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COVER SHEET

Motion, Music, Mediation: Bridging Tradition and Technology in Swedish Folk Dance-Music

Olof Misgeld

Abstract:

This exhibition presents an investigation into the folk music and dance practice polska, involving a group of Swedish folk musicians and dancers. The investigation employs optical motion capture (mocap) to explore interactive music and dance performances and create innovative artistic expressions by merging traditional practices with contemporary media technology. As a musician working closely with the dancers he plays for, the author explores ways to mediate dance through the sonification and visualisation of movement data. The focus is on the fundamental connection between sound and movement in this performance practice, particularly showcased in the project's centrepiece, *Dancing Dots*. Documentations of this and other works included in the exhibition present live music and dance with sonic and visual displays derived from mocap data, asking how such multi-modal mediations can facilitate understanding of the interplay between movement and music and open new avenues for artistic expression in this folk music practice. The use of optical motion capture is contextualised as a means of mediating music-dance through narrow streams of movement data, and the exposition introduces a web tool for accessible sonification of folk dance. The exposition applies music and dance theoretical concepts in designing the movement mediations, examines their relevance in an artistic context, and grounds the results in a practice-based understanding of the rhythmic/metric framework of the Swedish polska.

Keywords:

folk music, Folk music education, folk dance, polska, mediated dancing, sonification, motion capture, spelmansmusik, traditional music, visualisation

Published in: Journal for Artistic Research (JAR), Issue 35 (2025)
<https://jar-online.net>

URL: <https://www.researchcatalogue.net/profile/show-exposition?exposition=2274627>

DOI: <https://doi.org/10.22501/jar.2274627>

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Motion, Music, Mediation: Bridging Tradition and Technology in Swedish Folk Dance-Music

Olof Misgeld

Video description: A video recording entitled *Dancing Dots*, described by the author as a 'video abstract'. A montage juxtaposes documentation of dancers and a musician performing at a public event on the one hand and performing in motion capture suits in a studio on the other. These are overlayed with motion capture data visualisations and accompanied by music and sound. Concept and music: Olof Misgeld; dance: Ami Dregelid and Andreas Berchtold; sound and light: Hadrian Prett; camera: Josefin Pedersen, William Zakrisson; technician: Alfred Gefvert.

Click on <https://www.researchcatalogue.net/view/2274627/2468058#tool-3743407> to watch the video.

Introduction

This exposition presents the outcomes of a research project, where I, as part of a group of Swedish folk musicians and dancers, use optical motion capture (mocap) as a tool to explore our joint performance and to create new artistic output by combining traditional practice with contemporary media technologies. As a musician who plays for dancers and works in collaboration with the dancers I play for, I explore ways to mediate *polska* dance through the sonification and visualisation of data captured from the moving bodies. The exposition centres around live folk music and dance combined with sonic and visual displays of movements recorded from our performances in the mocap studio. I view such combinations as additional interfaces for exploring the tacit knowledge situated in the interactive polska music–dance practice and for the artistic purpose of extending the traditional art form into new forms of expression.

The research addresses two key questions: how movement sonification and visualisation can illuminate the articulation of polska rhythms in dance and music, and how such mediations can

create an augmented experience of the polska music–dance interplay in performance contexts beyond the participatory social dance. Approaching these questions, this exposition engages with the mediation of mocap-recorded dance as a novel interface for experiencing the rhythmic-metric framework in polska music and dance. The methodology involves conducting and documenting performances in the mocap studio, designing sonification and visual displays of movement data and evaluating such mediations through interactions within the polska music and dance practice.

The primary perspective of the research comes from my role as a dance musician, for which I am solely responsible for designing and conducting the research and interpreting the results. However, the dancers' contributions involve their co-creating in performances, providing their recorded movement data, reflections, and interview responses at various stages of the research. Although music is the dominant perspective, the outcomes therefore shed light on a shared, interactive music and dance practice. The investigation focuses on the fundamental connection between sound and movement. Previous works (Misgeld and Holzapfel 2018; Misgeld, Holzapfel, and Ahlbäck 2019; Misgeld and others 2021) have used music and dance theoretical concepts by Ahlbäck (2003) and Blom (1981; 1993) to analyse such music and dance interactions. These analytical concepts are here utilised in the design of movement mediation and applied and tested in an artistic context.

Optical motion capture (mocap) is a technique that uses infrared cameras to record the positions of reflective markers placed on bodies and objects. In the entertainment industry, mocap is frequently used to project the performance of human actors onto virtual characters, thereby imbuing digital creations with the elusive authenticity of actual human performance. In contrast, this work builds on our ability to recognise human actions even when they are mediated through limited streams of movement data, such as single marker movements on a dancing body. A previous study (Misgeld, Holzapfel, and Ahlbäck 2019) examined how musicians can align their playing to point-light visualisations of selected dance movements displayed on a computer screen; I here apply these findings to visualise and sonify dance movements in an artistic context.

Sonification encompasses a broad range of practices for translating data into sound (Hermann and others 2011; Dubus and Bresin 2013), including utilising the human capacity to detect time-based patterns in acoustic signals. Sonification applications are typically influenced by the intent of conveying data relationships in forms that align with specific purposes. For instance, somatic sonification (Giomi 2020) represents interactive sonification practices that seek to enhance embodied awareness in physical activities, such as dance, sports, or rehabilitation. In artistic contexts, sonification can refer more broadly to generating sonic output from data for diverse artistic purposes (Polotti and Goina 2021). In this work, I use sonification to create transparent mappings from movement data to sound, facilitating the experience of movement and sound interactions in the context of folk music and dance. The tool SonifyFOLK (Misgeld, Lindetorp, and Holzapfel 2023), designed for accessible sonification of folk dance movement data, serves as the basis for all sonic outputs in this exposition.

By analogy with how dance-music denotes forms of music intended or performed for dancing, one could imagine the term music–dance for dancing strongly connected to particular forms of music performance, such as with the Swedish polska. This exposition revolves around the performance, *Dancing Dots — The Exhibition* (first performed 14 September 2022), which showcases a combination of live music and dancing, along with sounds and light displays generated from dance movement data captured through optical mocap. In the piece *Dancing Dots*, sonified polska dance is treated as dance-music — by listening, dancing, and playing to it in ways reflecting the traditional forms of the practice. With these performance interactions, the aim is to develop new ways of artistic expression in Swedish folk music and dance and, through the mediation of dance movements into digitally created sound worlds, offer new entrances for experiencing this art form. As such, this bridging across performance contexts involves hybrid forms of pre-recorded, mediated, and live performance, whereby the roles of interaction in the traditional setting are challenged, and the traditional, participatory polska dance is staged in an immersive performance space and extended visual/sonic landscape. Thus, the project’s overarching theme is to explore concepts for an open-ended development of artistic expression with traditional practice both as a departure point and a primary source of inspiration.

The exposition is organised into sections covering various aspects of the project. ‘The Video Abstract’ gives a non-verbal overview of the process and performative results.

The ‘Polska’ section provides historical context and explains essential concepts related to the dance and music, such as *svikt* and asymmetric beat. ‘Towards a Mediation of Dance’ presents a background on transmitting and interpreting dance through sonified motion capture data. ‘Sonification — From Motion Capture to Dance-Music’ explains the process of collecting, selecting, and processing movement data, mapping data to audio, and interpreting the sonic results with examples of playing to dance sonifications. The ‘Visualisation’ section displays animations of the same data selection used in the sonification and discusses how these visualisations relate to the polska dance. The ‘*Dancing Dots — The Exhibition*’ section showcases various approaches towards combining live dancing and playing with sonified/visualised dance in the documentation of performances. Finally, the ‘Discussion’ section summarises and discusses the project’s results.

The participants in this work, including the author, the dancers Ami Dregelid and Andreas Berchtold, and the musician and sound/light artist Hadrian Prett, are established performers and pedagogues in the Swedish folk music and dance community and employed within central educational institutions in the field, such as the Department of Folk Music at the Royal College of Music in Stockholm (KMH), the Folk Dance Education at Uniarts in Stockholm, and the Eric Sahlström Institute in Tobo, Uppland, Sweden. The research was conducted as part of the doctoral project ‘Music-Dance Mediations — Performative Explorations into an Asymmetric Type of the Swedish Polska’ (Misgeld 2024) at KTH Royal Institute of Technology, Stockholm, Sweden.

Image description: A colour photograph shows a performance of *Dancing Dots* at the FLOCK Scendansfestival, Falun, Sweden, on the 17th of September 2022. A live audience surround the central performance area and the dancers musician and sound/light artist are

visible. Photo: Håkan Larsson.

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[The Polska →](#)

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The Polska

Historical context as inspiration for the transformation and augmentation of a living tradition

This work is grounded in the traditional Swedish folk music practice, *spelmansmusik*. Like many other traditional music cultures, *spelmansmusik* and dance are interconnected practices influenced by music and dance forms passed down and adapted over centuries across the European continent (Ramsten 2003; Gustafsson 2016). This relationship between dance and music has undergone ever-changing performance contexts: from sixteenth-century court dances; to rural ceremonial wedding dances; to the choreographed national-romantic ballets of the nineteenth century; the folk dance teams movement emerging in the twentieth century; the folk revival of the 1960s and 1970s seeking to reconnect dance with practices and repertoires of rural society; and the emergence of a dance house movement intending to revive a social dance practice linked to the ongoing revival in folk music. Today, the social folk dance practised with live music thrives at folk music festivals, fiddlers' meetings (*spelmansstämmor*), and concert venues in the Nordic countries and exists in parallel to folk dance groups with more historically informed or staged folkloristic approaches (Nilsson 2011). With the folk music revival came a demand for courses and education, and since the mid-1970s, folk music performance programmes have been introduced at several higher music education institutions in Scandinavia. Folk dance has also been included in higher dance education in Sweden since the 1980s, which has led to the development of folk dance pedagogy and contemporary dance works by choreographers influenced by their background in folk dance (Öberg and Ruth 2023).

Video description: A black and white archival video recording entitled *Gammelpolska från Orsa*, shows couples dancing the polska; dir. by Johan Larsson and Ingvar Norman, 1947 (Norman and others 2000).

Click on <https://www.researchcatalogue.net/view/2274627/2468064#tool-2468070> to watch the video.

The polska style

Most of today's Swedish folk dances are based on documentation of single tradition-bearers recorded by amateur collectors during the twentieth century (Helmersson 2012). In 1947,

fearing the local polska dance was dying out, dance enthusiasts Johan Larsson and Ingvar Norman gathered dancers and fiddlers for a documentary film (Video 1) in the small town of Orsa, Dalarna, Sweden. The film is a staging of a dance event in old times, in the old village hall and with all participants in traditional clothes. The purpose of documenting the dance practice can be noted by the camera gradually focusing on the dancers' feet. The film is without sound, but the fiddler seen in the film — Gössa Anders Andersson (1878–1963) — is well documented in over one hundred recordings and is one of the twentieth century's most influential musicians in Swedish folk music. The film's seconds of joint dancing by the older couple Back-Kersti Eriksson (born 1886) and Erik Sköld (born 1873), together with the recordings with fiddler Gössa Anders are a great inspiration for this work — their timing, qualities of movement, tone and tonality. The polska didn't stop with them, and their performance shines through layers of time, space, and later interpretations. These archive recordings represent performances with the recorded sound of Gössa playing and the visual recording of the dance. Our exploration of auditory and visual renderings of dancing and playing establishes an imaginary layer of how the dance in the historical film could have sounded and, conversely, how the sound of Gössa Anders' playing could have been visualised.

Score description: A black and white image shows a transcription of 'Polska efter Pellar Anna' performed by Gössa Anders Andersson.

Click on <https://www.researchcatalogue.net/view/2274627/2468064#tool-2469106> to see the score.

Audio description: An audio recording of Gössa Anders Andersson performing, *Polska efter Pellar Anna* (Caprice Records 1995); duration: 01:48.

Click on <https://www.researchcatalogue.net/view/2274627/2468064#tool-2468073> to listen to the audio recording.

Since its introduction in the sixteenth century, the polska has evolved into a variety of forms in the Scandinavian countries, most commonly played in three-beat metre. The polska in the style of Gössa Anders Andersson is often asymmetric (Ahlbäck 2003), with the three beats taking on uneven, short–long–medium proportions of a measure. This asymmetry is not fixed and usually the proportions of the three beats vary across different parts of a tune (Misgeld and others 2021), which is reflected in the above notation by the beaming of rhythms either as 2+4+3 or 3+3+3 sixteenth-note groupings.

Svikt

Scandinavian folk music researchers have highlighted the importance of understanding rhythm and metre in relation to movement. The concept of *svikt* plays a crucial role in this context. Svikt was first defined by Norwegian ethnomusicologist Blom (1981; 1993) as the vertical movements of the body's centre of gravity resulting from the weight-carrying leg's

stretching and bending movements. Therefore, svikt patterns arise owing to the elasticity of the gait during the dancer's footwork, and svikt cycles correspond to the rhythmic and metric elements of music and dance types such as waltz, polska, *springar*, and *halling*. Svikt has become a central concept for characterising Scandinavian folk dance styles and describing how dances connect to the music's metre (Bakka 1991). Blom's findings, based on his observations of Norwegian traditional dances like the Telespringar, have been replicated in studies using optical motion capture (Haugen 2014) and force plates that register the dancers' steps (Mårds 1999). Such measurements are relevant for how svikt patterns can be attributed to musical beats (Kvifte 1999) and the physical experience of force and weight shifts during dancing.

Describing the dance

The following description of the polska dance is intended for understanding how the sonifications and visualisation connect to the mechanics of movement during the dance, and should not be interpreted as a definite account of how the dance should be danced, nor as valid ethnographic descriptions of this polska dance. The perspective is my own as a musician observing the dancers Ami Dregelid and Andreas Berchtold, for whom I play. To this end, I also include short phenomenological accounts of my experiences of these interactions. These include wordings borrowed from the dancers Dregelid and Berchtold, including my interpretations of terms invented by them. Video 2 of our performance, including mocap data animations, illustrates these descriptive accounts.

Traditionally, the roles of couple dancers have often been related to gender. In contemporary social folk dance, gender-neutral terms that are more functional for understanding the joint effort in the couple are often used. In line with this, the following account uses the terms left dancer (LD) and right dancer (RD), decided by the dancer's positions in the couple during the side-by-side promenade part of the dance. These positions correspond to the traditional terms *kavaljer* (male) and *dam* (female).

Video description: A video recording documents the recording process in the PMIL studio at KTH Royal Institute of Technology in Stockholm and includes animations of the mocap data. The data from this recording were sonified and visualised in the *Dancing Dots* performance.

Click on <https://www.researchcatalogue.net/view/2274627/2468064#tool-2468316> to watch the video.

The dance consists of two main sections, promenade (*försteg*) and turning (*omdansning*), that the dancers alternate between.

Promenade — Försteg

The dancers walk side by side, arms holding, resting on each other's shoulders or backs. They walk around the room in a larger circle, shifting their weight on beats one and three of the

three-beat cycle of the polska. The walking results in a vertical oscillation, or bounce of the dancer's centre of gravity — svikt. Between walking mainly with the left foot on beat one and the right foot on beat three, the right foot swings on its way towards beat three. This motion helps to articulate another svikt on beat two, resulting in three svikts for each measure. The dancer Ami Dregelid refers to this as swinging the 'air-leg' (*luftben*), the leg currently above the floor.

As a musician, I interpret svikt as the dancers articulating the beat by balancing their body gravity, just as the fiddler articulates the beat with balanced bow movements. Watching the svikt connects to the rhythmical timing of the music as played by Gössa Anders; the slight lift in each svikt before landing on the next step connects with up-beats in the music, e.g. in the short tone in long-short melody rhythms on the third beat of the polska; the dancers' concise weight shifts with Gössa Anders' clear articulation of the first beat; the small bounce on the second beat with the alert timing of the slightly asymmetric metre. This connection is somatic and immediate, felt in how the arm weight relates to up–down bowing in accordance with the gravity of the dancing body and as a cue for the articulation and timing of notes.

Turning — Omdansning

The dancers rotate or spiral forward around a shared axis, face to face but slightly side-shifted, holding with both arms around the partner's back and upper arms. The dancers turn a full circle in one measure, alternating stepping on each of the music's three beats (LD steps on beats two and three and RD on beats three and one). The svikt pattern in the rotation differs from the promenade, with two svikt per measure instead of three. The first svikt describes one vertical oscillation during beats one and two, and the second svikt is faster, with one down–up movement during beat three. The turning takes the form of a springing rotation, with the dancers taking turns stepping forward and backward around each other. When one dancer takes a step, the other follows the rotation, standing on the heel or ball of the foot. Although the dancers have different stepping patterns, both the rotation and svikt is thereby synchronised as if the dancers are forming one unit — what Dregelid calls a four-legged dance-animal (*dansdjur*). The turning follows the metre so that the second beat is articulated through an acceleration of rotation speed.

The intricate movements involved in the turning are fascinating to watch. There are many layers of movements to follow, such as the feet, legs, backs, shoulders, and heads. One can choose to follow one dancer's movement or watch the couple as a unit. One particular step pattern involves an accelerating left foot on the second beat by the left dancer, followed by a firm landing on the one by the right dancer. The view changes based on the dancers' proximity, direction, and angle as they move towards, away from, closer to, or further away from the observer in the room. The physicality in the shifting provides the turning with a firm resoluteness of bodies with real weight moving and pushing their balance. It creates a feeling of unstoppable thrusting, throwing, and catching, yet with a delicate balance. The continuous movement offers many entry points to connect the phrasing of the music to the ongoing rotation. This way of rotation inspires firm note and beat articulations using distinct bow speed and direction changes.

Towards a Mediation of Dance

This section provides a background addressing topics relevant to mediating dance through sonification, and for combining such mediations with live folk music and dance performance.

Mediation and liveness

Auslander (2008) criticises distinctions between live and mediated performance from only spatial (co-presence and absence) and temporal (simultaneity and anteriority) variables, arguing that the concept of liveness itself is unsettled and subject to historical redefinition in relation to technological development. Hybrid events with live, and otherwise, recorded and technologically mediated elements are now commonplace in both mass-media and popular concert settings and continuously shape our expectations and perceptions of what counts as live performance. One example of such hybrids is the notion of ‘live recording’ often used to represent a recorded concert performance or music produced by musicians performing simultaneously in a recording studio. Liveness may thus be viewed as an affective experience rather than an objective category. Going to the roots of the concepts of ‘technical’ and ‘mediation’, Auslander concludes that ‘there can be no such thing as technologically unmediated performance because performance is itself a technology and the idea of a performance is a mediation that shapes audience identity and perception of an event’ (117). Such critique opens the possibility of considering how various technological mediations shape our perception and understanding of the world (Rosenberger and Verbeek 2015).

As one aspect of mediation, in *Dancing Dots*, dance movements recorded from a previous live music–dance interaction have been sonified, and these sonification recordings are used with live music and dance, forming a hybrid event of live and pre-recorded performance. The motivation of the piece is to bridge across performance contexts and to expand the social dance — which entails a live interaction — into an immersive visual/sonic performance space. This is attempted through augmented movements aiming to provide the spectator/listener with a heightened impression of the musical qualities embedded in the dance. The paradox the performance is facing is that, despite the pre-recorded character of the sonifications, they are intended to create a heightened experience of the ‘liveness’ of dance and music interaction, in which the hybridity of performance itself challenges the live interaction.

A second aspect of mediation entails the ongoing processes of reproduction, reviving, and reinterpretation that make a music tradition. Rosenberg (2019) examined how ways of transmission affected the stability or variation of aspects of a song performed over time. These aspects — ‘the singer’s imprint’ — were found to be influenced by the learning context, whether it was directly from a performer, a sound recording, or a written music notation.

Traditional/folk music performances carry references to previous musicians — and it is common for practitioners to relate their practice to historical sources. In this way, traditional music performance involves a mediation of previous practices and can be seen as interactions between current and historical performances. Fredriksson (2023) studied recent performative uses of archive recordings in contemporary Swedish folk music that reveal such interactions — what Fredriksson calls ‘musical wormholes’ that augment the processes of tradition between past and present performers. In *Dancing Dots*, the influences of historic performers are not explicitly displayed but are present in the choice of music and dance. Still, an earlier recording provides background for performing other elements, tunes, and improvisations beyond the original recording. This hybridity between past and present, live and pre-recorded, becomes the space for negotiating the liveness of the performance.

On the motion capture imaginary

The challenge, lying at the centre of the transposition of body-centred to data-centred transmission, is to make digital renderings of dance data accessible and intelligible. This emerging research requires a new analytic approach to dance that is not readily available in existing dance literature.

(Karreman 2017: 83)

Photography of this sort might be better understood as a device for translating the unseen or unseeable into something that looks like a picture of something that we could never see.

(Mitchell, as quoted by Karreman 2017: 101)

In her thesis, ‘The Motion Capture Imaginary: Digital Renderings of Dance Knowledge’, Laura Karreman (2017) discusses motion capture (mocap) as indexical traces of movements. Drawing on semiology, such digital footprints are connected to, without sharing any other similarity with, the object they refer to. Mocap data generally consist of vast amounts of numeric data. However, rendered as a sensory output, such data can ultimately ‘bring out the kinaesthetic properties that are strongly associated with (i.e.) dance’ and, as such, gain an ‘indexical authenticity’ (121). Karreman points out that mocap practices inherited paradigms from their precursors, photography and film, and she discusses problems of optical bias, staging, and dimensionality. Just as photography has offered visual evidence for what lies beyond the capacity of the human eye, mocap promises an unveiling of the unseen by the possibilities of capturing movement and replaying it in multiple spatial angles, dimensions, and scales. Like the development of photography, mocap is conditioned by technical limitations that require careful staging.

Against a presumed indexical authenticity of mocap it stands that, for most renderings, mocap data are processed, smoothened, and manipulated to be then projected on virtual bodies. In the film and media industries, this has affected labour conditions, with the development of new roles, such as performance capture actors that provide performance data for further creative digital post-production. The sharp relation between sign and referent can thus become vague and ‘flickering’ as new hybrid forms of performance develop. Furthermore, doubts can and have been raised about the extent to which data from markers of the surface of dancers’

bodies offer an epistemological entrance to dance knowledge of the ephemeral and embodied experiences of dancing. Karreman describes the uses of motion data in conceptualising and abstracting choreographic ideas and principles, exemplified by Forsythe's *Synchronous Objects* (2009), which visualises structures and forms in choreography. Through this and other works, Forsythe established the concept of choreographic objects, intended to communicate the thinking in movements across disciplines. In a related way, the present approach aims to communicate dance by abstracting sounding musical objects through movement sonification.

Mediating dance through sound

Compared with most renderings of mocap data, sonification adds another layer of mediation by converting optically registered movement into sound, which follows a mediation from the visual into the auditory domain. Karreman's work ignores auditory renderings of motion-captured dance; still, her topics are relevant for the sonification of motion-captured dance. This pertains to sonified movement data as sonic traces of movements. Sonification of recorded markers transfers an optical registration into a sonic modality. The sound design and parameter mapping in such transfer are bound to influence the perceived 'indexical authenticity' of these sonic traces. Sonification of movements can take advantage of the fact that human cognition is conditioned by our somatic presence in the world, allowing us to sense the physicality and presence of beings and objects across all sensual modalities. Cross-modal and multi-sensory perceived loops between movement and sound are also prosaically embedded in the practice of folk music and dance: dancing and playing entails seeing and feeling movements through fingers, arms, feet, legs, weight, touch, vibrating strings, bows, etc. Renderings of movement as sounds therefore easily tap into the bodily practices of dancing and playing.

Rosenberg (2021) investigated collective methods for improvisation, creativity, and flow from within a 'cognitive frame' of folk singing. This cognitive frame is shaped by the stylistic expressional features of folk singing, contained in the oral/aural character of the tradition: modes of variation, tonality, relations between spoken language, rhythm, and articulation, etc. Similarly, a music and dance style can work as a cognitive frame for an embodied understanding and creative exchange of impulses and responses in movements and sounds. Sonified dance might offer additional affordances for understanding the components of such agreed interpretations by investigating the conditions for experiencing music and dance through the same auditory modality.

A key question for this project is how to use sonification to create a meaningful experience of mocap dance data. Two perspectives can be used to understand the sonification design and interpretation of the sonic results, both related to music and dance practice. The two perspectives are not mutually exclusive and can be used to better understand the variety of possibilities with dance sonification.

The first perspective focuses on how sound renderings become meaningful through an embodied understanding of dance movements. Like Giomi's (2020) exploration of somatic sonification in dance pedagogy, this perspective relies on the embodied experience of movement, which Dregelid refers to as '[Gerör](#)', in connection to qualities in the dance style. As an example, Dregelid stated on dancing to a sonification (see Video 3, 0:05–0:10 and 1:00–

1:10) created by white-noise generators mapped to feet data:

With these wind-like sounds, I get a strong inclination for rotation, for the horizontal body movements, and for the shape and speed of how we rotate in the dance. I feel this in contrast to dancing with your live playing when I sense movement in all directions. (Dregelid 2023)

She compares the specificity of the qualities communicated through this sonification to the diversity of movements afforded her by real, live music.

Video description: A video recording entitled *Dancing Dots*, described by the author as a 'video abstract'. A montage juxtaposes documentation of dancers and a musician performing at a public event on the one hand and performing in motion capture suits in a studio on the other. These are overlaid with motion capture data visualisation and accompanied by music and sound. Concept and music: Olof Misgeld; dance: Ami Dregelid and Andreas Berchtold; sound and light: Hadrian Prett; camera: Josefin Pedersen, William Zakrisson; technician: Alfred Gefvert.

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The second perspective focuses on how the sound renderings become meaningful within the musical context of the polska. This perspective relies on knowledge of the music and dance style and can, to some extent, be represented by music theory concepts of rhythmic, metric, and tonal relations. In the Video Abstract, two sonification approaches that were created and motivated by the music are presented. The first approach (see Video 3, 1:30 onwards) uses the maxima of downward velocity, captured from markers on the dancers' backs, to trigger distinct notes tuned with the music. This sonification was chosen because these trigger points were found to be in time with the beats of the music, and the mapping to shorter sounds aimed to bring out this relation as a music phenomenon. However, in interviews, Dregelid and Berchtold stated that these shorter, distinct sounds felt less suggestive for their dancing as compared to the other sonifications (Berchtold 2022; Dregelid 2022). The second sonification approach (see Video 3, 1:45) uses modulated looped fiddle samples sent through a bandpass filter, narrowly tuned in steps conforming to frequencies of partials of the fiddle tone. This sonification creates a continuous, drone-like sound, with embedded arpeggios of overtones because of the frequency of the bandpass filter following the vertical position of the dancers' back markers. This sonification brings out the continuous svikt patterns and creates a soundscape fitting the music's tonality and metre. This design offered multiple interpretations to the dancers without inducing the specificity of a particular movement. Both these sonification approaches provided stylistically functional accompaniments for the fiddler, as illustrated by the fiddle improvisations at the end of the video abstract (Video 3, 2:35).

Sonification of movement can thus serve various objectives depending on purpose, ability, and practice. For a musician attempting to play music to a sonification, there may be a need to extract rhythmic and metric clarity, focusing on movement points that synchronise with beats in the music. For dancers, it may be interesting to experience the speed or arc of a movement,

potentially favouring different types of sonification, i.e., continuous sounds. For a student seeking an understanding of the mechanics of the dance, the synchronisation of steps in the rotation can be the goal, while a more music-oriented perspective seeks an understanding of how such synchronisation relates to music metrical structures. Mocap dance data typically contain noise, along with unstructured and redundant parts, which usually require filtering and smoothening depending on the desired outcome. Taking into account these processes, along with aesthetic preferences and modes of mediation, the sonification of movement can assume a variety of sound forms and provide numerous simultaneous outcomes, interpretations, and interaction possibilities, of which this project can only skim the surface.

[← The Polska](#)

[Sonification - from Motion Capture to Dance-Music →](#)

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Sonification - from Motion Capture to Dance-Music

This section provides a detailed account of the process of sonifying the polska dance. The aim is to critically deconstruct this process to offer insights and results, as well as to illuminate performance strategies. The narration begins with the performances in the motion capture (mocap) studio, followed by the selection and processing of data, and the mapping of movement data to sound. Examples of sonifications are examined in detail, focusing on their rhythmic and metric features in relation to the dance movements. Finally, I include recordings of my fiddle playing to demonstrate sonifications that illustrate the musical rhythms emerging from the movement sonifications. The section thus draws a full circle from playing for dancing in the mocap studio to performing with the sonifications of dance movements.

Image description: A colour image shows three performers wearing motion-capture suits in the PMIL studio at KTH. Photo: Petter Berndalen.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2475330> to see the image.

In the mocap studio

Over the course of four years, 2017–21, I spent repeated sessions in the mocap studio, recording myself playing fiddle for the dancers Ami Dregelid and Andreas Berchtold. At the beginning of this project, these sessions involved more musicians and dancers; however, COVID restrictions limited the recordings to this closer group. I conducted about six sessions recording various dance types — such as polska, *springlek*, and *schottis*. Through these experiences, I gradually developed a method for recording in the mocap studio.

Running a mocap session involves many steps and procedures that can be overwhelming: preparing the studio, learning and managing the software, calibrating a mocap space, setting up additional sound and video recording, ensuring markers and Velcro suits are in order, monitoring and running recording software, and cleaning, labelling, and exporting files. By mastering these steps, I gained some competence in performing this myself; however, acting and thinking simultaneously as a musician, researcher, and technician was exhausting. Engaging a technician to manage the recordings during our sessions made a significant difference in my ability to concentrate on the actual performance practice I wished to investigate. An emerging question within our group was how to capture ourselves performing at our best level. We all had experiences while performing that we would describe as

becoming more connected, grounded, in time, relaxed, open, able to let go, effortless, and so on. One of us articulated it as remembering ‘how to do it’. We identified this as a shift occurring recurrently during repeated performances in longer sessions when teaching dance in groups. Similarly, we agreed that these experiences were generally accompanied by a sense of intertwinement between music and dance, of affecting and being affected by each other’s performance. We recognised these moments through profound somatic sensations of tension, release, balance, ease and drive.

For such moments to arrive, we needed to become familiar with the conditions of performing in the mocap studio: the room size, the floor, the acoustics, wearing tight mocap suits and Velcro shoe covers and caps, and being monitored surrounded by cameras in a high-technological studio space. We decided to spend at least a whole day in the studio each time to give space for retakes, repetitions, and reflections to allow things to develop. Furthermore, we met online between sessions to review and discuss our last performances. As a method for measuring the quality of our repeated takes during such longer sessions, we collected our individual reactions immediately after each recording. Each participant completed a survey, rating the last performance on a 1–7 Likert scale and scribbling down notes in response to open questions about their performing experience. After filling out forms in silence, we would tell each other our responses and decide whether we would like a new take with the same music/dance or move on to another piece. In these discussions and notes, many practice-specific terms and wordings were used. Many of these were invented by Ami Dregelid (AD) during her decades of pedagogic collaborations with fiddlers like Ellika Frisell, Sven Ahlbäck, and others, including the author.

Some examples:

- *Dansdjur* (dance-animal, the function of the couple as one unit with a shared balance, AD)
- *Stödben* (support-leg, the leg that is currently supporting the balance of the couple, AD)
- *Luftben* (air-leg, the leg that is currently without floor contact, AD)
- *Å-så-hej!* (onomatopoetic for a phrasing leading to the first beat, AD)
- *Sväng-balans* (turning-balance, the way to balance the body’s centre of gravity to facilitate turning, as compared to managing the balance, e.g. when standing, walking, or running, AD)
- *Upptakt* (musical upbeat)
- *Svikt* (Blom 1981)

In retrospect, I see the procedures of performing at our own pace, allowing retakes, reflecting collectively and individually, acknowledging our experiences and using our own language as necessary for making and inhabiting a space for our performance in the studio. The Likert ratings also turned out to be on the upper half or top end of the scale, from medium to exceptional, which confirmed that overall, we were satisfied with our performances.

Image description: A colour image shows two computer screens, one with motion capture software and one with a live video conference call, during a session between recordings.

Photo by the author.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2475342> to see the image.

The mocap recordings

The recordings were conducted in the PMIL studio at KTH, Stockholm, using an Optitrack optical mocap system with 17 infrared cameras. We were wearing mocap Velcro suits with full-body marker setups and markers attached to the violin and the bow. One such complete setup included a total of 110 markers. The mocap system recorded the three-dimensional position of each marker, resulting in three data variables (XYZ) for each marker at a rate of 120 frames per second. Optical mocap requires that markers are visible from at least three cameras simultaneously. Although the studio space was enough for us to perform in, the dancers were occasionally dancing at the outer limits of the area covered by cameras — the motion capture space — resulting in partial marker drop-outs and data loss. The Optitrack mocap system includes a system for automatically assigning markers to a body model, which becomes rendered as moving avatars in the programme's graphic interface. However, the closeness of the dancers in sections of the dance, particularly while turning, resulted in sequences where the automatic body tracking failed, as markers were occluded or mixed up by the system — causing the avatars to assume absurd postures with limbs sticking out in impossible positions. The system provides smoothening and gap-filling functions for interpolating occasional marker data drop-outs. Still, this half-automated procedure of data cleaning would have required weeks or months of manual correction time for one performance only. This motivated me to focus on a manageable subset of the data.

Data selection and processing

From all our mocap studio sessions, the data to be used in the *Dancing Dots* performance was narrowed down to just one of the recordings out of our session: a (highly rated) take of the tune 'Polska efter Pellar Anna' from the fiddler Gössa Anders Andersson's repertoire.

A previous study showed that players were able to align their playing to point-light displays of single markers (Misgeld, Holzapel, and Ahlbäck 2019). In connection with these findings, I extracted a similar set of markers as in the previous study: markers at performers' feet/ankles and between the dancers' shoulders. These markers were chosen as consistent substrates of how the dance expresses the metre of the music: feet markers for capturing steps, transfers of weights, and the player's foot-tapping; back markers for capturing movements at the body's centre of gravity, including the svikt. Tidying up the labelling of these markers was a manageable task, also since their placement on the bodies of the performers made them less prone to drop-outs.

When choosing variables for sonification, I primarily scanned for patterns corresponding to the rhythmic/metric structure of the polska. As described above, each marker had three data variables for its coordinates in three-dimensional space. In addition to this position data, I obtained variables for velocity by calculating the first derivative of each dimension. The movement in the vertical dimension (position and velocity variables) were determined by the

dancers' pacing to the music, connecting to the concept of svikt, and relevant to the expression of metre in polska dance. Furthermore, using the Matlab Mocap Toolbox (Burger and Toiviainen 2013), a derivative of the Euclidean norm vector was calculated to measure each marker's overall movement velocity. This variable represents the speed magnitude of a marker regardless of its spatial direction. This is useful for representing feet and body movements, i.e. during rotation. Therefore, the three movement variables, vertical movement, vertical velocity, and speed, became the focus for mapping with audio in the next step.

Image description: A colour image of a violin with reflective markers, used in the motion capture process. Photo by the author.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2515633> to see the image.

Audio mapping and sonic design

The mocap data were sonified by mapping them to audio generators, i.e., digital instruments including noise generators, samplers, and oscillators with gain, filters, and envelope parameters set to be controlled by the data variables. We implemented these mappings in the web-based interface [SonifyFOLK](#), depicted in Sonification examples 1 and 2 (for a further description of the application, see Misgeld, Lindetorp, and Holzapfel 2023). This tool allows users to try out mapping from movement data to sound parameters through a web browser without installing further software. The design of the digital instruments was guided by considering affordances for playing and dancing with sounds fitting within the framework of the folk music/dance style. This was achieved by trying sonifications with playing, getting feedback from the dancers, and conducting workshops with music and dance students (ibid.).

The audio mappings in the SonifyFOLK prototype interface were kept at a minimal complexity, following the idea of providing accessibility to sonification for non-experts. This means that in general, each variable controls a single parameter of one audio generator, for instance, the pitch of an oscillator or the frequency for filtering white noise. The more advanced sound designs involved controlling amplitude envelope parameters for percussive sounds and modulating overtones of a violin sample. For the *Dancing Dots* performance, these sounds were processed further. Still, the character of transparent movement sonification was maintained, aiming for a playful, energetic, and explorative expression inspired by using a course-grained, straightforward sound synthesis. As the sonifications followed the repetitive dance movements, they provided textures over which the fiddle's melodic gestures and passages contrasted its warmer acoustic timbre to the synthesised sounds. When sonifications involved pitched sounds, these were selected to support the idiomatic folk music-style fiddle improvisations, for instance, using overtones or drones blending into the tonality of the fiddle music. In the sense of such complementary textures, the sonification sounds and live playing thus reflect the dance-music bi-modality, where each part inhabits its own expressive (sonic or spatial) space but interacts within the shared polska idiom. This relation can crudely be exemplified by how musicians and dancers independently can shift between parts of a melody and sections of walking and turning in the dance.

Sonification examples

The following examples will illustrate some resulting sonifications and show how the choice of marker and movement variable affect the affordances for interpreting sonifications with rhythmic-metric features of the music. In *Dancing Dots*, these and other sound mappings were used to compose the full sound design of the performance. This space doesn't allow going into details of all these audio mappings; rather, it attempts to illustrate outcomes of sonifying different dance movements by mapping them to the same parameters of a simple oscillator and a white noise generator.

Sonification example 1: Svikt during promenade and turning

Video description: A screen grab shows *Sonification example 1*, depicting how the number of oscillations per measure changes from 3 to 2 at 0:12, reflecting two different svikt patterns.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2468244> to watch the video.

The vertical positions of markers on the two dancers' upper backs are mapped to two audio units (Noises 1 and 2), both generating white noise that passes through a bandpass filter. The frequency of each audio unit's bandpass filter is controlled by the position data of one dancer. The svikt-pattern changing between turning and promenade sections can be heard as alternating between three and two (one long and one short) oscillations per measure, respectively.

Sonification example 2: The vertical beat

Video description: A screen grab shows *Sonification Example 2*. The graph displays vertical velocity with three oscillations per measure. At 0:12 the pattern becomes more asymmetric.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2468252> to watch the video.

Instead of position data, this sonification uses the vertical velocity variable of the same upper back markers as in the previous example. Short sounds are used to represent the points at which the body reaches its maximum downward velocity. These points indicate the moment while taking a step when the downward acceleration is cushioned by the hips, knees, and ankle joints. Compared to the data used in example 1, the velocity data variable displays three oscillations per measure both during the promenade and the turning. This reflects a shift of

speed during the first, longer oscillation (svikt) in the rotation section. The sonification uses short, percussive tones tuned in two octaves (A3 and A4) and panned to the right and left channels for the right (RD) and left dancer (LD), respectively. In addition, a lower sound (A1), panned to the centre, is triggered by the player's foot tapping (on beats one and three) using the same movement parameter: the maximal downward vertical velocity. The sonification is presented with the original music recording, which makes it possible to hear how these patterns synchronise to the beat.

The patterns are more even/isochronous during the promenade and become more asymmetric during the rotation (00:12 and forward). These changes form an interesting parallel to the music's shifts between an asymmetric 'early second' beat and sections with symmetric beat patterns (Misgeld and others, 2021).

The following Sonification examples 3, 4, and 5 are all sonifications of the dancers' feet, using four data sources: markers on the left (LF) and right (RF) foot of the left (LD) and right (RD) dancers, from which the variable for overall speed was chosen as the data source controlling the sonification. Each data source is connected to one white noise audio generator with a bandpass filter controlling the output. The parameters affected by the data source include the frequency and bandwidth of the bandpass filter and the output gain of the audio generator. The examples contain repeated sonifications of a subset of the performance data: eighteen measures with the dancers in a turning section. The sounds in the examples are crossfaded between looped combinations of different data source sonifications. This setup made it possible to explore the character of different movement sonifications across the same section of the dance. A sonification of the player's foot-tapping (marking beats 1 and 3) at the start of each example is added to give an initial cue to the metre.

In example 3, all parameters are mapped so that higher values in the data source (higher speed) correspond with higher frequency, narrower bandwidth, and a higher gain. As a result, the sound becomes louder, higher in pitch, and more whistling when the feet move at a higher speed.

In example 4, all parameters are mapped inverted to (a) — so lower values in the data source (lower speed) correspond with higher frequency, narrower bandwidth, and a higher gain. As a result, the sound becomes louder, higher in pitch, and more whistling when the feet move at a lower speed.

Example 5 combines these sonifications of higher and lower speed for each marker, resulting in one sound combination for each foot.

Each of the examples includes one sound recording of the sonification and one recording of my fiddle playing to the sonification. Here, I use another tune in the tradition of Gössa Anders: 'Hambraeuspolkan', which is in a similar style as the tune 'Polska efter Pellar Anna' played in the mocap recording session.

The sound waveforms illustrate how the sonification aligns with the polska metre and are presented, from top to bottom, in the order of sounds introduced in each example.

Sonification example 3: Feet high-speed

Image and audio description:

A colour diagram explains feet high-speed sonification. The waveforms of the sounds are aligned to one bar of 'Polska efter Pellar Anna', with a rhythm figure emphasising the short–long–medium asymmetry of the polska metre.

A sound file describes how the sound intensity increases with the movement of the feet at a higher speed. The sounds are introduced in the order of LD–LF (00:05), LD–RF (00:35), RD–RF (01:05), and RD–RF (01:35) and are then faded out in the same order.

A sound recording of a performance of 'Hambraeuspolkan' to the sonification. The author adds the following notes:

These windy, whistling sounds feel light and speedy, anticipating the beat, like swinging movements. In the first part, it is hard to find the position of beats in relation to the sounds. The metric structure becomes clearer further into the examples. At 1:35, when all four sounds are present, a typical rhythm appears for Gössa Anders's style of polska with short–long–medium beat asymmetry: three notes of equal length over the two first beats, with the second beat articulated on the second note, as shown in the notation.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2468270> to see the image and listen to the audio recordings.

Sonification example 4: Feet low-speed

Image and audio description:

A colour diagram explains feet low-speed sonification.

A sound file describes how the sound intensity increases with the movement of the feet at a lower speed. The sounds are introduced in the order of RD–LF (00:05), RD–RF (00:40), LD–RF (01:05), LD–LF (01:35) and are then faded out in the same order.

A sound recording of a performance of 'Hambraeuspolkan' to the sonification. The author adds the following note:

These sounds feel shorter with more of a pumping character compared to Example 3. I get a stronger impression of vertical movement and that the sounds are timed on, or after, the beat. As with the previous example, each sound presents one puzzle piece of the whole three-beat cycle. For example, the sound of the RD-LF at the beginning of the example, emphasises the early second beat through an increase of loudness.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2468278> to see the image and listen to the audio recordings.

Sonification example 5: Feet high- and low-speed

Image and audio description:

A colour diagram explains combined speed sonification.

A sound file describes how each foot marker is sonified using a combination of sounds with increasing intensity at higher or lower speeds. The sounds are presented in the following order:

LD-LF (00:05)

LD-RF (00:40)

LD-LF+LD-RF (01:10)

RD-LF (01:40)

RD-RF (02:05)

RD-LF+RD-RF (02:35)

All feet (02:55)

A sound recording documents the sonification with a performance of 'Polska efter Pellar Anna' and 'Hambraeuspolkan'. The author adds the following notes:

Compared to examples 3 and 4, the combined sounds of speed and inverted speed of each marker project in this example produce a richer rendering of the three-beat cycle, each with different characteristic articulation and distinctiveness. With the sounds of the RD-RF, the second and third beats can be heard more clearly compared to other sonifications. During a 'normal' situation, this small movement of the dancer's right foot during turning can be obscured by an outside observer. As an effect of the sonifications, this detail is here brought forward as a rhythmic component in dialogue with the music.

Click on <https://www.researchcatalogue.net/view/2274627/2468227#tool-2468298> to see the image and listen to the audio recordings.

[← Towards a Mediation of Dance](#)

[Visualisation →](#)

This accessible page is a derivative of <https://www.researchcatalogue.net/view/2274627/3678326> which it is meant to support and not replace.

Visualisation

Although the main focus of this article is on sonification, visualisation plays an essential role during all stages of the project: as animations for exploring the dance movements, for mapping sound to data in the sonification interface, and as material for the light design in the *Dancing Dots* performance.

All single-dot visualisations (excluding stick figures) represent the same subset of markers used in the sonifications. The visualisations are created using relatively straightforward methods of plotting marker positions into animations, which are synchronised with the sonifications and sound recordings. The animations either display markers connected with lines into stick figures, as two-dimensional monochrome dots, or as trails of movement resulting from attaching tails to markers. A characteristic of these plain animations is that they maintain a transparent connection to the data. Still, the viewer is invited to interpret and imagine the underlying movements actively. This is true particularly when markers are displayed without apparent connections to a body part, as single markers or without connecting lines.

Video description: A video file presents data visualisations including dot animations showing the vertical and horizontal movements of the markers attached to the dancers. Accompanying these are stick-figure animations of the dancers and musician. The video is accompanied by music from the visualised performance.

Click on <https://www.researchcatalogue.net/view/2274627/3678326#tool-3747501> to watch the video.

The vertical movements of upper-back markers reveal repetitive, periodic bouncing in sync with the music, with continuous, subtly shifting pulsations. The same markers viewed horizontally, with motion trails, resemble worms meandering in looping paths.

Video description: A video file presents data visualisations of the movements of the dancers' feet, shown as motion trails,

Click on <https://www.researchcatalogue.net/view/2274627/3678326#tool-3747514> to watch the video.

Switching to a viewpoint from above unveiled figurations and geometrical figures — stars, circles, petals — drawn by the rotations, the turn-taking, and the alternating foot movements in the couple.

Video description: A video file presents data visualisations, with an overhead view of the movement of the dancers' feet, shown as motion trails, and dots describing the movement of the performers' back markers.

Click on <https://www.researchcatalogue.net/view/2274627/3678326#tool-3747520> to watch the video.

Dancer Andreas Berchtold described figures plotted from overhead as confirming and strengthening his inner images of rotation techniques — an example of how the emerging shapes connect to the embodied experiences of dance movements. Similarly, the plots of foot markers show how the dancers adjust their pacing speed according to their position in the couple and the rotational feet patterns illustrate shared balancing and turn-taking in the couple rotation.

These patterns are valuable to make an embodied knowledge of dancing become more tangible. More so, the intrinsic qualities of the mediated movement gestures, with their distinct characteristics of speed, shape, and timing, lend themselves to musical interpretations.

For the performance *Dancing Dots*, point-light animations were projected using pixel light tubes placed upright in a circle surrounding the space for the performance. In the video clip the light tubes are seen displaying vertically moving points, which have been rendered using data captured from performers' feet. The point in the light tube to the left of the fiddler distinctly drops down on the polska beats one and three; this point-light was rendered from the player's foot tapping. The point in the light tube to the right of the fiddler drops to beat one and reaches the highest point on beat three, resulting in only one oscillation per measure. This second light was recorded from the left foot of a dancer. Both lighting patterns stay slightly on beat one before moving up again, again with slightly different characters: a distinct lift (the player's foot tapping) or a more sweeping, continuous motion (the dancer's foot).

It is not far-fetched to relate such gestures to bow movements and articulations: patterns of speed, pressure, and hand movement trajectories. However, in the video passage, the fiddler is not copying the light movements but, instead, plays complementary notes on beats two and three, contrapuntal to the lights marking the first and third beats. Such dialogue between the visual and the sonic can be seen as mimicking relations present in the polska dance/music interplay, where a beat can be marked by the dancing but be silent in the melody.

Video description: An excerpt from a video recording of *Dancing Dots* (performed on the 14th of September 2022).

Click on <https://www.researchcatalogue.net/view/2274627/3678326#tool-3747544> to watch the video.

← [Sonification - from Motion Capture to Dance-Music](#)

[Dancing Dots - The Exhibition](#) →

This accessible page is a derivative of <https://www.researchcatalogue.net/view/2274627/2468100> which it is meant to support and not replace.

Dancing Dots — The Exhibition

The idea behind *Dancing Dots – The Exhibition* (Misgeld, Dregelid, Berchtold, and Prett 2022) is to create an augmented experience of the polska through an immersive light and sound world created as an extension of the music and dance interplay. This entails extending the social participatory dance experience into a staged dance-concert performance. As described in other parts, the movement data was captured from an earlier recording - thus, in *Dancing Dots - the Exhibition*, Andreas Berchtold and Ami Dregelid are dancing to, and I am playing to, renderings of our own previous performance, which are controlled live by the sound and light artist, Hadrian Prett. With the following excerpts (Videos 10–13), various approaches to performing with sonification and visualisation of movement data are illustrated. The next sections include comments from the dancers, discuss implications of performing with the static sonifications and provide additional performance documentation and details of the stage setup.

Excerpt 1: Live dancing and playing

Video description: An excerpt from a video recording of *Dancing Dots* (performed on the 14th of September 2022).

Click on <https://www.researchcatalogue.net/view/2274627/2468100#tool-2468106> to watch the video.

This clip illustrates the foundation of the work in a traditional way of playing and dancing a polska.

Through our repeated co-performances of polska and other dances, we seek a relation as parts of an ongoing conversation in an interplay where both empathic receptiveness and pronounced articulation are key ingredients. With dance and music being complementary, impulses can travel in mutual directions between sounds and movements. To that end, an artistic goal as a musician is to gain an increased sensitivity for dance movements and to continuously explore the expressive variability of the repeated patterns in the dance and the music.

Excerpt 2: Visualisations

Video description: An excerpt from a video recording of *Dancing Dots* (performed on the 14th of September 2022).

Click on <https://www.researchcatalogue.net/view/2274627/2468100#tool-2468112> to watch the video.

Point-light displays of recorded movement data from feet and upper backs are introduced in the light tubes. The dancers are at first dancing in silence to the lights, then followed by my sparse fiddle playing.

When playing for dance, I have a strong visual focus on the dancers. In couple dances such as polska, the rotation is a complex phenomenon; it is possible to find articulations of the beat in different body movements. When playing for dance, I actively choose between strategies in my observation: focus on specific body parts to connect timing to one particular dance movement or adopt a more peripheral gaze, for example, over an entire dance floor. In all instances, the intention of these strategies is to activate a 'listening' to the dancers — to sense their movements kinaesthetically and interpret these sensations musically in my playing. Playing sparsely is a strategy for creating space for the dancers' interpretation to take the lead, to focus the attention on the dancers' phrasing.

Excerpt 3: Sonification, wind-feet

Video description: An excerpt from a video recording of *Dancing Dots* (performed on the 14th of September 2022).

Click on <https://www.researchcatalogue.net/view/2274627/2468100#tool-2468123> to watch the video.

The speed of the dancers' feet is mapped to noise-based, wind-like, non-tonal sounds.

In the first experiments with dancers and sonified dance, it became apparent to me how much the dancers already make sounds: the treading, stomping, rustling of clothes, breathing etc. Still — many movements are in relative silence or are impossible to hear when playing. Sonified dance creates new conditions with the dancing body as a sounding instrument of music. Among many possible approaches to sonifying dance, the sounds are here created from pre-recorded movements. Auslander (2008) describes various hybrids of 'liveness' in contemporary media and popular music performances. Folk music and dance generally have a high degree of liveness — with simultaneous, often acoustic, performances sharing a physical space and moment in time. This performance introduces a hybrid of mediated, pre-recorded dance with live dance and music. With this comes a challenge for performers to refer to the mediated pre-recorded material in our close and immediate interaction.

Excerpt 4: Sonification, svikt-overtones

Video description: An excerpt from a video recording of *Dancing Dots* (performed on the 14th of September 2022).

Click on <https://www.researchcatalogue.net/view/2274627/2468100#tool-2468129> to watch the video.

The sonified data are the vertical movements of markers attached to the dancer's upper backs — representing the dancer's svikt, or 'patterned libration of the body's centre of gravity' (Blom 1981). These data control frequency shifts in narrow bandpass filters that are tuned stepwise to overtones in recorded violin samples. In addition, bursts of shorter sounds are triggered by the crests and troughs in the vertical 'svikt' oscillation.

The resulting soundscape fluctuates with each beat in the three-beat cycle, embedded in an overtone-based tonality common to Nordic folk traditions that serve as a background for my fiddle improvisations. The dancers dance separately and, in their dancing, play with various metric groupings of the ongoing beat.

When playing for dancing, I am motivated to create an inviting space in the music for a dancer. The intention is that such space also becomes a space for a listener to step into, so to speak — so that it opens for listening and musical experiences outside the function of dance music. With the sonification of dance movements, this space becomes inhabited by dance sounds, and playing with these sounding movements opens new explorable spaces for playing for dance.

Comments from the dancers

I conducted individual interviews with Berchtold and Dregelid a few weeks after each performance to gather their experiences. During the interviews, I used recordings of the performances as a reference. The interviews had a semi-structured format and included questions about how the dancers experienced the sonification and visualisations in relation to their dancing. The following quotes have been translated from Swedish. Both dancers stated that sonifications, in general, made great dance music and that they could feel the sounds as movements in their bodies. Dregelid stated: 'I feel it in my sacrum. I can feel my pelvis turning' (Dregelid 2022). Dregelid emphasised how the continuous, wind-like sounds generated from white noise resonated with rotation in the horizontal plane: 'those (shhh) sounds create some really cool feeling of spinning [...] and suddenly I thought about this shawl that Back-Kersti [Eriksson] wears when she dances, which sort of swings out like that!'

The dancers referred to sounds with spatial connotations, such as horizontal, with height, articulated with 'tails', flat or shallow shapes, and that, as compared to the live playing, the sounds emphasised specific spatial movement directions or experiences in the body, 'it [a sonification] reinforces some dimension of something that I think is one of the parts that I get out of when you play the whole tune' (Berchtold 2022). Dregelid also compares with music

when describing a type of sonification sound: ‘They feel a bit spherical in a lovely way, but the tone starts are not as pronounced as when you play’ (Dregelid 2022). When asked in detail about the relation between mediation and dancing in the performance, Berchtold referred to ‘from the start, I recognised that it is us dancing like I’m almost dancing to myself’. He explains further: ‘I listen to it as music and with this feeling that, as I can have with music, it’s not like I hear first and do later or do first and hear later, but [...] it happens together, so I place myself with the sonifications, place myself in the sound, but I hear it as music around the dance’ (Berchtold 2023).

The live interaction was also described as missing when dancing to the pre-recorded sounds. Dregelid referred to sonification sounds as ghosts: ‘So it’s a one-way communication from that ghost then. We are the only ones who should communicate with the ghost and the ghost does not communicate with us’ (Dregelid 2023). Still, the dancers expressed general excitement about how the performance allowed them to interact in the augmented setting. ‘It’s kind of fun because it’s so weird/strange and yet it’s based on you playing for real and we’re dancing our craft like for real’ (Dregelid 2022).

Performing with sonified movements

Performing to the dance sonifications required a focus on interpreting the movement sounds in relation to the underlying musical metre. A risk with adding pre-recorded sounds to a live interaction may be that the live interplay becomes redundant and that performers simply follow a pre-recorded beat before finding a mutual timing through their interplay. To avoid this scenario, we kept the volume of the sonification sounds at a level that would not overshadow the fiddle’s sound. Also, as the fiddler, I was not provided with a support monitor. The intention was to create a room for intense listening, where it would not be too obvious for the performers how to align with the pre-recorded sonifications — forcing us to actively listen, adjust and negotiate our interpretations.

The performance (twenty minutes) featured varying combinations of sonifications and/or visualisations with live playing and dancing. With some of these, it was harder for us to locate the ‘correct’ metric beat in the sequence. At points, we would then drift into phase-shifting the metric beat so that the sonified first beat was danced as the second beat. In discussions during rehearsals, it was decided that these moments were to be acknowledged as alternative ways of dancing to the sonification rather than failures. Considering such drifts as failures illustrates the basic preoccupation with being in time as the basis for the music–dance interaction. However, with more practice and performances, we became more and more confident in learning how to interpret the sounds with the polska metre. During both rehearsals and performance, on occasion we noticed that our joint timing had drifted against the sonifications and visualisations. These ‘failures’ were recognised as a sign that the live interaction remained the strongest tie. As a musician performing in a more static position, I could focus on the light tubes and, from time to time, used these visual stimuli to correct my alignment to the beat — which was then immediately followed by the dancers.

Further documentation of *Dancing Dots* performances

Dancing Dots was performed on five occasions during 2022 and 2023:

1. KMH Lilla Salen, Stockholm, 14 September 2022 (Videos 10–13).
2. FLOCK Scendansfestival, Falun, 17 September 2022 (Video 14).
3. KMH Lilla Salen, 13 December 2022.
4. R1, Reactor Hall, KTH, Stockholm 15 June 2023 (Video 15).
5. Farsta Gård, Stockholm, 17 April 2023, with only the sonification part, which the musician controlled (Video 16).

Stage setup

The stage setup for performances 1–4 placed us (dancers, musician and sound and light artist) on chairs facing inwards around a circle with a diameter of 8–10 metres, outlined by eight vertically standing Astera pixel light tubes. Four speakers were placed in corners outside the circle, projecting sound towards the centre. In addition, a subbase speaker was placed outside the circle. The sonifications were controlled using Ableton Live with Max MSP patched to Resolume, the light programme controlling the point-light visualisations displayed in the pixel light tube. These visualisations were created using the same marker movement data as the sonifications. This staging, like a conventional dance floor setting, allowed Berchtold and Dregelid to dance the polska as they would normally do, on the floor in the centre, while I, as the musician, together with the sound and light artist Pretti, could visually focus on the dancers from the side. The audience was positioned outside, surrounding the circle.

Video descriptions: Three video recordings document performances and rehearsals:

FLOCK Scendansfestival, Falun, 17 September 2022.

R1 — Reactor Hall, KTH, Stockholm 15 June 2023 (rehearsal).

Farsta Gård, Stockholm, 17 April 2023.

Click on <https://www.researchcatalogue.net/view/2274627/2468100#tool-2476015> to watch the videos.

[← Visualisation](#)

[Discussion →](#)

Discussion

Innovative combinations of digital and acoustic sounds are not uncommon in contemporary folk, traditional, and world music, and extensions and adaptations of instruments have contributed to the evolution of the genres in modern times. This work has explored the mediation of motion-captured movement to unveil performance practice and explore new ways for artistic expression in Swedish folk music and dance. An artistic goal has been to bridge across performance contexts by creating an immersive sonic and visual landscape out of a traditional music–dance performance. Sonification of dance becomes a new articulation of the music and dance practice with the potential for developing knowledge and understanding. This way, several results can be identified that are open for further exploration:

New artistic expressions

Sonification of movement opens a previously unexplored interface between dance and music in Swedish folk music, offering new entry points and dimensions for experiencing dance–music interaction and allowing new forms of interactions than in the traditional setup, such as performing to sounds derived from dancing. Movements manifested as sound gain substantiality in the audible domain and become an additional sonic layer to the dance-music. The digital sound worlds created by movement sonification open ways to experience folk music beyond traditional representations with acoustic instruments, tunes, and dances. The sound design in this project aims to maintain essential aspects of rhythm, metre, and tonality in order to facilitate real-time interactions between digital sounds and traditional performance. Furthermore, it exemplifies digitally created dance music with human, flexible, non-quantised timing. With this said, this work leaves areas open for further explorations of fields of tension between electro-acoustic and folk music aesthetics.

Unveiling practice

Sonifications of movement augment patterns in the dance as an audible complement to the metric/rhythmic fabric of the music performance. Such unveiling of previously unheard parts of the practice gives access to new layers of understanding of the music–dance relation, with the potential to inform the practice that it is based on and provide a basis for developing artistic expression.

From my experience as a musician in the present project, the sound augmentation of movements revealed details and relations that may not otherwise have been perceived. Examples are the rhythmic cycles of specific dance movements and the relations between the

asymmetric metre in the music and the dance. Previous research on polska music has shown that variations of the polska metre, i.e. with a more or less asymmetric beat, are usually consistent with rhythmic gestures. That is to say that the degree of asymmetry in polska tunes changes with the melody. With the sonified dance, different rhythmic layers become present simultaneously through sonifying different movements. For example, in turning sections, sonification show more pronounced beat asymmetry. This is not to suggest that dancers do not continuously follow the beat asymmetry of the melody, but that the relation between asymmetric beat variations in music and dance is not simply one-to-one, as if the dancers at all instances would change movements strictly according to the beat variations implied by the melody. Rather these sonifications suggest that the dance and music, at some level, function as repositories for one another, allowing multiple simultaneous rhythmic/metric interpretations within the shared framework of the polska. Such an approach to movement sonification offers musicians additional ways to explore the variability of polska metre with attention to a multiplicity of rhythms in the dance movements. The project's design has been influenced by theoretical concepts in polska music and dance, which have played a crucial role in the aesthetic choices made during the sonification and visualisation processes. For instance, the sonification of position and velocity data explores 'svikt' as an expression of 'asymmetric' polska metre. This exploration found that these and other concepts are valuable tools within this artistic context.

A tool for the arts

Movement data can be seen as a repository with potential for various interactions. In our case, dance movements are captured as data streams, and after processes of calculation, sonification and staging, they are re-mapped onto the bodies of the performers, as they are interpreting the sounds by performing to them. Through the open-ended character of these processes, sonified movement becomes a resource for interactions and interpretations through different practices. Karreman (2017) exemplified how recording technology has influenced performance practice, with actors becoming performance capture artists with the use of mocap in film and gaming. The sonifications in this work are rendered from recordings where the performers were unaware that the data would later be used for generating sound and, therefore, did not intend to adjust movements for that purpose. Recent research on historical performance has studied archival recordings by contemporary players' recordings with early recording technology (Stanović and Billiet 2021). In related ways, sonification of dance movements could be applied to archival recordings for investigations into historical dance practice.

Challenge the performance context/the interaction

In *Dancing Dots*, the pre-recorded dance sonification imposes a temporal grid for the live performance. An exciting result of this is that although the dance sonification sounds were described by the dancers as highly relatable and recognisable, they felt utterly insensible towards their actions — as if coming from a 'ghost'. Upon reviewing our performances, we noticed that our timing sometimes drifted in relation to the sonification and the moving lights. Still, the interaction between the live playing and dancing remained interlocked through these

parts. In interviews, Ami Dregelid contrasts the discomfort of being unsure of her timing with the sonification to feeling how naturally things fall into place when dancing to live music. The interviews with dancers revealed how they simultaneously understood the sonification through recognising their own movements and interacting with sounds interpreted as dance-music and how they, in particular, favoured continuous sound models.

The multidimensionality of these experiences suggests further explorations of the affordances of dance sonification interactions in artistic and pedagogical settings. Although a successful mediation of the embodied experience of dancing was achieved to some degree, the dimension of the live interaction through shared timing resisted bridging the performance context. One route towards overcoming this would be to approach a real-time sonification with a sufficiently low degree of latency. Such an approach would further affect the roles in the interaction by, in effect, making the dancers instrumentalists. Other possible extensions of this work include capturing and sonifying other aspects of movement, such as the distribution of weight, to reach further into the embodied interactions of movements and music. To summarise, the mediation of motion-capture data has offered new perspectives on movement patterns in Swedish polska through abstractions, reductions, and spatial conversions, made accessible in sonic and visual renderings and interpretable through embodied, performative interactions.

Image description: A black and white image depicts a rehearsal in Lilla Salen, KMH. The stage setup, dancers, musician and an open laptop are visible. Photo: Hadrian Prett.

Click on <https://www.researchcatalogue.net/view/2274627/2279040#tool-2515644> to see the image.

[← Dancing Dots - The Exhibition](#)

[Acknowledgements and References →](#)

Acknowledgements

I thank Andreas Berchtold and Ami Dregelid for their invaluable contributions, enthusiasm, and generosity. Similarly, thanks to Hadrian Prett for making the performance possible by developing and controlling the sound and light design. Thanks to Andre Holzapfel and Sven Ahlbäck for their substantial contributions to the writing and Susanne Rosenberg for valuable input. Thanks to Hans Lindetorp for providing the platform and the collaboration in designing SonifyFOLK, which was the initial inspiration for this work. Thanks to Alfred Gefvert for technical support and Petter Berndalen, Josefin Pederson, and William Zakrisson for camera work.

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This accessible page is a derivative of <https://www.researchcatalogue.net/view/2274627/3748667> which it is meant to support and not replace.

Page description: The page creatively introduces the author's experience performing his project, mixing text with still and moving images: data visualisation animations, photographs and diagrams.

Appendix: Score for a Mediated Polska

This text articulates my experiences performing various parts of the project and serves as an additional entrance to the research. It narrates the process of engaging in mediated interactions between music and dance in fragments of texts visually interleaved with images and animations.

1. Music–Dance

Play

Articulate

Listen

Keep at it

Seek resonance

and relaxation

Re-consider Re-take Repeat

Keep on Repeating

Articulate beats

Create swing

Follow

balanced

relaxed shifts.

Lift, let go

with balance.

With dancers

Pendle

Release

Jump

Fall

Throw

Catch

negotiate within the framework,
the tune,
the dance,
the turning,

the turn-taking,
the side-by-side,
the polska.
'Å så hej'

Find togetherness in time!
Find being in a conversation!
Become embedded in each other's listening!
Articulate
Follow
Listen

2. In the mocap studio

Monitor
cameras
and microphones.
Put on mocap suits,
place markers on bodies, fiddle,
velcro shoes and hats.
Cover postures:
limbs, joints, left, right,
up, down,
T-pose

Record

<—>

Perform

<—>

Rate

<—>

Discuss

<—>

Repeat

Review takes

Mark, Select, Label

Re-label

Process data

Fill gaps, smoothen, remove outliers, compute derivatives, reduce framerate

Export — three columns for each dimension, one row for each fraction of time

3. Visualise.

Plot markers

Connect to stick-figure matrix.

Select lines, dots, tails...

Animate.

Consider the emerging

Traces ,

Signifiers,

Dots

Patterns:

pulsations

Circles,

Reductions,

Movements,

Stars,

Dancing

Abstractions,

Flowers...

Watch

Listen

Play with

Move with

4. Sonify

Map sound parameters to movement variables

Code digital sound generators

Select variables: position, dimension, velocity, acceleration, speed...

Explore:

>Try Windlike to speed of feet...

>Try Blipp Blopp to downward velocity...

>Try Overtones to svikt...

>Reverse the order and re-try!

Listen

Truncate

Tune

Scroll

Probe

Scan

Patterns

Articulations

Rhythms

Beats

Feel

Sections

Phrasings

Play with sounds

Move with sounds

....

Try Windlike to the speed of feet, try Blipp Blopp to downward velocity, Try Overtones to svikt.

....

Reverse

Play - Listen - Move

Re-select - Re-map

Re-consider

Adjust

Repeat

Save, Re-save,

SaveSave, Super-Save

Export, Re-export

Write, Over-write

Arrange exported sonifications into sound-scapes

5. Perform:

Book a room, engage co-performers, technician and invite the audience!

Place chairs in a circle.

Display animations of marker movements in pixel light tubes.

Re-play arranged sonifications in loudspeakers.

Reach from the core of the practice.

Feel sounds as agency to move

move — arms, fingers, bow, feet, guts.

Spine — stretch, Shoulders — release.

Watch

Listen Play

Move Dance

Recognise

Question

Tap into the moving bodies. .-.-.-.-

Tap into the sonic patterns. .-.-.-.-.-

Tap into the visual patterns .-.-.-.-.-

Tap Tap and Re-tap

Align and Reorient

Negotiate, Interpret

Re-select, Re-map

Re-consider

Tap tap

Switch attention

between
prerecorded
and live movements
and
Back again
Play sparsely
Listen
Articulate
Improvise
Go a bit wild
Roam around
...
...
Repeat
Play
Listen
Suggest
Articulate
Respond
Listen
Repeat

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