been written on phenomena such as marking (dancing a phrase in a less than complete manner) (Kirsh, 2010), and on choreographic methods for creating novel, high quality dance (Kirsh, 2009). Kirsh collaborates with noted contemporary choreographer Wayne McGregor and his Random Dance Company, and it is the filmed rehearsals and interviews with Random Dance that makes up the core of the video archive used in this study.

1.2 Purpose

The current study has been conducted with the purpose of exploring how sonification is used in a dance context. The topic is a specific one and accordingly, previous research is scarce. The purpose of this study has thus been to investigate and describe the phenomenon in order to gain a basic
understanding of it, as well as to facilitate further research. Studying sonification in a dance context might offer insights as to how and when non-verbal speech acts can be used to communicate, and what different purposes it might serve. Given the qualitative nature of the data an ethnographic approach has been chosen, resulting in inductive, data driven theories. The research questions are expressed in detail below.

1.3 Research questions

In what way, or ways, does the choreographer use sonification to communicate with the dancers during rehearsals? This general research question generates two specific questions.

The first question is:

- Are there different types of sonifications? If so, describe these.

  No hypothesis exists regarding what these differences in sonification might look like. However, given the qualitative nature of the phenomenon, it seems plausible to assume that a non-verbal speech act can be used in more than one way during a dance rehearsal. Thus, this first research question is aimed at investigating what these different types of sonification might look like, and to describe them.

The second question is:

- Does the choreographer’s use of sonification change with a change in context during the rehearsals?

  During the rehearsals, the choreographer works with the dancers in different ways to create the new piece. For example, they can spend the morning figuring out a duet, while in the afternoon switching to rehearsing different routines together. This second research question is aimed at investigating whether the way the choreographer uses sonification changes depending on the context in which they are currently working.

1.4 Delimitations

The data used in this study comes from filming one choreographer and his dance company rehearsing for three different productions over a period of three years. No other choreographer or dance company was studied, and it is possible that sonification is used in other ways by other choreographers. However, due to limitations in time and availability, investigating that is outside the scope of the current study.

1.5 Disposition

The report consists of this introduction, followed by an overview of the theoretical concepts important to this study. These concepts are mainly sonification and movement perception, the affordances of sound, and the working memory model. The knowledge gained from these works will serve as a foundation for the analysis done in this study. After the theoretical background the method will be presented, including a description of the procedure and equipment used. The next part will present the results, along with a discussion of these as well as the methodology. Conclusions and proposals for future studies make up the last part of this report.
2. Theoretical background

This part will present the theoretical background relevant for this study. Main concepts are the role of auditory information in movement perception, the possible affordances of sound, and the working memory model as proposed by Baddeley. The working memory model is included since it might help explain what cognitive benefits sonification might have in dance instruction. A brief overview of the dance terminology used in the study is also presented.

2.1 Sonification and Movement Perception

Effenberg (2005) has investigated the role of sonification in movement perception. In one study subjects got to watch a video of an athlete jumping and were asked to judge the difference in height between two jumps. One group got to see only the video; another group got to hear sonifications (not the actual sound of the jump but an artificially created sound that matched the movement) while watching the video. Subjects’ estimates of the athletes’ jumps were significantly more correct when they received auditory information along with the visual information. In another study, participants were asked not only to report the estimated height of the jump but also to reproduce it. A so called Kistler Force-plate was used to measure the jumps of the participants. Again, one group got to watch the video without sound, and another group got to hear sonifications along with the video. This time, too, sonification improved performance. Participants’ reproductions of the jump were more correct (i.e. equally high as the athletes) when they received additional auditory information along with the visual information.

Effenberg argues that in sonification research, an ecological approach to acoustic perception is essential. In the real world a kinetic event is necessary to generate a sound event: if there is no movement, no sound waves will occur. Putting a glass down on a table is a kinetic event that will create vibrations of the materials and generate sound waves. When these waves reach our ears we perceive them as sounds. The details of the sound, such as pitch and timbre, will tell us the details of the event that caused it: a glass put down on a wooden table will sound different from a glass put down on a stone table. The force of the movement will also be evident in the sound: the more energy the glass was put down with, the louder the sound of the impact will be. Artificial sonifications must follow these real-world rules to facilitate movement perception. One of the most basic requirements is that the audio-visual information should be convergent. This means a “temporal coincidence and spatial convergence of both stimuli as well as similar stimulus duration and intensity resulting in a structural equivalence” (Effenberg, 2007). The sound and the movement must thus occur at the same time and place, and these temporal and spatial aspects are important for a sonification to be interpreted as belonging to a specific event.

Connecting information from one modality with information from another modality in this way is called multisensory integration. Since activation of multisensory integration areas in the central nervous system correlates with enhanced perceptual performance, Effenberg (2007) in an fMRI study investigated whether audiovisual integration sites were activated when participants were watching a video with additional sonifications. This turned out to be the case, supporting the theory that activation of multisensory integration areas correlate with enhanced perception as well as behavioral performance.

To summarize, Effenberg’s studies show that both perceptual and motor control mechanisms benefit from additional acoustic information, and that it is possible to enhance perception and reproduction of human movements (in this case jumps) by adding sonification.
2.2 Metaphors and Affordances of Sound

Metaphors can help us understand abstract concepts – such as music. Lakoff and Johnson (1980) define conceptual metaphors as when one understand a conceptual domain in terms of another, and among others distinguish between orientational metaphors and ontological metaphors. Orientational metaphors are based on spatial orientation (up-down, near-far, in-out, etc.), and ontological metaphors are based on our interaction with the physical world and with our own bodies. An example of an orientational metaphor would be HAPPY IS UP, SAD IS DOWN, while an example of an ontological metaphor would be THE MIND IS A MACHINE, or THE BODY IS A CONTAINER.

Bakker, Antle and van den Hoven (2009) investigated what embodied metaphors children use to (unconsciously) structure their understanding of musical sounds. They did this by observing how children, aged seven to nine years old, enacted their understanding of musical sound through movement. The children got to listen to sound samples (20 seconds long) where one of the following parameters changed over the course of the sample: volume, pitch, rhythm, tempo, timbre, harmony, articulation, and tone duration. The children were then asked to use movement to enact the sound changes. Bakker et al. examined the relationships between the movements the children made and the associated sound changes to look for evidence of embodied metaphors. They found that the while the children used multiple different ways to structure their understanding of the different sound concepts, some sound-action mappings occurred more frequently than others. For some parameters of sound, the type of movement changed. For others it was the location in space that differed. Some were a mix of both. Changes in tempo or rhythm for example, were not surprisingly enacted as slow/fast or rhythmic/arrhythmic movements (movement change). Changes in volume were enacted as small/big, quiet/wild movements (movement change), but also as low/high (change in location). This was also true for pitch, were changes in pitch were clearly related to change in location. This finding is consistent with Zibikowskis (Zibikowski, 1998) theory that PITCH RELATIONSHIPS ARE RELATIONSHIPS IN VERTICAL SPACE. For the concepts tempo and rhythm, and partially also volume, the suitable metaphor was termed MUSIC IS BODY MOVEMENT.

Other studies have investigated the affordances of sound as enacted by adults. Nymoen et al. (2011) investigated what movements were made by adults when they heard a sound and were asked to move a rod in the air, pretending that moving it would create the sound they heard. The study showed that, as found in other studies, changes in pitch was illustrated by movement of the rod in vertical space. For non-pitched sounds no significant correlations were found, but tendencies were that loudness of sound was correlated to horizontal position and to velocity as well.

2.3 Working Memory, Chunking and the Phonological Loop

A central theory on memory in cognitive psychology is Baddeley’s model on working memory (Baddeley, 2000). Working memory is the system that holds information that is currently used in mind; it may be verbal or non-verbal. Baddeley proposed that our working memory consists of four different parts; these were the visuospatial sketchpad, the phonological loop, the central executive and the episodic buffer (Baddeley, 2000). Together they work with the encoding and integration of information, the linking of new knowledge to old, the integration of acoustic and visual information through cross-modality, and with the organization of information into meaningful chunks.

This chunking of information is important because of the limited capacity of the working memory. Experiments have shown that the working memory can hold seven items, plus minus two items, and that it can hold this information for about thirty seconds unless it is rehearsed (Baddeley, 2000). The grouping of information into so called chunks is a way of reducing the amount of workload by keeping the number of items down. A chunk is a pattern of more basic elements, usually elements that a person has previously learned (Sternberg, 2009). What is perceived as a chunk therefore
depends on the individual’s past learning. For an English speaker the phrase “Good morning” can be divided into the sub-chunks “Good” and “morning” and into further sub-chunks by chunking the words into separate letters. To recognize familiar chunks among the material to be learned helps memory since this means that the amount of new information to be learned is reduced. To help memory further the material should ideally be chunked in the same way from one occasion to the next. Apart from previous knowledge, closeness in space and appearance favor visual grouping into chunks, and closeness in time and quality favor auditory grouping into chunks (Sternberg, 2009).

The phonological loop is, as mentioned above, one of the four parts of the working memory (Baddeley, 2000). The phonological loop is responsible for handling auditory information such as speech and environmental sounds. It briefly holds the perceived information and makes it available for verbal comprehension or acoustic rehearsal. Unless repeated and/or stored in long-term memory, information in the phonological loop only stays around for about two seconds. Through so called sub-vocal rehearsal (repeating the information quietly to one self) we can store the information in memory.. The phonological loop, too, has limited capacity. The number of syllables pronounced for each item affects the number of items we are able to recall: when items have larger number of syllables, we can remember fewer items (Baddeley, 2000).

2.4 Dance Project Terminology

For a reader with little knowledge about dance some explanations of the terminology used in this study might be of use. The terminology is also used by Kirsh in the bigger study that this one is part of, which explores the different concepts in a more in-depth manner (Kirsh, 2009, 2010, 2011).

Below are shorter descriptions of a few terms that will show up later in this report:

**Marking:** Marking means dancing a phrase or movement in a less than complete manner. Dancers mark to save energy and to save the body from strenuous movements such as jumps and lifts. Examples of marking is substituting a leg movement with an arm or a hand, or keeping the rhythm of a phrase but only taking small steps and “scaling down” the movements. Marking can be used for example when two dancers are talking about a phrase they both are familiar with, or when they are memorizing and rehearsing a phrase on their own.

**Making:** In a making session the choreographer is working with one or a few dancers to create new steps. These might result in a solo or a duet, or perhaps in a longer phrase. Even though the choreographer is only working with one or a few dancers the others are usually standing around, watching and trying out the movements themselves.

**Structuring:** When structuring the choreographer is working with already choreographed or “sketchy” material to create a structure. Shorter movements or phrases are combined into a longer phrase or choreography. He can try his ideas out on the dancers to see if the sequence and movements looks good.

**Showing:** During a showing session the choreographer is giving the dancers new material to learn. Usually he is standing in front or in the middle of the dancers, and they watch his movements and copy them.

**Tasks:** The choreographer is sometimes giving the dancers tasks to work on. These can be to illustrate a word or action with movement, or to create phrases based on concepts such as “high” and “low”. This is a method to maintain the creativity in the dance company, since the choreographer gets ideas for future choreographies from watching the dancers.
3. Method

The following chapter will describe the methodology used. The first paragraph presents the Cognitive Ethnographical Paradigm that is the foundation for this study, whereas the second part will account for the origin of the video data and how it was analyzed, as well as for what equipment was used along the way.

3.1 Cognitive Ethnographical Paradigm

The method used in this study is inspired by cognitive ethnography and has an inductive, data driven approach. Cognitive ethnography is similar to traditional ethnography in that the data collected is qualitative and comes from observations, video recordings, interviews and such. In addition to that, cognitive ethnography allows for quantification of data and for interpretations based on theories from cognitive psychology (Ball & Ormerod, 2000). Since few studies, if any, has investigated the use of sonification in a dance setting before, this study is an explorative one. Main focus will be on exploring the subject and on describing what is in the data, and to generate theories based in data rather than in previous research.

3.2 Data

The video data used in this study extends to hundreds of hours and was collected by David Kirsh, University of California, San Diego (UCSD), between the years of 2009 and 2011. The video recordings capture the dance creation process of a well-regarded choreographer and his dance company during their rehearsals for three different productions. The first one was filmed during thirteen days at UCSD in the spring 2009. The dance team was working on a new dance piece and those thirteen days represent about 60 % of the total time spent creating the final production. Five high definition video cameras were mounted on the walls in the dance studio, and two standard camcorders were mounted on the ceiling. The cameras recorded an average of six hours each day, filming whenever the dancers were practicing and/or the choreographer was present.

The second rehearsal period was filmed with a similar set of cameras during thirty work days in 2010 and covered all scheduled interaction between choreographer and dancers as they were working on their next piece. Said piece premiered a week after its completion at a major dance venue in London. The third one was filmed during 2011 under similar conditions.

Video material also includes extensive interviews with the choreographer and the dancers. The choreographer was interviewed each morning and night for most days, with interviews ranging from between forty and sixty minutes. Four dancers were selected at the end of each day and interviewed for thirty minutes each. The aim with the interviews was having the choreographer and the dancers reflecting on the creative process and the events that had taken place during that day.

The data collection was also part of a UCSD course, Dance Cognition, taught by Kirsh. Students were therefore present during the rehearsals, taking field notes and interviewing dancers.

3.3 Material and Apparatus

Five high definition cameras and two standard video cameras were used for filming the rehearsals. As mentioned earlier, collecting the video was not part of this study but of an earlier one. The media player QuickTime 7 for Mac was used to view video and to extract snippets of video containing instances of sonification.
3.4 Procedure

As a first stage in the data processing, hours of video material were browsed through. As the video archive consists of hundreds of hours of video, looking at all of it was not within the scope of this study. Therefore, with the chosen phenomenon sonification in mind, the video with the best audio quality was selected and viewed. The audio quality depended on factors such as in what studio the company was rehearsing and how much music/background noise was interfering with what was said. About ten hours of dance video was viewed as part of this first stage, and notes were taken on whatever seemed interesting and noteworthy. It soon became evident that sonification occurred frequently throughout the video material, and that it would not prove difficult to find enough instances of sonification to serve this study.

The next step was therefore to collect snippets of video containing examples of sonification that would serve as the basis for further analysis. All video was watched in QuickTime, which allows for parts of a video to be extracted and saved as a separate file. A total of 90 video snippets were collected, with duration of snippets ranging from between five seconds and about two minutes. In the longer snippets, sonification occurred on and off during a relatively extended period of time, whereas in the shorter snippets, only an isolated sonification and a few seconds pre- and post sonification were included. Notes were taken to document in what context the sonification occurred, as this would serve further analysis.

After collecting a solid amount of 90 snippets, it became evident that sonification was not used in one single context, with one, unchanging purpose; but within different contexts and with seemingly different purposes. With that, the idea to sort the snippets into sub-categories began to emerge. A first, rough sorting resulted in six categories where the choreographer was using sonification for seemingly different purposes. A second, refined sorting resulted in the addition of three categories, making a total of nine categories. A description for each category was written, along with criteria that needed to be met in order for a snippet to qualify into that specific category. The categories were not mutually exclusive, as a snippet could qualify into multiple categories at once. After the final sorting, each sub-category contained between 2 and 30+ snippets. Not all snippets ended up in the categories, since some did not display clearly enough the purpose of the sonification. Only the best 58 snippets ended up in the categories; those were the ones that clearly met the criteria for the category. The categories were then each illustrated with an example of that type of sonification, and the sonification in the example was transcribed in detail.

Since the video archive also consists of interviews with the choreographer, some of these interviews were browsed to see if they contained material that would be relevant for this study. Here, too, snippets containing information regarding the choreographer’s use of sonification were extracted. Less detailed transcriptions were done by students in the Dance Cognition course at UCSD and these were used and somewhat refined for the purpose of this study. Quotes from the transcriptions are presented in this report. The complete transcriptions can be found in the Appendix.
4. Results and Analysis

In this part the results will be accounted for, starting with a presentation of the nine different purposes sonification was found to be used for. Each of these nine is reported with a description, criteria and an illustrating example. Following this is a presentation of when, i.e. in what contexts, sonification is typically occurring. After that, the choreographers own comments on his sonifications are reported. Lastly, two related phenomena that were observed are briefly described and commented on.

4.1 How is sonification used?

After extracting and sorting video snippets containing instances of sonification, nine different categories emerged. Each of these categories represents a purpose or a situation where sonification is used by the choreographer to communicate with the dancers. The categories were identified and named as follows:

- Sonification to highlight a certain part of a movement
- Sonification to trace a dancer’s movement
- Sonification to communicate dynamics
- Sonification to communicate temporal aspects
- Sonification to communicate the structure of a movement
- Sonification to communicate the duration of the current exercise
- Sonification when marking
- Sonification to indicate upcoming change in a phrase
- Sonification to synchronize dancers

As mentioned earlier the categories are not mutually exclusive, but a sonification can qualify into two or more categories at the same time. This means that a sonification can carry multiple layers of information at once. Of the 58 sorted snippets, 36 qualified into two categories and three qualified into three categories. The reason for this is mainly that Sonification to communicate dynamics and Sonification is to communicate temporal aspects are built-in into the sonification – it is impossible to make a sound without giving it a certain pitch, volume or tempo. Therefore, in the snippets where the primary purpose of the sonification was for example to coordinate the dancers, when the sonification clearly met the criteria for “Sonification to communicate dynamics” or “Sonification to communicate temporal aspects”, it was sorted into those categories as well. The different types of sonifications did not occur equally frequently, though. Sonification to synchronize dancers, for example, was observed 26 times, while Sonification to indicate upcoming change in a phrase was observed was observed 2 times. The reasons why this might be are brought up in the Discussion. Table 1 lists the different categories and how many times they were observed.
Table 1. The nine different types of sonifications and their frequencies.

<table>
<thead>
<tr>
<th>Type of sonification</th>
<th>Observed frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sonification to highlight a certain part of a movement</td>
<td>6</td>
</tr>
<tr>
<td>Sonification to trace a dancer’s movement</td>
<td>3</td>
</tr>
<tr>
<td>Sonification to communicate dynamics</td>
<td>32</td>
</tr>
<tr>
<td>Sonification to communicate temporal aspects</td>
<td>12</td>
</tr>
<tr>
<td>Sonification to communicate the structure of a movement</td>
<td>6</td>
</tr>
<tr>
<td>Sonification to communicate the duration of the current exercise</td>
<td>8</td>
</tr>
<tr>
<td>Sonification when marking</td>
<td>2</td>
</tr>
<tr>
<td>Sonification to indicate upcoming change in a phrase</td>
<td>2</td>
</tr>
<tr>
<td>Sonification to synchronize dancers</td>
<td>26</td>
</tr>
</tbody>
</table>

On the following pages the nine categories are presented in-depth. Each presentation consists of a description and analysis of the nature of the sonification, and what criteria had to be met in order for a sonification to qualify into that specific category. Each presentation also contains a detailed real-life example and a transcription of the sonification made in that example.
4.1.1 Sonification to highlight a certain part of a movement

Sonification can be used as a means to highlight a certain part of a movement. This can be anything the choreographer wants to draw extra attention to, such as the extension of an arm or the height of a jump. The reason he does this is usually that he wants the dancers to perform the movement in a different way.

The choreographer is often silent or sonifies in a normal voice before he highlights. He then changes the intonation or raises his voice to stress the particular part of the movement that he wants to highlight.

This type of sonification is related to the next category to be presented: “Sonification to communicate dynamics”, because the choreographer can sonify to highlight that he wants a movement to be more dynamic. He raises his voice/changes his intonation to point out that it is this particular movement he is focusing on, and at the same time the raise in voice or change in intonation is a way of asking for more dynamics in that movement. The following example will demonstrate this.

Criteria for category: One or more dancers are rehearsing a movement or a phrase. The choreographer is working with them and giving them directions, using sonification as a medium of instruction. The highlighting sonification occurs when he wants to put extra emphasis on a specific part of a movement. If he hasn’t been sonifying before, the emphasized movement is sonified for. If he has been sonifying he change the sound, volume and/or amount of stress on the part of the sonification belonging to that particular movement. Usually this is one or two syllables. This type of sonification is closely related to sonification for upcoming change, and to sonification for dynamics.

Frequency of sonification: 6

Example: A dancer is working on a phrase, and the choreographer wants her to add a jump.

Context: The dancers are spread out in the studio and working on new individual phrases. The choreographer is walking around the room looking at the dancers and sometimes giving them input.

What’s happening: One of the female dancers is trying out a series of movements, which ends with what can be described a sideways snake with her weight on her right foot and her left leg stretched out. She pauses in that position for a moment and seems to be contemplating where she should go from there. However she doesn’t add something but start over from a few steps before the snake. The choreographer notices the dancer as she is once again trying out the last part, and asks her to repeat it. When she stops by the end of the snake, he grabs her with his hands around her upper arms and lifts her, indicating that he wants her to add a small jump at the end of the snake. He then shows her the movement himself, adding a “wuUH!” when he jumps. She quickly gets the idea and repeats the movement; this time the choreographer is standing still but adds the same “wuUH!” when she gets to the jump. He then praises her with a “that’s it. exactly”, and moves on. She repeats the phrase once he’s gone, this time adding the jump at the end.

Transcription: “wuUH!” “wuUH! that’s it. exactly”
4.1.2 Sonification to trace a dancer’s movement

The choreographer sonifies while he is watching dancers rehearse. This kind of sonification is used when he is focusing on the steps of a single dancer and giving those movements his full attention – for example when working on a duet and adding new steps. When the dancer performs the steps that are the main focus at that particular time, he watches closely and sonifies along with the dancer’s movements.

This does not seem as a way for the choreographer to dictate the movements to the dancer, since the dancer knows what to do and the sonification follows slightly after, rather than precedes, the movement. Rather, it seems like the sonification is used by the choreographer as a way to “trace” the movement he sees.

Important to note is that in situations such as these when the choreographer is working on something new with the dancers, he knows what movements to expect since he recently choreographed them himself. Also, in some of the observed instances featuring this kind of sonification, he had already been using sonification when explaining the step to the dancer. That way, a particular step could already have a sound “assigned” to it. Sonifying along with the movements thus might be a way of checking that the steps are turning out as imagined – if the movement does not match the sound, it might be performed in the wrong way.

Criteria for category: The choreographer is working with one or two dancers on a phrase or movement (other dancers can be present). They are working with the details of a particular movement and the choreographer is instructing the dancer on how he wants him or her to perform it. When the dancer is performing the movement, the choreographer is giving it his full attention. He sonifies as he is watching, following the movement with his eyes and timing the sonification to what he is seeing.

Frequency of sonification: 3

Example: The choreographer is working with two dancers on a duet.

Context: The choreographer is making a duet and trying out steps and instructing the couple in the middle – they have the main part of his attention. The surrounding couples watch and copy the new steps as they are added to the routine.

What’s happening 1: The choreographer is trying out a step where the male dancer stands behind the female dancer, supporting her with his hands on her waist while she is on the toes of her right foot. She kicks her left foot sideways twice, then the male dancer turns her around 360 degrees in a slow pirouette. The choreographer is watching the dancers closely, adding sonification to the different movements when they try it out for the first time. The two sideways kicks is sonified as “ti-am, ti-am”, while the pirouette is sonified as “dijaaa-uumM”. The last, emphasized “M” corresponds to when the pirouette is just finished and the dancers come to a halt.

Transcription 1: “ti-am. ti-am, diiaaa – uumM, lovely. yeah, yeah, and then yeah and then it, it can be obsessive”

What’s happening 2: Later in the same session the dancers are in the same position, the male dancer this time dipping the female dancer sideways to her right. The choreographer is instructing them using a combination of verbal instruction, touch, sonification and his own body to show them how to perform the movement. The dip is quite slow and sonified as variations on “waaaaa” and “wuuuh”. 
Transcription 2: “This is nice if you just keep that whole shape and then it be like waaaa (pulls the female dancers arm so that she “falls” to the right), okay, just like this (shows her how he wants her to do the dip) waa, (the dancers take the starting position) just on two yeah, ta ta ta (the female dancer kicks her left leg three times), on two waaaa that’s it. finish, make sure you finish and then it be like wa, and then w↓uuuh. (The dancers try it again and the choreographer watches in silence until the dip comes) uuuh (sonifies the last part of the dip). yeah I think that I think not so much scoop. don’t scoop around like this (makes a scooping motion with his head, then goes on to show her how he wants her to do it instead).“
4.1.3 Sonification to communicate dynamics

The choreographer can use sonification as a means to communicate the dynamics of a movement. Because of the certain inherent metaphorical characteristics of sound, this type of sonification can be more or less present whenever a sonification is made.

Here, a short definition of the word dynamics will be in place. The word derives from the Greek word *dynamis*, meaning “power”. Dynamics in contemporary dance has been defined by dance legend Rudolph Laban as being made up by four main factors: space (direct or indirect), time (sustained or sudden), weight (light or strong) and flow (free or bound). Different combinations of these eight possible ways of executing a movement create variations in dynamics. To exemplify this, Laban named eight basic actions that would result from these combinations: punching, floating, pressing, flicking, gliding, slashing, dabbing and wringing. Outside this theory, qualities of movement associated with expressive, affective or other physical components are also referred to as dynamics as used in contemporary dance today. You might say that it’s got to do with energy (or effort, as Laban put it). Seen this way, dynamics is how much energy you put into a movement relative to how big that movement is. A movement can take up a lot of space, but it doesn’t have to be dynamic. The energy put into it, and therefore often also the speed at which it is performed, determines how dynamic a movement is.

Dynamics is closely linked to metaphor and to feeling. The choreographer sometimes wants the dancers to imagine that they’re falling or being pushed, and that that’s where the movement comes from. By imagining this they’re performing the movement with more feeling, and therefore also with more dynamics. When the choreographer uses sonification to communicate dynamics, the characteristics of the sonification matches the change in movement he wants to see. A common example is when he wants the movement to be more of something – higher, deeper, with more punch etc. He then typically raises his voice. The sonification “ah ah AH” could for example accompany two light punches followed by one hard.

Dynamics is related to metaphor because of the way we interpret sound. Thanks to our ability to think metaphorically we can ascribe certain characteristics to sound – a sound can sound happy (major) or sad (minor), “upward” (high-pitched) or “downward” (low-pitched) (Bakker et. al, 2009) and so on (more on this in the discussion). Because of this, the sonifications used by the choreographer will carry “information” on multiple levels – the rhythm will tell the dancers at what tempo to perform the movement, and the pitch and loudness will give clues as to what the dynamics (and perhaps feeling) should be like.

This kind of sonification is closely related to highlighting, in that that the choreographer can raise his voice and highlight the part of a movement that he wants to be more dynamic – a raised voice communicates a raise in energy.

In an interview, when asked about the “high and low”-task the dancers worked with, the choreographer had the following to say on his sonifications:

“so I said that about high and low, and the other thing that I just helped them with a little bit was the sound, the feeling of sound. To help them (…) yeah, kind of pull that out and expand and release it. so, to give it a little bit of elasticity.”

He says he helped them with the “feeling of sound”, to expand and release the movement and “give it a little bit of elasticity”. This particular sonification for “high” and “low” was a clear example of sonification for dynamics. This classification fits well with the choreographers own description of the event, since *elasticity* is a dynamic quality of a dance movement.
Criteria for category: The choreographer is using sonification while instructing the dancers. The tone, pitch, volume and/or particularly stressed syllables of the sonification corresponds to the way the choreographer wants the dancers to perform the movement. The dancers are changing the dynamics of the movement according to the instructions. The sonification can have other purposes as well, such as communicating timing, rhythm or the duration of the movement.

Frequency of sonification: 32

Example: The dancers are practicing a short movement of the arms.

Context: The dancers are standing in two loose lines in front of the choreographer. The choreographer is trying out a short movement of the arms and is instructing the dancers how he wants them to perform it.

What’s happening: The choreographer asks a male dancer in the first row to show him how he does the arm movement. The dancer lifts his arms from his sides and let them sweep in parallel up in front of him and over his head. When he can lift the arms no higher he bends his elbows and smoothly brings his palms down to shoulder level, then stretch out both arms straight in front of him. The entire movement takes about a second and is very smooth. In the last part when he stretches out his arms it seems like he is imagining pushing something away from him. The choreographer watches him and comments “we go ta ta ta”, then asks the dancer to show him again. He does, and the surrounding dancers repeat the movement. The choreographer then tries it out himself, on the last “pushing” part commenting that they are to “really clean out like that and then stop”. He then says “so we’re gonna go niaah-um like that, yeah?” and again performs the movement himself. The “niaah” of the sonification corresponds to the part when the arms go up and over the head; and the “um” of the sonification corresponds to when the arms are pushed away in front of the body. The dancers watch him and on his next “niaah-um” try it out themselves. This time they perform the “pushing” motion as if their arms actually met resistance.

Transcription: “show me. we go ta ta ta. show me again? really clean out (**) like that and then stop so we’re gonna go niaah – um like that niaah-um yeah? niaah – um. niaah- um. niaah-um.”
4.1.4 Sonification to communicate temporal aspects

In a way, most of the sonifications made by the choreographer can be seen as containing information on the temporal aspects of a movement. The rhythm and tempo at which the sonification is spoken will give the dancers a clue about at what rhythm and tempo the choreographer intended for the movement to be executed. Since any sound or speech act develops in time in a linear fashion the choreographer can’t choose not to sonify at a certain tempo, and so temporal information is automatically built in into every sonification. Unless he explicitly states that the temporal aspects of the sonification are unimportant, the dancers will most likely assume that the tempo of the sonification is the intended tempo of the movement.

Sonification can carry information regarding both rhythm and tempo. Rhythm would be the pulse of the movement and how the beats are organized; it is the pattern that is repeated. Tempo is at what speed the movement is to be executed. The Waltz, as an example, has a time signature of $\frac{3}{4}$ and can be danced fast or slow. If you change the time signature, however, it will no longer be a Waltz.

Following the same principle, a phrase can be taught in a slower tempo than it is intended to be performed. This was observed at least once in the data material. The reason for this is probably to make sure that the dancers know the steps of the phrase and master them before the tempo is increased. The rhythm should remain the same though, unless the phrase is to be changed fundamentally.

Dancing together to music has the advantage that everybody can hear the music and synchronize their movements according to the beat. Since the dance company studied here seldom is rehearsing to music, the choreographer’s sonifications can be seen as serving as a substitute for music. At the times that music was present the dancers were mostly rehearsing by themselves and not receiving any instructions, while at the times when the choreographer were instructing and using sonifications the music was often turned down.

This aspect of sonification, to communicate temporal information, is closely related to the kind of sonification used to synchronize dancers. When all ten dancers can hear the rhythm and tempo of the sonification, it is a fair guess that it makes it easier for them to synchronize their movements.

**Criteria for category:** The choreographer is instructing the dancers using sonification. The rhythm and tempo of the sonification corresponds to the rhythm and tempo of the movement sonified for. The dancers are performing the movement at that rhythm and tempo.

**Frequency of sonification:** 12 (7 rhythm, 5 tempo)

**Example:** The choreographer is showing the dancers a new phrase.

**Context:** The choreographer is showing the dancers a new phrase during a showing session. He has shown them the phrase, which consists mainly of small steps and turns, and put some words on what he is doing, such as "left foot forward", "tight turn" and so on. The dancers are now spread out on the floor and rehearsing the phrase for themselves.

**What’s happening:** A male dancer is going through the phrase from start to finish, it takes him about twenty seconds. The choreographer is walking around the room watching the dancers. When the male dancer has finished the phrase the choreographer spontaneously run through the phrase again, this time sonifying the whole phrase distinctively, about one sonification per $\frac{1}{8}$ beat. The majority of the dancers stop to watch him. It takes the choreographer about seven seconds to run through the phrase. The male dancer watches the first part of the phrase, then turns away and just as the choreographer is finishing his sonification the dancer starts the phrase over again. Now he has increased the tempo, it takes him thirteen seconds this time from start to finish. The fact that he
turns away and does not watch the choreographer dance indicate that it was not insecurity of the steps that made him dance at a slower pace the first time. More likely he needed some time to rehearse and consolidate the phrase, and when the choreographer sonified the phrase he became aware of at what tempo they were to perform it. He was then ready to speed it up.

**Transcription:** "ei a da um ei a ei um ei a da um ei a ei um ei a da um ei a ei um"
4.1.5 Sonification to communicate the structure of a movement

The choreographer can sonify to communicate the structure of a movement or the pattern of a shorter phrase. When doing this he is usually using a combination of gesture and sonification, with the sonification accompanying the gesture. On one occasion though, he was observed using only sonification to illustrate part of the structure of a phrase. This happened when he was instructing the dancers to stand still for the time of three “step units” (see the example below).

This kind of sonification is in a way inherent in most sonifications, in that that the structure of the sonification almost always corresponds to the structure of the movement. Thus, when sonifying for a step with three distinct parts, such as (right arm → left arm → right arm, throw), the sonification will typically consist of three syllables – one for each part of the step. It might sound like “um – um – ah”.

With that said, sonification seems to sometimes be used with the explicit intention of making the structure or pattern of the movement more clear to the dancers.

Criteria for category: The choreographer is instructing the dancers. Sonification occurs in the process of explaining the structure of the movement or phrase (usually before they start practicing it). The choreographer’s main focus of the instruction is explaining the structure of the movement or phrase; however, the sonification may also contain information regarding rhythm, tempo, dynamics etc.

Frequency of sonification: 6

Example: The dancers are rehearsing “throwing” during a structuring-session

Context: The dancers and the choreographer are trying out the movement “throwing” during a structuring session. First, the choreographer has the dancers repeating the movement fourteen times. He then gives them instructions on how they are to combine the throws into a longer phrase.

What’s happening: The movement “throw” imitates a throwing movement and can be divided into three parts: 1. Make throwing movement with right arm, at the same time take a step forward with left leg and put weight on it, keep right foot still on the floor. 2. Put arm down, shift weight back onto right foot. 3. Bring back left foot and put hands together as if transferring an object from left hand to right. The choreographer has seen the dancers repeating the movement fourteen times. He is now giving them instructions on how to combine the throws into a longer phrase, saying “I think I’d like it to be four, and then rest... for what would be three, and then another three. Three of the units, so one, uh-uh-uh, uh-uh-uh, uh-uh-uh”. During these sonifications he marks the three parts of the movement, so that each part of the “throwing” described above corresponds to an “uh”. He then stands still for three “units”, sonifying in the same way to communicate the structure of the pause – the dancers are to think of the pause as three non-performed units of throwing. Thus, the sonification for this part sounds like “uh-uh-uh, uh-uh-uh, uh-uh-uh” and no movement occurs. He then sonifies for the last three units to be performed, again marking the movement: “uh-uh-uh, uh-uh-uh, uh-uh-uh”. He finishes the instructions with a “yeah?”, and the dancers nod and hum in agreement. They then repeat the phrase from beginning to end, the choreographer sonifying and throwing along with the dancers.

Transcription: “I think I’d like it to be four, and then rest... for what would be three, and then another three. Three of the units, so one, uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh. Yeah? Okay let’s try that ready=four, and then rest three, and then three. We go ready aaaand, woom-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh. Yeah? I think I’d like it to be four, and then rest... for what would be three, and then another three. Three of the units, so one, uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh. Yeah? Okay let’s try that ready=four, and then rest three, and then three. We go ready aaaand, woom-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh, uh-uh-uh-uh, uh-uh-uh, uh-uh-uh-uh.”
4.1.6 Sonification to communicate duration of the current exercise

The choreographer sonifies to communicate for how long the dancers are to perform a certain movement. This movement is often of a repetitive character, such as jumping continuously up and down, imagining throwing a ball several times in a row etc. The choreographer can start the dancers on a movement and then sonify along with them, and they just keep going as long as he sonifies. When he stops, they stop.

This type of sonification is used primarily when the choreographer and the dancers are trying out new movements that they've just come up with, or when existing dance moves are put together into more coherent phrases. This means that the choreographer doesn’t yet know what he wants the movement look like or for how long they should keep doing it. By keeping the dancers moving he can see what the movement will look like, whether is it as they imagined it from the beginning or with alterations. He keeps them repeating the movement until he’s figured out how he wants it (or, sometimes, decides to move on).

This kind of sonification to communicate duration is typically repetitive in its nature, just as the movements are repetitive, with one part of the movement corresponding to one sound of the sonification. Thus, the movement of jumping straight up and down is once sonified as “um-pei, um-pei, um-pei”, with the “um” corresponding to when the dancers are at the highest part of their jump, and the “pei” corresponding to when they are at the lowest part of the jump, i.e. landing and preparing for the next jump.

**Criteria for category:** The dancers are trying out a new movement together with the choreographer. The movement is fairly short and the choreographer let them repeat it over and over again to see what it looks like. He is sonifying for each major part of the movement, repeating the sonification as the dancers repeat the movement. The sonification is consistent and doesn’t change markedly, neither does the movement. The dancers don’t know in advance how many repetitions they are to perform. As long as the choreographer is sonifying they keep repeating the movement. When he stops sonifying, they stop repeating the movement.

**Frequency of sonification:** 8

**Example:** The dancers are rehearsing “throwing” during a structuring session.

**Context:** The dancers and the choreographer have just begun trying out the movement “throwing” during a structuring session. The dancers are lined up and the choreographer is standing facing them.

**What’s happening:** They are trying out the movement “throw”, and the choreographer is sonifying for each part of the movement. The movement imitates a throwing movement and can be divided into three parts: 1. *Make throwing movement with right arm, at the same time take a step forward with left leg and put weight on it, keep right foot still on the floor.* 2. *Put arm down, shift weight back onto right foot.* 3. *Bring back left foot and put hands together as if transferring an object from left hand to right.* The choreographer is demonstrating the movement and sonifying. Each part is sonified as a distinct syllable: “uh-uh-uh”. The dancers pick up the movement and start repeating it in synchronization. The choreographer keeps sonifying, but after a few throws stops rehearsing it himself and merely mark the movement or just watch the dancers. The dancers keep “throwing”, synchronized with the sonification. After fourteen throws the choreographer stops sonifying and says “great, ok, great”. When he stops sonifying and start speaking, the dancers stop repeating their “throwing”. The choreographer then begins telling them how he wants them to proceed (see the example on Sonification to communicate the structure of a movement).

**Transcription:** “uh – uh – uh”, repeated fourteen times.
4.1.7 Sonification when marking

Sonification is used by the choreographer and the dancers when marking, that is when dancing a phrase in a less than complete manner. Recall that dancers mark to save energy and to save the body from strenuous movements such as jumps.

Sonification occurs in combination with marking when two or more persons are working together and mark for each other. They can for example be rehearsing a new phrase, mark the leg movements with the hands and say “so I go ba, ba”.

Sonification as used when marking could be a way of enhancing the marking. By adding sound that is consistent with the gestures or possibly small movements of the marking, the marking dancer is making clear what he or she is talking about. It could be a way of showing that “this is what we’re doing, this is what’s on the table right now”. Also, since she might already have said “so I go...” when working with a certain step, she has already begun using her voice. Sonifying might be a natural extension of the sentence already begun. Seen in that way, she could just as well have said “so I go leg, leg”. “Leg”, after all, is an established English word and guaranteed to be known by the fellow dancer spoken to. What is interesting is that the use of actual words when marking for body parts is not as common as you might think – sonification seems to fill that space well enough. What is the reason for this? It might be that the hands used to substitute the legs in the marking already says “legs” clearly enough for experienced dancers, and that the sonification is better used to enhance the rhythm and dynamics of the movement. The sonification, then, would not mirror the message sent by the hands but add information to it. However, these are just speculations.

Criteria for category: Two or more dancers and/or the choreographer are rehearsing a movement. The sonification occurs when the person who sonifies is marking. The temporal onset of the sonification corresponds to the temporal onset of the marking. The main purpose of the sonification seems to be to accompany the marking, however, the sonification may also contain information regarding tempo, dynamics, etc.

Frequency of sonification: 2

Example: The choreographer and two dancers are working on a duet.

Context: The choreographer is working with two dancers on a duet during a making session. He is instructing them and they try out and rehearse the new steps he’s giving them.

What’s happening: The choreographer is watching the dancers rehearse the phrase when they get to the end and stand still, he walks up to them and says "so go um, so go um" and looks like he’s thinking the movement through. He then says "you know yia - da - da - dumm - pa - YA - DA - BOM! tia - um " while quickly marking the phrase. He is keeping up the tempo of the sonification and the marking, but the first movements are just marked with is hands while he is walking. When he sonifies the "YA - DA - BOM" the movements get bigger and he is moving his whole body, as this is the movement he wants the dancers to focus on and incorporate into the duet. The marking and sonifying is thus a way to communicate to the dancers where in the phrase they are working. The dancers seem to know the phrase well enough to understand his small hand movements and see where in the phrase he means them to do the movements sonified for a as "YA - DA - BOM".

Transcription: "so go um, so go um, you know yia - da - da - dumm - pa - YA - DA - BOM! tia - um"
4.1.8 Sonification to indicate upcoming change in a phrase

By changing the intonation, volume or the actual sounds of the sonification the choreographer can indicate to the dancers that there’s an upcoming change in the routine. He does this to help them as they’re dancing, as a cue for them to remember the upcoming change.

This type of sonification is relatively rare with only two observed instances. Both of these took place when the dancers were rehearsing new steps. The reason for this is presumably that it is in those situations that the dancers are both in need of, and susceptible to, the extra information added by the sonification. As professionals, they are expected to pick up choreography quickly and remember it.

Despite its rareness, it is clear that sonification can serve the purpose of indicating an upcoming change. The example below demonstrates this.

Criteria for category: The dancers are rehearsing a shorter phrase with elements of repetition in it. At some point in the phrase a smaller change occurs. The choreographer is instructing the dancers and sonifies as they perform the phrase. The main purpose of the sonification is to communicate the rhythm, tempo or dynamics of the phrase, or to synchronize the dancers, or all of it. When the small change in the phrase is about to occur, the choreographer change the volume and/or intonation of the sonification to indicate to the dancers that the change is coming. This type of sonification is closely related to highlighting.

Frequency of sonification: 2

Example - The dancers are rehearsing a series of jumps during a structuring session.

Context: The choreographer is explaining the structure of the series of jumps. He has figured out that the series should consist of eight jumps with feet down plus eight jumps with feet up, making a total of sixteen jumps.

What’s happening: When the dancers are practicing the series of jumps, the choreographer sonifies for each jump and after eight jumps change the sound of the sonification from an “um-pei” to an “um-pa” to indicate that they’re to start lifting their feet up higher in the following jumps. The first syllable after the change, when they are to start lifting their feet, is stressed to highlight the change. The last syllable of the last jump is also more stressed than the last syllables of the previous seven jumps, indicating that the series of jumps is coming to an end.


This could be seen as a form of highlighting, which is supported by the fact that he also raises his voice when the change occurs; probably to make sure the dancers will not miss it.
4.1.9 Sonification to synchronize dancers

The choreographer use sonification as a tool to synchronize the dancers. This can happen for instance when they are putting together a routine or are trying out what new steps might look like with all the dancers performing them at the same time.

Since they are rarely dancing to music during the early rehearsals (they’re sometimes dancing with music in the background, but they do not dance to the beat or to that specific piece), the dancers cannot use music as a way to synchronize their movements with each other. Therefore, with ten dancers in the group, the choreographer will at times function as much as a coordinator as a choreographer. By using his voice it seems he’s giving the dancers sounds to map their movements onto, making it easier for them to arrive at certain points of the routine together.

The example below describes how the choreographer uses sonification to start the dancers over when they are performing a step out of sync. However, these mistakes were rare, and this type of sonification is also used frequently when all the dancers are rehearsing new steps together for the first time - and particularly when they are started on those steps. When they know the steps, the need for this kind of sonification seems to lessen. This makes sense since the dancers are professionals and expected to quickly pick up and remember new choreography.

Criteria for category: All the dancers are rehearsing the same movement or phrase. The choreographer is sonifying for one or more of the movements and the dancers are coordinating their movements based on that sonification. The main purpose of the sonification seems to be to synchronize the dancers, however, it can also contain information about change, duration, tempo, rhythm or dynamics.

Frequency of sonification: 26

Example: The dancers are rehearsing the step “spring” together during a structuring session.

Context: All ten dancers are lined up for a rehearsal of the structure and steps of a new phrase. The phrase consists of a chain of different steps named after actions. The choreographer and the assistant choreographer are standing facing the dancers and helping them remember the phrase by calling out the name, and sometimes number of repetitions, of the next step. For example, the step before “spring” (a jump) was “wrestle”; the step after was “fall”.

What’s happening: When starting the dancers on the new step called “spring”, the choreographer calls out the name of the step and then sonifies once, ” waa- eii um a ei”, as they start jumping. However, the dancers are not jumping in synchronization. They look at each other and recognize the problem, but seem to choose different fellow dancers to try to synchronize with. After three jumps they are still not jumping in unison. The choreographer notices this and steps in with a “let’s start spring together, we go spring ready aaand, woom – eii – um – ah, woom – eii – um – ah.”. He jumps with them the first two times, and the assistant choreographer jumps with them until jump number six. After two jumps the assistant choreographer tells them “seven times”, and the choreographer then modifies his third sonification to “woo-three”. He then counts the rest of the jumps, with slight variations on where in the jump the number is called out. The dancers, once started together and reminded the rhythm of the step, remain synchronized during all seven jumps.

Transcription: “spring, waa-eii um a ei. let’s start spring together, we go spring ready aaand woom – eii – um – ah, woom – eii – um – ah.” (Assistant choreographer:’seven times’) “woo-three, four, five, six, seven.”
4.2 When is sonification used?

Sonification was found to be used by the choreographer when he was instructing and communicating with the dancers. It was hardly ever used by the choreographer or the dancers when they were rehearsing by themselves. This is hardly surprising since a sonification can be seen as a non-verbal speech act, and speech-acts typically occur when people engage in conversation. What was a bit surprising was that the dancers seldom sonified. While the main focus of the study was the choreographers sonifications, due to the explorative nature of the study the dancers sonifications were still of interest. However, only once was a dancer observed sonifying. This happened when two dancers were rehearsing a duet and marking for each other. This does not necessarily mean that dancers do not sonify. It is possible that more sonifications made by dancers can be observed if focusing on occasions when dancers are rehearsing together and mark for each other.

As for the choreographer’s use of sonification, examples were abundant. Different types of sonifications were found to be more common in certain contexts than in others. One exception is Sonification to communicate dynamics, which turned out to occur more or less in all contexts. Why this might be will be further elaborated on in the discussion. Below is described what types of sonifications typically occurred in the different rehearsal sessions and why this might be.

Making session: During making sessions the most common types of sonifications observed were Sonification to trace a dancer’s movement, Sonification to communicate dynamics, and Sonification when marking. This makes sense because in a making session, the choreographer usually focuses on one or two dancers and works with the movements in detail. The need to coordinate many dancers or to communicate duration of an exercise is therefore small. What the choreographer does in a making session is to communicate to one or two persons the finer details of a movement, and to judge whether their performance is what he imagined or not. The types of sonifications listed were used in this purpose.

Showing session: During a showing session the most common types of sonification observed were Sonification communicate temporal aspects, Sonification to communicate dynamics, Sonification to communicate the structure of a movement, and Sonification to highlight part of a movement. The main focus for the choreographer in a showing session is usually to communicate a phrase to all ten dancers. This means that he is sonifying for his own movements, not what he sees the dancers do or to coordinate them. By sonifying for his own movements he probably makes it easier for the dancers to perceive what he is doing, since when all ten dancers are present, some are bound to stand further back in the studio and perhaps have a limited line of sight.

Structuring session: During a structuring session the most common types of sonifications observed were Sonification to synchronize dancers, Sonification to communicate duration of current exercise, Sonification to indicate upcoming change, Sonification to highlight part of a movement, and Sonification to communicate dynamics. The reason for these observations is probably that in the structuring sessions observed, the choreographer was working with all the dancers present and trying out his ideas. Not all structuring sessions might look like this, in which case other types of sonification might be more common. However, in the structuring sessions observed over the course of this study, the choreographer used sonification to coordinate and synchronize the dancers, and to work with them in “real time” by communicating upcoming changes and the duration of current exercises.

Tasking session: Only a few tasking sessions were observed since these usually did not contain longer instances of sonification or instruction. The one type of sonification that was observed was Sonification to communicate dynamics. When giving the dancers instructions on how to work on their tasks the choreographer could sonify in an addition to the verbal instruction. When giving them the task of working with the concepts “high” and “low”, he used sonification while himself making “high” and “low” movements. This was after his first verbal instruction, when the dancers had started
working on their tasks but the choreographer felt that they were not quite getting it right. He then
sonified and made high and low movements. In fact, this particular sonification was interesting
because of the changes in pitch he made while shifting from a low position to a high – the low
movement was sonified for with a low-pitched sound, while the high position was sonified for with a
high-pitched sound. This is in line with previous research (Bakker et al., Nymoen et al. etc.)

Figur 1. Example of what the dance studio could look like with the dancers, choreographer and assistant choreographer rehearsing.
4.3 Related phenomena

In addition to sonification, some related phenomena were also observed. These two are the choreographer snapping his fingers, and when he pronounces words in a “sonifying” way. Since they are not the main focus of this study but still of certain interest, these two phenomena will be presented and commented on shortly:

The choreographer snapping his fingers: The choreographer was often snapping his fingers while instructing the dancers. Sometimes this snapping co-occurred with sonifications, such as Sonification to communicate dynamics, Sonification to communicate temporal aspects, or Sonification to highlight part of a movement. There could be many reasons why the choreographer is snapping his fingers. One guess is it that is another way of using sound to instruct the dancers. Snapping his fingers when instructing the timing of a throwing motion, for example, could be an efficient way of highlighting that the arm should be fully extended at that precise moment.

The choreographer using words as a medium for sonification: It turned out that sonification not necessarily needed to be non-verbal. An interesting finding, though not very surprising, was that the choreographer sometimes sonified using words. An example is when the choreographer was instructing the dancers on how they could go from one movement to another and used the word “transition”. The word was pronounced slowly and with almost wave-like qualities of pitch – clearly not the usual pronunciation of the word. It makes sense that words are sometimes used as a medium for sonification. If the goal is to explain a certain concept or phenomena, for example, keeping the semantic meaning of the instruction could be more beneficial for the dancers understanding of the same concept. When giving instructions for “high” and “low” movements in a task as mentioned earlier, the choreographer used a mix of words, sonification and sonified words. When using the words “high” and “low” as medium for sonification, the word “high” was pronounced with a high-pitched voice, and the word “low” in a low-pitched voice. Once again this is in line with theory (Bakker et al., Nymoen et al. etc.)

4.4 Choreographer on his use of sonifications

The choreographer himself seems aware that he is using sonification in his instruction. The subject comes up in at least two of the interviews conducted after each day’s rehearsal.

In one of the daily interviews the choreographer had the following to say on an event where he had used sonification extensively:

“and I felt that sound wise I needed it was a layer of information I needed that wasn’t about words it wasn’t about interpretation of words, I could sing them a rhythm that would help them express the physicality so I could express what the transition sounded like to give them a kind of an embodied image of it.”

The transition he is mentioning is a transition between “high” and “low”, the two opposing concepts mentioned earlier that the dancers had been assigned to work with during that day. The choreographer didn’t merely want them to shift between moving high and moving low, but to work with the movements in between the two endpoints as well.

Later in the same interview, when asked about his use of “vocalizations”, he says:

“yeah I often vocalize actually I mean I’ve noticed that before yeah I often vocalize. I’m a very I find I’m a very I’m a quite physical choreographer so even when I’m making the first thing in the morning, the first thing, I’m very in there I’m very moving you know I’m very, and you know I think that kind of vocalization or intonation is another way of um just yeah just trying to ease along the process a bit”
In another interview, again on the “high and low”-task, he says:

“so I said that about high and low, and the other thing that I just helped them with a little bit was the sound, the feeling of sound. To help them (...) yeah, kind of PULL that out and expand and release it. SO, to give it a little bit of ELASTICITY.”

He says he helped them with the “feeling of sound”, to expand and release the movement and “give it a little bit of elasticity”. Using the term developed for describing his type of sonification, this particular sonification was a clear example of sonification for dynamics. This classification fits well with the choreographers own description of the event, since elasticity is a dynamic quality of a dance movement.
5. Discussion

The first part of the discussion will focus on the results of the study and discuss these in relation to the theories presented in the theoretical background. In the second part of the discussion the pros and cons of the method will be brought up and commented on.

5.1 Results

The research questions of this study has been "Are there different types of sonifications? If so, describe these", and "Does the choreographer’s use of sonification change with a change in context during the rehearsals?" The results indicate that there indeed are different types of sonifications, and that sonification in dance instruction can serve multiple purposes. Nine different purposes were identified and described. The fact that these categories are not mutually exclusive is not seen as a problem with respect to the first research question, which was to investigate whether there are different types of sonifications. The reason for this is that sonification can be seen as a multi-tool, as soon will be discussed, and that the majority of the snippets which qualified into two or more categories ended up in one of the categories “Sonification to communicate dynamics” and “Sonification to communicate temporal aspects”, due to the inherent characteristics of sound discussed earlier. It also turned out that different types of sonifications could be observed more often than others, and that some were more common in certain contexts than in other. Some types of sonifications also appeared to be more related than others. Elaborating on these similarities and discussing them in relation to theory will be the topic of the first part of the results discussion. This will be followed by some thoughts on how the dancers interpret the sonifications.

5.1.1 Sonification as a multi-tool

Of the nine different categories that were identified and described in this study, some seems to be more related than others. This suggests that they can be sorted into top-categories, and in this study, the following grouping of the categories are suggested: Sonifying for quality of movement, Sonifying for communication, and Sonifying for coordination.

1. Sonifying for quality of movement: Three types of sonification in particular seem directed at communicating the quality of a movement. These are sonifications made to communicate dynamics, sonifications made to communicate temporal aspects and/or sonifications made to highlight part of a movement. All these types of sonifications are concerned with the quality of movement in that that they focus on the details. How the individual dancers interpret the instruction and perform the phrase will be influenced by the characteristics of the sonification. This could be said to be true for all sonifications, but the three types of sonifications listed here (for dynamics, temporal aspects and highlighting) intuitively seem more related to the quality of a specific movement than for example sonifications made to synchronize dancers or to communicate the duration of a movement.

One of the reasons for the choreographer’s use of sonification in instruction might be the inherent metaphorical qualities of sound. As various studies from Bakker, Nymoen, and Zibikowski has shown, some sound qualities seem to invite to certain patterns of movement. For example, louder volume invite to bigger, faster, wilder movements (Bakker, 2009), and higher pitch and/or higher volume invite to higher movements in vertical space. By making use of these built-in clues in his sonifications (this may happen consciously or unconsciously), the choreographer give the dancers more information on how he wants them to perform the movement than he would have by simply
showing it to them. It is possible to describe a movement in words only, but it is tedious and depends on the interpreters verbal skills. Showing is a more effective and direct way of telling someone how you want them to move – it captures all the details of the movement. What might be harder, depending on the skill of the person watching, is interpreting the dynamics of the movement – the feeling, if you will. Using sonification might be a way of adding a layer of feeling to the movement in a way that is more transparent than using words or by showing only would be. If the results from Bakker, Nymoen, and Zibikowski studies are correct, they suggest that some universalism might exist in what metaphorical affordances people ascribe to sound. This in turn suggests that the dancers might interpret the sonifications intuitively. The choreographer himself in an interview when asked if “the sound meant to represent the energy or was the sound representative of tempo” answered that the sound he made had to do with the “pressure” of the movement. “Pressure” is a typical dynamic quality. By adding sound to his instruction he was probably “showing” them what the sound of “pressure” might sound like.

As for communicating the details of a movement, sonification might also help the dancers perceive the movement as well as reproduce it more precisely. Research by Effenberg (2007) has shown that sonification that converges with visual stimuli of biological movement helps a person perceive the movement better and also to reproduce it more accurately. In our daily life we partially depend on acoustic information to interpret what is happening. We can hear if a glass is put down on a wooden table or on a ceramic table, and we can judge by the sound of the impact how hard the racket hit the tennis ball. These action-consistent sounds help us perceive our environment. But we do not hear every sound – some are too faint. Our muscles create sound when they tense and relax, but these sounds are outside of the human hearing range. Thus, our bodies only create hearable sounds when they connect with other materials. This might be one more reason why sonification comes in handy in dance instruction. By adding matching sonifications to his movements the choreographer might help the dancers perceive the movement itself – the information is then available in two modalities instead of one. This might be extra helpful if the dancers have impaired or restricted vision.

Concerning the temporal information that a sonification can communicate, it might be interesting to discuss the rhythm and tempo of a sonification with the concepts of working memory and the phonological loop in mind. From the dancers’ perspective, if you’re rehearsing a phrase and you know how to perform it but not at what exact tempo, you could listen to the sonification and get extra information on rhythm and tempo from there. Then you could quietly repeat that sonification in your head, keeping it in the phonological loop while rehearsing the phrase. This might be easier than to first look at the choreographer and see at what tempo he is dancing, and then repeating that visual information in your head as you rehearse your phrase. Acoustic information, intuitively, seem more adapted to carry temporal information than visual information is (ever seen a parade use pictures to get their participants to march in synchronization?). By listening to a sonification and then repeating it quietly to himself while he rehearse, it would be possible for a dancer to judge how well his movements match the tempo intended by the sonification. If he is not a certain point at a certain sound he will need to make adjustments. Keeping the sonification in the phonological loop might thus be a way to hold temporal information about the movement in mind while rehearsing. However, these theories are speculations.

2. **Sonifying for communication:** Three types of sonification in particular seem to have communication between the choreographer and the dancers as main purpose. These are Sonification to trace a dancer’s movement, Sonification when marking and Sonification to communicate the structure of a movement. These three often occurred in the same contexts, particularly in making sessions. Sonification to communicate the structure of a movement also occurred in showing and structuring sessions. These three types of sonifications have in common that they help the choreographer and the dancers to work together in a tight coupling and to figure
out a movement together. Using sonification while marking might be a way of directing the other persons attention towards the marking (since marked movements often are smaller than movements danced full out), and to create consensus that it is this particular part they are working on right now.

Sonifying to communicate the structure of movement is another interesting purpose to discuss. From a cognitive psychology-point of view, this way of using sonification can be analyzed with the concepts of working memory and chunking in mind. It is usually claimed that our working memory remember units more easily than uninterrupted chains. Chunking a stream of movements into smaller units should therefore make it easier to remember. By giving each part of the movement a corresponding sound and combining these sounds into a sequence, the choreographer is making clear what the different units in the phrase are – the dancers can hear it as well as see it. This was clearly demonstrated in the example provided with the description for the category.

3. **Sonifying for coordination**: Three types of sonification in particular seem to have coordination of dancers as main purpose. These are Sonification to synchronize dancers, Sonification to communicate duration of exercise and Sonification to indicate upcoming change in a phrase. These types of sonifications were mainly observed during structuring sessions when the choreographer were trying out different steps on the dancers and figuring out how to combine them. Since they did not dance to music, and all dancers were present, the sound of the choreographer’s voice was what they used to synchronize with each other. To sonify is probably a convenient way for the choreographer of having the dancers doing what he wants them to in that precise moment. Instead of saying “one more time, one more time, one more time” he sonifies, and with the sonification comes the benefits that he can modify it as he likes without losing semantic meaning (as changing parts of the sentence “one more time” might do) and that he can load it with metaphor - “round” sounds for round movements, low-pitched sounds for low, heavy movements and so on. Again, this might be conscious or unconscious.

To sum up this part of the discussion: Sonification is what you might call a multi-tool. It is a way for the choreographer to communicate that is richer than using only words would be, and sometimes it is more efficient as well. This might be the reason why it is used so extensively.

5.1.2 **Interpreting a sonification**

Given that sonifications do not carry semantic information as such, the context should play an important role in how a sonification is interpreted. The phrase “Red is a color” contains the same information wherever or whenever it is spoken. With sonifications, this is not the case. The same sonification might be interpreted in different ways in different contexts (indeed, some of the sounds the choreographer use to sonify seem to reappear every now and then). This means that the dancers and the choreographer needs some form of shared knowledge to understand each other, and for the sonifications to have meaning. The knowledge might be expressed something like: “we’re random dance company, we have a certain history both as individual dancers and as a company, today we’re working on this piece and right now we’re focusing on this step and I know we see each other and pay attention” and so on. This shared knowledge can also be seen as a form of common ground (see Clark, 1996). In a structuring session for example, the group needs to agree on what movement is currently in focus and how they are working with it. Does it help them to synchronize or is the choreographer trying to get them to change the movement? The same sonification used later for a different movement in a different session will be interpreted according to that context, and not the earlier one.
In his paper *Choreographic methods for creating novel, high quality dance*, Kirsh (2009) briefly mentions sonification and comments that they “were not able to show that all dancers interpret the sonification in the same way”. A later comment on the subject came from a couple of students at the Interactive cognition lab at UCSD, who had the idea that sonification probably does not create a particular body motion, but rather limits the plausibility of movements. A sonification, thus, when used in combination with other types of instruction (verbal and visual), would not induce a particular body movement but rather constrain the range of body movements accessible to the dancer. For example, making a low movement for a high-pitched sonification might not be as natural as making a high movement for the same sound. The same should go for temporal aspects – dancing to the beat is generally more a more natural thing to do than not dancing to the beat, especially if you are a group of professional dancers trying to synchronize.

To sum up: sonification might not tell the dancers exactly what movements they should make, but rather constrains the range of plausible movements. The context and shared understanding of the situation should help the dancers interpret the sonification and determine how to respond to it.

5.2 Method

The method used in this study was inspired by cognitive ethnography. This approach is well suited for analyzing qualitative video data in an explorative manner, since it allows for a theory-generating rather than a theory-testing study.

To analyze video material in detail is probably both the easiest and the most valid way to study sonifications in a naturalistic setting. Video allows for a situation to be viewed again and again, and things that might pass by unnoticed to an observer taking field notes can in video be analyzed second by second. The fact that some context and “mood” is invariably lost on video is balanced by this fact. In addition, a sonification is a fairly isolated event that takes place during the course of a few seconds to a minute, so extracting snippets and losing some context should not be as crucial as when studying more complex processes (such as how a dance piece is evolving over time, or the relationships between the dancers in the group).

The data consisted of video material recorded in a naturalistic setting and the ecological validity of this study is therefore fairly high. One can argue that the researcher and students who recorded the material might have disturbed the dance company when they rehearsed. However, while watching the video it became apparent that the researcher and students stayed very much in the background during the rehearsals; they had the interviews in the beginning of and at the end of the day to ask questions.

One of the major difficulties of this study has been to make the results reliable. Since the video material has been analyzed by a single person, it is possible that the interpretations made and the conclusions drawn are not consistent with reality. To have at least one other person, preferably more, analyze the video as well would improve the reliability of this study. However, this was not within the scope of the course within which this study was conducted.

Coding video is a way of making the content more transparent and to enable computational analysis. During this study the idea of coding video has come up, as it might be a way of making the results more reliable. Coding video would probably prove more difficult for certain types of sonification than others. For example, Sonification when marking and Sonification to communicate the duration of an exercise would be easy to measure and code for (when marking and sonification co-occur for the first type, when the dancers keep on repeating a movement as long as sonification is present for the second type). To code for Sonification to communicate dynamics would be harder, since details of movements are harder to both see and describe. However coding is a time consuming activity, and
since only a single person would be developing the code and code the video, the benefits of coding
to improve reliability would be marginal. Since the main focus of this study has been to investigate
whether different types of sonifications existed and to classify and describe them, and not to define
each type of sonification in code or make computations on it, the decision was made to go for
detailed examples and transcriptions instead. Hopefully this might also give the reader a better
understanding of the different sonifications.

The differences in observed frequency for the categories are quite big, ranging from two (when
marking) to over thirty (for dynamics). There can be two main reasons why the results look like this:

1. Certain types of sonification are more rare/common. The sample of sonifications collected is
   representative of the “population” of sonifications.
2. What hours of video material were selected and viewed was based on the quality of sound. It
could be that parts where one type of sonification occurred frequently were missed, and that
the distribution of sonifications would have been different if other material had been chosen. In
fact, this case is the more probable. Therefore the number of observed instances for each type
of sonification might matter less, and the quality of the observed examples be of bigger interest.

One last important thing to note is that the results obtained in this study cannot be generalized to
other choreographers or dance companies. The results are strictly representing how this particular
studied choreographer and his dance company use sonification while rehearsing. More studies on
how other choreographers use (or don’t use) sonification in dance instruction is needed before
general trends can be discussed.
6. Conclusions

The two research questions of this study has been “Are there different types of sonifications? If so, describe these”, and “Does the choreographer’s use of sonification change with a change in context during the rehearsals?” The results have shown that there indeed are different types of sonifications, and that these are used for different purposes. The nine examples presented here have illustrated this. The results have lead to the description of sonification as a multi-tool, and as a way for the choreographer to communicate with the dancers that is richer than using only words would be. Analysis of the types of sonifications in relation to context has also shown that some types of sonifications occur more frequently in certain types of contexts than others, and also that each type of sonification can be seen as serving one of the three higher purposes: mediating the more detailed qualities of a movement, communicating with and instructing the dancers, and, lastly, coordinating the dancers.

This study has also argued that while sonification might not tell the dancers exactly what movements to perform, it rather constrains the range of plausible movements. The built-in metaphors, the context and the shared understanding of the situation help the dancers interpret the sonification and determine how to respond to it.

The current study is unique in that few studies, if any, has investigated the use of sonification in a dance context. The results gained here can therefore serve as a useful foundation for further studies, as suggested below. The knowledge of how sonification can be used in instruction is valuable in non-dance contexts as well. These could be learning contexts such as rehabilitation training, when developing tools for working with abstract concepts, when using sound to illustrate data, and many more.

There are many questions left to be investigated concerning use of sonification in dance instruction. Future studies should look closer at words as a sonification device. It would also be interesting to conduct an experiment to see if there is any difference in how the dancers pick up new choreography with or without instructions containing sonifications. Another experiment might look at how the same sonification is interpreted in different contexts. To investigate what types of sounds the choreographer tend to choose for different types of movements would be if interest, as well as to see if there is any relationship between number of syllables used and number of distinct body movements. Lastly, the choreographer and the dancers should be interviewed in a more in-depth way on their eventual thoughts on sonification. Theirs is the first-hand experience of the phenomenon.
References


http://www.randomdance.org/docs/lacacognition_0.pdf (2012-04-19)

Appendix A - Transcriptions from interviews with choreographer

C = Choreographer
I = Interviewer

1.
C: Well I learnt, I mean I learnt I guess today something about, even this, I wanted this energy of high and low but just to say high and low it wasn't just a spatial, it wasn't just about a spatial organization for me it was about a feeling of moving and it was from the inside out rather than the outside in so it wasn't, yeah, it was the in a way it was like when we played with Scott when we played pong. this idea of feeling up and then feeling gravity it's the same kind of thing and I felt that sound wise I needed it was a layer of information I needed that wasn't about words it wasn't about interpretation of words, I could sing them a rhythm that would help them express the physicality so I could express what the transition sounded like to give them a kind of an embodied image of it. Does that make sense?
I: yeah, sure, it was fun actually I was delighted to see you make great data
C: yeah I often vocalize actually I mean I've noticed that before yeah I often vocalize. I'm a very I find I'm a very I'm a quite physical choreographer so even when I'm making the first thing in the morning, the first thing, I'm very in there I'm very… and you know I think that kind of vocalization or intonation is another way of um just trying to ease along the process a bit.

2.
C: yeah, the extreme position of it. Look they could have lots of choices, didn't they? Because this could be the action, this could be low, the whole body could go, everything could go low. This could be high, and the body could go low, and could pull the whole thing away. It could be that… everything could go high. And that, so that three options, with the three options below and the transitions in between gives you how many permutations? Quite a lot! So, transition-wise, you've got a lot of options, rather than just, yeah, you've got a lot of options. So I said that about high and low, and the other thing that I just helped them with a little bit was the sound, the feeling of sound. To help them
I: pull it out
C: yeah, kind of pull that out and expand and release it. So, to give it a little bit of elasticity.
I: sorry I was writing down.
C: I would go [makes crazy sound], to give them a kind of ahh
I: that's different than high-low
C: yeah, well yeah
I: how do you want them to. Show me, show me. So, do a high, and then show me how you would lay over the [repeats crazy sound]
C: well, I think it has something to do with the difference between going, "This is a high move", and "This is a low move"
I: OK, so, ok
C: So I can do that by just going, I'll just do it with my arms, I can do that by going...
I: you'd better sitting if you don't mind, I'm so sorry.
C: it's alright. So this is high, and this is low. My instruction could be that!
I: yeah sure
C: so the transitions could just be this, if that's interesting. Maybe. but, I asked them to... I wanted to get in the sense of bodies kind of pushing beyond that, so this idea of high with, high was the highest point, and then this like [heavily stylized enunciation] ar~ti~cu~la~tion low. Yeah, it gives you, it kind of embodies a whole way of think about, it not being a transition. So look, my energy is. This is a key-frame, the energy is clear, this is clear, the energy is here. When I do that, the energy between is not really.

I: OK, so was the sound meant to represent the energy or was the sound representative of tempo?

C: I think there's something to do with pressure.

I: Pressure?

C: pressure of action.

I: OK. Of dynamics?

C: yes, it's something to do with what. IT's the difference between me just thinking just the position and the position, and kind of likeness in between, and using your

I: yes, yes,

C: using the whole interpolation to say something. SO, yeah, so

I: So, yeah. SO What? [laugh]

I: I'm OK. What does it have to do with your thematic elements?

C: what does it have to do with my... Well, at that moment, I mean I I don't remember.

C: it doesn't

C: well... It does have anything to do with your thematic elements?

I: you're working with the shape and what was opportunistic at the time!

C: yeah, yeah, I guess

I: would you think you'll ever remember it in terms of the [sound] ua-oh-ahhh?

C: well, only if I see that they are not doing that. I can see the difference between this and this.

I: yeah, but, when you. Have you taken anything from that yet? Or is that just like stuff that is supposed, that they're supposed to remember?

C: yeah, they just remember it.

I: so you're letting them remember it?

C: yeah
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