Synchronizing teams

Musicological case study in the social gaming context

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“I will never make a single player game again. I personally believe that the days of single player games are numbered.”
(Callaham, 2009, p.1)

”The majority of rhythm production studies on sensorimotor synchronization and entrainment have so far focused on the cognitive abilities of individuals and have not taken into account the nature of music as a social activity.”
(Himberg, 2006, p.1)

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Preface

The creation and development of the Sync in Team game would not have been possible without the support of the whole Institute of Psychoacoustics and Electronic Music.
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Thank you.

Introduction

Games that deal explicitly with music have become very popular. Almost everything, from improving your dancing skills to directing a virtual orchestra, has become possible thanks to the formats like Wii-Music, Guitar Hero or Dance Dance Revolution.

This kind of gaming is crucial to the industry. It is offering new ways to engage with music that catches the attention of a large amount of public. What is the role of musicology in this field? Can we learn something from gaming?

This work is meant to suggest several possibilities of this conjunction.
Music-related games are important to us for two main reasons: One, because they bring a refreshing perspective in the complex ways humans deal with music; and two, because they can offer a playful platform for research of social and musical interaction.

According to Lefford (2007, p.129) games are ideal platforms for musicological research; because they provide a set of explicit constrains that - somewhat like rules of grammar- make generated patterns and reactions to music more comprehensible and comparable.

As musicologist interested in the value and true nature of the musical experience, games are important to us. They can bring research closer to real forms of encountering, far from cold laboratory research. The playful nature of music engagement can be closely observed. This will not only help us to understand it better, but will also help to create new devices that favour truly immersive experiences and feel more natural.

What tools and methods are available to observe and research this phenomenon? Are objective measurements of the subject's movements sufficient, or do we need to relate them to subjective descriptions? What alternatives can we think of?

To answer these questions, a tram of experts at IPEM created and developed a new game, the 'Sync' in Team'. This is an interactive interface, which focuses on beat-synchronization and team play, and was tested by more than 150 subjects.

The goals were two:

1) Using this game as a platform to conduct research regarding synchronization skills and interpersonal entrainment. The focus laid on the influence of social aspects on music encountering.
2) To develop and improve the playability and naturalness of the format, making it as consumer-oriented as possible.

The first one explored the hypothesis that personality and interconnection between players do have an influence on the development of a game experience. Questions asked were: May the relationship between the players affect their synchronization? Do partners that know each other for a long time synchronize better with each other than teams of complete strangers? To resume: Do social factors have an effect on the way people deal with music games? And can these factors be measured?

The second experiment was held in public science fairs. The reactions of more than 150 players were observed, within several musical genres. Questions asked were: How did people of all ages respond to the game? To what kind of music genre did teams synchronize the best? What was the most chosen genre? This helped to improve the game in its playability and naturalness.

But first things first: Let us start with the true nature of playing. What are games? And how do we locate gaming research in the actual panorama of systematic musicology?

Music-gaming and the embodied approach

Musicological research is increasingly highlighting the role of the body as mediator between music and mind (Leman, 2007b). It is therefore no longer believed that solely the brain deals with music; we live and feel in an embodied manner.
Developers of music technology are looking closely to how the body moves to give shape to their new designs. The underlying idea is that electronic devices should feel increasingly natural to us.

This focus on the body has also unsurprisingly been introduced in music games, as a form of 'active playing'. New games demand movement; jumping around playing the guitar device (e.g. Guitar Hero) synchronizing the pom-poms like a cheerleader (e.g. We Cheer), or singing and dancing like the celebrities (e.g. Boogie Superstar).

Music plays a key role in personal development and social bonding (Hargreaves & North, 1997). Latest tendencies make place for collaborative play, where people with no music background at all can create and play music together, enjoying immediate and acceptable results. Another established trend is 'performance enactment'; players are not making the music but reproducing and re-creating famous movement patterns. In all of them, learned gestures and spontaneous movements are combined; imitation, interpretation and spontaneity are keys to the enjoyment of the game.

Musicological research is increasingly focused on human factors (Leman, 2007a). This should not be surprising: To make new and natural devices, knowledge about ways of personal musical engagement is required. According to Hashimoto (2007), technological devices have to be made according to each user's own expressive manners. According to Leman (2007b) new devices should feel as extensions of our own body. People react actively to music; and this is reflected on corporeal articulations. It is the task of the researcher to quantify and observe this phenomenon. Yet how can we register it? How can personal engagement with music be measured?

Musicologists have confronted these questions using different methods. There are three basic perspectives to look from:

1) 1st person descriptions; Using this form, we can ask the subject personally how a particular piece of music is felt, what kind of emotions flourish, what kind of associations are made. This might be interesting, but remains strictly descriptive and not really spontaneous. The subjects are already *thinking,* being aware of their reactions, while people often react to music in a direct way, without analysing it. This is why first person descriptions are not enough.

2) 2nd person descriptions involve inter-subjective communication. In a second person description, gestures are seen as a bodily expression of a subject that is meant to be understood by another subject (Leman, 2007a). One subject communicates its feelings to another. Second person descriptions are therefore of great interest, because of the spontaneous and communicative character. Gestures, and their meaning, become crucial. How this can be done optimally is still a matter of research

3) 3rd person descriptions are concrete measurements of human behaviour in response to music. The intensity of the movement of dancing subjects can be analysed using, for instance, accelerometers or visual motion capture. These may remain a bit cold, for they cannot capture how the subjects feel, but could therefore be combined with personal descriptions.

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The embodied paradigm assumes that music is *decoded* in a corporeal way before accessing the mind. This corporeality is a clue to social music-related experiences. In a social interactive context, listeners can communicate with each other, (e.g. when dancing together) in a non-verbal way. They use corporeal types of communication, but the functioning of these is still poorly understood (Leman, 2006). One of the challenges for systematic musicology is to identify the social factors that are relevant to the development of social music computing. Music technology has to focus on its social domain.

This motivates research on social interaction in the music-gaming context. Subjects do not always behave in the same manner; the context and people surrounding them are crucial. Further experiments will explore the difference in movement intensity and accuracy of the

dancing subjects in different contexts of music game play. How and to what extend do listeners correlate with each other? ? According to Leman (2007b) it is likely to assume that moving in a group may reinforce inter-subject correlations.

How can music gaming offer a platform for music research? A closer look from the origins of gaming to the most recent developments might help to clarify this question.

1. The gaming phenomenon

As we speak, millions of subjects are connected to computers, consoles, or mini devices, involved in solitary or multiplayer gaming-experiences. In his article 'Games Industry Grows Despite Poor Economy' (2009) analyst Kris Graft calls attention to the impressive success of video and pc games, despite the worldwide crisis that was supposed to affect all industries. According to Dan DeMatteo -coordinator of the known videogame retailer 'Gamestop'- "The videogame business continues to enjoy robust growth, making it the fastest growth of all consumer goods categories," (Parfitt, 2009).
What is it about gaming that keeps people so interested?

1.1Gaming History

According to Huizinga (1938, p.27) playing games is older than culture itself, and is clearly present in animal behavior. It involves a "voluntary action, carried out in a certain limits of space and time, assuming the freely accepted though bounding rules, containing a goal in itself and accompanied by feeling of tension and joy and the awareness of being 'different' than the 'ordinary life'" (Huizinga, 1938, p.29)
The small history that will be traced here includes exclusively computer and console-games, developed in the 20th century. It is of our interest of knowing when these formats appeared, because it throws some light on the current tendencies.
The first computer-game was 'Noughts and Crosses', the simple and entertaining 'Tic Tac Toe' we have all played at school. It was implemented by A.S. Douglas as part of human-computer interactivity research at Cambridge University in 1952. Even though it was not available for the great public, its success among those first 'players' set the idea of further development. Short after that, the physicist William Higinbotham was looking for 'something' to entertain the many visitors from the National Laboratory. He implemented a tennis-game that was played on an oscilloscope, and 'Tennis for two' certainly caught the attention of the audience. (Schermer et.al, 2008)
The video games, played on a console like the actual Playstation, X-Box 360 and Nintendo DS, were Ralph Bader' s object of research (Kent, 2001). He was obsessed with making games playable from the TV screen. This phenomenon reached a part of the audience in the

seventies, 1972 was a crucial year for video consoles. Magnavox presented the *Odyssey*, allowing people to play more than 25 games on their television screens. But the big favourite of the time was *Pong*, played in coin-in machines (arcades). The computer enterprise Atari had the idea to put the machines in a local bar. Surprisingly, people soon formed a line to play the game: the arcade period had started. From the early seventies to the mid-eighties, arcade games became extremely popular. The public adored titles as PacMan (1980), Defender (1981) and Donkey Kong (1981). There was also a market for video console games, but it was not until Atari 2600 and Colecovision arrived that we can speak about massive console gaming.

Computers-games tried to keep up, offering famous games in computer format, or inventing their own. The third generation of video-consoles arrived at a time when popular games had begun to repeat themselves. This is called the "video-console crash" of 1983. New enterprises invaded the game industry: Nintendo and Sega. They offered refreshing alternatives to the classic games. And they did well: Nintendo's Super Mario Brothers became the best-sold game ever.

The third generation of video consoles came with Sega's *Megadrive* and Nintendo's *SNES*. More than 30 millions of each was sold. Furthermore, the personal computer was on its way to expansion and so were the computer games. 'Space Quest' and 'Monkey Island' became famous. These were the days of Nintendo's Game Boy, which conquered Europe in 1999 with the popular 'Tetris'.
The real innovation of this time was the distinction between the FPS (First Person Shooter) genre and the RTS or 'Real Time Strategy' games, still until today the most popular types. Games begun to specialize in these directions. With 'Wolfenstein 3D' (1992), players were able to shoot from a first person point of view into a 3D dimensional virtual world. Graphical realism was the key to its success.

In RTS games, players have to pursue their goals managing the available resources as well as possible. These are played in all formats, console and computer. The improvement of the graphical cards for pc's cared for a growing number of games adapted for computer. 3D graphics were becoming more and more realistic. (Schermer et al, 2008 p. 61)

The expansion of the Internet favoured online multiplayer games. From their PC's, people play simultaneously in what is called Massively Multiplayer Online Role-playing Games (MMORPG'S). The success of *Second Life* is a good example of an ambitious multiplayer online game: a whole new world is (re) created with the use of avatars.

At the moment, the seventh generation of video consoles have arrived. The use of sensors and the possibility of connecting your console to the Internet open new doors to multiplayer experiences. Besides the extremely sophisticated console and computer games, there is room for small simple games to be used in mobile phones or other handheld formats. These are becoming impressively popular.

1.2 Gaming as an influential activity

What is it about games that people enjoy so much? How can players throw themselves into games so intensively?

Games can be considered as packed experiences, passports to another world. Deprived of the efforts and seriousness we are used to achieve goals in real life, playing a game can make us handle the result of our actions without really worrying for the consequences. Through games situations are enacted, and one is able to project oneself in a safe way. When someone hits their guitar playing Guitar hero, they can enjoy the enactment of a musical performance without having to make the effort of really learning how to play the instrument. After several sessions the player can feel like a master, controlling several parameters. When the state of flow is achieved (Concept defined by Csikszenmtmihalyi in 1999 as 'deeply satisfying experiences that alter the state of consciousness'), the only concern of the player is adding expressive gestures in order to have more fun.

The categorization of games as packed experiences relates to how humans learn. Interpreting experiences in terms of the achievement of goals is what experts define as learning (Gee, 2007). Video games are virtual experiences of problem solving; they recruit learning and mastering as a form of pleasure (Idem). A great deal of authors see gaming as a great opportunity to acquire new information (Salen, 2004), while others worry about its assumed uselessness or damage. (Provenzo, 2008)

Scholars and parents, who see gaming as a powerful and influential activity, are becoming more and more concerned about its possible consequences. As Provenzo (Idem, p. 59-95) observes:

"Video games can be powerfully compelling. Children play them with passion and intensity. Because of their strong appeal, their long-term influence becomes especially critical. (…) Games, like mythology, are a way to grapple with the meaning of life. But what if the games we play are corrupt? What if, instead of ennobling the individual, as great literature does, our games debase our humanity? What if our games cheat our children in their quest for deeper meaning? What if they blind the child's vision rather than liberating her consciousness?"

Provenzo agrees with the fact that aggressive feelings could be discharged through symbolic play, but ads that current games fail to make this fully possible. Little freedom is left to the player, and the negative connotation of the virtual environment does not help either (Provenzo, 2008). Positive voices attribute gaming great powers to improve hand-eye coordination, media usage, stress relief and processing skills, all of which may have a good effect on inter-personal communication.
Research on gaming is being done with varied focuses: commercial, sociological, psychological, pedagogical and ethical. Understanding this phenomenon that is already really present on our everyday lives has become a point of interest for several disciplines. From the side of musicology, games could bring us closer to music experience, providing a framework to make reactions to music more comprehensible and comparable (Lefford, 2007).

What we will analyse now is the growing tendency towards multiplayer experiences. Games involve a sensing of the self and the other, highlighting the relation between both cooperating and competitive scenarios.

1.3 The Social gaming phenomenon

The tendency towards multiplayer experiences has two main bifurcations: MMORPG's and Social console party-games.

1.3.1 Massively Multiplayer Online Role-playing Games

Individuals can be immersed in a game with other players all over the world in a simultaneous manner. This frequently enhances a feeling of participating and belonging to an 'invisible team'. Virtual worlds have become meeting points, places were communities are formed. A player does not only play the game, but participates at blogs, forums and other sites that expand the network. What makes these online playgrounds so attractive?

According to Putnam(2000), the rise of online communities is typical of our post-modern society. Traditional civic organizations (church, joint family time, neighbourhood activities…) have severely declined, and the places were people used to meet, (like taverns, public squares or pubs) are for a great deal being lost or substituted for artificial encounter places like the mall. Architecturally speaking, families are losing cohesion. People still need each other because humans are social by nature. This makes them look for alternative ways that fit in our strict individualistic society. Internet is used to replace real social encounters with virtual ones. (William, 2006: p15).

Players of all ages engage in games with avatars, in which their real identity is hidden. This may be an important key for the processes of expression and identification, especially for young players. But the visage of a solitary teenage gamer playing alone in his basement for hours is disappearing. The ISFE consumer guide states that 66% of the European gamers spend regular time in social activities, and share the console with friends (Nielsen, 2008). In her research about social virtual worlds, Betsy Book (2004) concentrates on cultural codes in the online world. The recreation of these cultural codes within virtual worlds allows players to explore and interact as participants rather than passive consumers. Many virtual worlds already defy strict categorization as games, serving more as extensions of reality than escapes from it. People 'log in' to reopen and opportunity of socialization in a new context.
Book(2004) defined six features that characterize all virtual worlds:

Six Features of Virtual Worlds

1. ***Shared Space****:* the world allows many users to participate at once.
2. ***Graphical User Interface***: the world depicts space visually, ranging in style from 2D "cartoon" imagery to more immersive 3D environments.
3. ***Immediacy****:* interaction takes place in real time.
4. ***Interactivity:*** the world allows users to alter, develop, build, or submit customized content.
5. ***Persistence****:* the world's existence continues regardless of whether individual users are logged in.
6. ***Socialization/Community***: the world allows and encourages the formation of in-world social groups like guilds, clubs, housemates, neighbourhoods, etc

While, according to Nielsen (2008) social aspects are not rated among the top reasons for gaming in general (13% play video games for this reason), online gamers are twice as likely to cite the opportunity to play/socialise with others as a reason for engaging in online gaming (27%). This represents a strong secondary motivator and differentiates online gaming from general game play. It may also be indicative for the growing importance of video games. Online environments are becoming an increasingly prevalent means of communication and self-expression for a younger generation (Nielsen, 2008).

1.3.2 Social console games

The new generation of videogames enhance *real* social interaction. The game is meant to be played by a group of people sharing the same space and time. This determines the development of new formats, and finds its roots in marketing strategies based on customer's surveys. Contrary to the opinion of the majority, 'individual based' videogames are often played in-group. Players compete in one-to-one contests, or take turns to play different levels. Several game developers proposed the development of console games specially designed for social interaction. This was already largely implemented in pet games (e.g. monopoly, twister), but not as much in videogames. The ISFE consumer guide reveals that many regular players -especially teenagers- talk about the social factor as the most important one to play a game (Nielsen, 2008).

Another important commercial reason for developing social games is the integration of family members. As reported, more that 40% of parents engage in videogame activities because their children ask them to. New games made for the whole family are therefore an interesting target. Wii music, for example, is designed that way. Games like Rock Band and Guitar hero World Tour, as commented below, also created opportunities towards multiple player experiences.

Social gaming can be seen as a remarkable trend, especially considering to music related games.

2. Music in the social-gaming context

2.1 Crossroads between music and gaming

Music and gaming interfere and collaborate at different levels:

1) Music as included in the soundscape of a game, helping to create atmosphere and highlighting its functional tools.
2) Music related activities as clue to the game; singing, playing or creating music

As for the first function, several authors are inclined to think that music plays a fundamental role defining the 'identity' of a game, and that its presence, though sometimes unperceived, helps to enhance a feeling of flow and intrusion into another world. Godwin (2008, p.4) relates to it in the following way:

"The background music sets the mood and the tension (…) of a game. 'Call of duty' , for example, uses evocative sounds to provide the player with realistic feelings, as if they were fighting in the war themselves. Music is used to help telling a story, and also adds to the fun factor of a game. One has to listen to every aspect. Taking the sound out of it would completely take away almost all aspects (…) that add to the climax of the game"

The second intersection between these two fields comes with games in which the performance or enactment of music related activities as the key. These will be the object of further development, and subdivided in dancing games (Dance Dance Revolution), singing (Singstar), enactment of musical performances with instruments (Rock Band, Guitar Hero, Wii Music), composing music (PureJoy), or coordinating jam sessions (JamiOki).
These kinds of games have gained great popularity. Millions of guitar controllers are sold, and groups of friends around the world love to recreate rock concerts. The development of music gaming is largely affected by several general trends.

2.2 General trends in the music-gaming world

Several trends are commonly noticed in recent game formats. We will be commenting those that have a special impact on music related games.

1. Making the experiences of being actively involved with music **accessible** for people with little or no musical training.
2. Encouraging the social aspect of the game: make the experiences **collaborative**.
3. Games are favouring **physical movements** for the enactment of several activities, instead of passively activating a controller.
4. Cross formatting or integration: a **flexible** link is made from console games to online worlds. You can, for example, play DVD's, download songs from the Internet or chat with other players directly through your video console.
5. The **experience** of enacting musical performances is what counts. Games therefore try to create pathways to immersive experiences. The goal is to create tools that enable identification/imitation processes - like 'Pop Idol'- or social bonding -like 'Rock band', with slogans like "Become a Star" or "Share the Rock experience".
6. Games frequently integrate features that permit the player to **personalize** the game. This goes from customizing the avatars to the development of objects and scenario's in the virtual world itself.

2.2.1 Accessibility: when anybody can play

"Although music is available for more people, on more locations, and for longer periods of time, most listeners experience it in an incidental, unengaged, or utilitarian manner."

The main idea that Weinberg (2005) points out is that the overwhelming character of a creative musical experience should be available to anyone, and by this we mean people with no musical training at all.

When playing in a band, singing in a choir or conducting an orchestra the feeling is often very intense and gratifying. Learning how to play an instrument, however, is not always an easy task. Discipline and training are required, commonly starting at very young age. Game developers saw the possibility of offering the public the gratifying experience without much effort.! The Beatbugs were well received in the UK as the instruments you can play without music lessons.(See Fig.1)

The formula has affected not only the form and materials of the new devices (*squeezables*, movement sensors, digital music table, Wii) but also the usability. As Blaine & Fels affirm, the devices don't need to resemble a real instrument a priori (2008). The only condition is that they feel natural, accessible, easy to handle. The PureJoy, an instrument created at the MIT Media Lab, functions as a console-controller that records and loops sounds, and can easily be learned.

Trying to create new and accessible devices, which can be easily managed, often requires less attention to traditional music methods (Blaine & Fels, 2003). Devices created for novices should be responsive; otherwise they are too complicated or abstract. Gestures have to evoke a musical intent, in a certain comprehensible logic.

The main goal is to achieve deeply satisfying experiences that alter the state of consciousness, also known as 'flow' (Csikszenmtmihalyi, 1990).

Creating music is a communicative experience. Why not to make it possible for everyone?

Figure 1: The Squeezables and the Beatbugs, both easy and accessible music devices. MIT Media Lab ©

2.2.2 Collaborative game play: it's more fun to play together

The greatest value of a game is the multi-levelled experience it offers, going from the psychological processes that permit the assumption of rules and strategies to explicitly social-interactive ones. As Salen and Zimmerman (2004, p. 314) point out " The experience of play comes in so many diverse forms that creating a catalogue that takes them all into account would be an impossible task".
Sutton-Smith (1986) classified the different psychological processes by which games are experienced. This model evidences that playing a game is a complex activity which involves different mechanisms cooperating at the same time, i.e. visual scanning, auditory discrimination, motor response, concentration and perceptual patterns of learning. What, according to the philosopher James S. Hans (1981), lies at the centre of the gaming experience is playing with the unfamiliar. Every game involves risk. The rules and the people surrounding the player might be familiar, but the development and results of the game are not. It is because we manage the uncertain in the certain framework of rules and patterns that we enjoy gaming so much.

The game designer Brian Moriarty (1998) introduced talks about a certain 'rhythm patterns' present in all game play. Taking turns, preparing the cards for the next strategy, all these processes involve frequency and rhythm, and help to define a game pulse. "Rhythms and patterns exist in all games, if you watch (…) someone playing a game sometime. Not the game itself (…) but the player, and the space around him or her. Watch the rhythms emerge, and how the player and the game interact. It will become clear that a game is in fact an entrainment engine"

The term 'entrainment' is used here to refer to the rhythm patterns evoked when playing a game. (Salen and Zimmerman, 2004, p.341). This term is also used to define the synchronization between different individuals adapting their movements to each other, to lock up in a common phase; as a result of profound psycho- sociological processes. (Leman, 2007b) . General rhythmical behaviour in game play applies to music games, which frequently have rhythmical-musical- coordination as one of the most important features as well. In the famous music game 'Dance dance revolution', for example, missing a beat means

directly losing points. The players of ‘Singstar’ have to stay coordinated with other singers, and with the tempo of the play-backed music in order to win. This rhythmical entrainment is therefore taken to another level in music games.

The fact that games are now favouring multiplayer contexts is not really a new trend, but rather a returning point to the roots as a social element (Salen & Zimmerman, 2004). Games in which the acts of playing or dancing to music is the key element are thus taking this social root into account. It takes five persons to play Rock Band, and, although Wii Music can be played alone, the point is playing it with others, as even the virtual scenarios show multimember bands and not solo artists. In his speech (covered by IGN) Perry talked about how the games he is currently working on are, in his opinion, becoming the future of the industry: "I will never make a single player game again. I personally believe that the days of single player games are numbered." (Callaham, 2009)

What is so special about musical experiences, and why are they being integrated in games? Blaine and Fels (2003) agree that sharing musical experiences forging a sense of community. The interaction between players can be more or less mediated by the games rules, depending on the goal pursued. In order to reproduce an existing song playing Wii Music, for example, the intervention of the different instruments is stipulated and reflected on the screen. Beatbugs, despite its experimental and improvisational character, functions better when someone is directing the social interplay. Wii music, however, offers the possibility to have a jam session, during which each instrument is free to play, and hopefully a coherent and fun musical experience is achieved. The feeling of collaborating with others in a musical way is therefore key to the gaming pleasure.

Many collaborative instruments encourage various levels of movement, gesture, touch, and physical interaction. These design strategies lay the foundation for developing personal connections with other players and their instruments. According to Blaine (2003), those ‘synergistic’ relationships between players, even strangers, is the strongest factor to foster a sense of community, rather than the interface itself. This coincides with Salen and Zimmerman (2004, p 462). They observe social interactions between the players at different levels as “key to the gaming experience”. The relation of impressions people have from each other before starting the game, influence players’ relationships towards the game’s rules. For example, in the games Chaser and chased, someone will chase a person he/she likes

differently than if it is someone the player is not related to. Experiments commented in further chapters will explore these aspects.

Video console music games, like Rock band or Guitar Hero are usually played at home with friends or relatives (See Fig 2). The part of interacting with strangers observed by Blain is not unworthy, because individuals can attend contests were new teams of players are made. This "bringing people together" aspect becomes clear in this kind of music game contests. Dance Dance Revolution, for example, is known for its recurrent intercity gatherings, where players meet, compete, and form new teams.

Figure 2 Friends playing Rock Band ®. The devices simulate real instruments, imagination does the rest.

2.2.3 Physical movements

Games are increasingly demanding bodily movement from the player. To play the Wii golf, for example, the player has to hit the virtual ball with a remote controller, simulating the 'real movement'. The Wii fit goes even further: the whole game is designed to learn different steps and postures, from yoga to aerobic. 'We cheer' teaches young girls the choreography of real cheerleaders, and 'Boogie superstar' shows them the dance steps of musical celebrities.

Some scholars observe this increase of the so-called ‘movement games’ on the market as a reaction against the reviews that consider them addictive, useless and unhealthy. Producers have observed the trend of cultivating the body, and brought out games that encourage this aspect.
As Fitzgerald (2008) points out, computer games are frequently implicated in the increasing sedentary nature of modern lifestyles and associated problems such as childhood obesity. Any measures that help to incorporate physical exercise into computer games will help to advance the notion that they can be used to promote rather than hinder health.

Another important aspect is the feeling of reality and immersion provided by playing while psychically recreating the movements of the character. The movements you make have consequences on the screen, and therefore obtain a special signification. You feel the complex bodily movements being extended to the avatar you control, as seen in Figure 3.

Figure 3 Movements of the avatar as an extension of the player’s movements. Wii Golf.®

In arcade music games -Dance Dance Revolution in particular- the body of the dancer may become a spectacle for other players. The latter have to adjust their steps to the instructions

displayed on the screen, keeping track with the musical beat. Dance Dance Revolution debuted in Japanese arcades in 1998 and sparkled national sensation. It began appearing in the US arcades a few years later, where national press stories sometimes framed it in contrast to first-person shooters games and by extension the issue of teen violence (Smith, 2006). The success of movement games is notorious, as in january2009'Wii Sports' was rated as the most successful video game of all times.

The increasing tendency of games requiring soft to intensive physical movements is interesting from a musicological point of view. The embodied approach states: "corporeal articulations provide the basis for an immersive involvement with music" (Leman, 2007b p.173)

2.2.4 Mobility and integrations of formats

As Microsoft announced in March 2007, gaming is going to be possible *anywhere* (Verkroost, 2007). Nowadays, owners of a pc with Windows Vista can have access to a Live account and play several games with Xbox 360 users. Nintendo Wii and Playstation 3 offer online services. Downloading music and movies from the console is also possible, as well as classifying songs automatically with metadata available on the net. This is meant to erase all boundaries between pc and console players, and to extend their normal use. The goal is to provide games with a limitless range of possibilitie. Mobile services are also increasing.

Almost half of the gamers surveyed in the questionnaire of the Interactive Software of Europe (Nielsen, 2008) play games on a portable and/or wireless device (whether a mobile phone or handheld console such as the Nintendo DS or Sony PSP).
Given their inherent mobility, it may not be surprising that wireless games are played in a variety of locations. However, while a significant proportion play mobile games while they

are on the move (53%), even more gamers tend to play them at home (70% of the surveyed played at home most of the time).
Motivations to play mobile or wireless games are primarily their capability of filling 'dead moments'. They share attributes of home-console and PC based gaming in terms of providing fun, challenge and an opportunity to engage the imagination. It should also be noted that respondents under the age of 16 were not interviewed, and therefore responses should only be taken as representative of an adult audience.

However, in order to further develop the appeal of wireless gaming for a more adult audience, it appears that a clearer and more active entertainment proposition (beyond filling in time) is required. In the near future, a special "Wii TV" will be created, confirming the trend of format mixing and integration and connectivity.

Reuters
Wednesday, December 24, 2008; 8:40 PM TOKYO (Reuters) - Dentsu Inc, Japan's largest ad agency, said it would team up with game maker Nintendo Co Ltd to launch a video distribution service on Nintendo's wildly popular Wii console. The two companies plan to offer programmes created for the service, a Dentsu spokesman said, in contrast to most online channels, which tend to carry existing TV shows and movies.

Viewers will need to pay to see some of the new programmes, while others will be offered free of charge and accompanied by advertisements, the spokesman said on Thursday.Nintendo has sold 34.6 million Wii consoles, which feature a motion-sensing controller that looks like a TV remote control, as of the end of September, far outselling Microsoft Corp's Xbox 360 and Sony Corp's PlayStation 3.

Dentsu and Nintendo will start offering the new service in Japan next year, while the timing for overseas sales has yet to be set, the Dentsu spokesman said.

(Reporting by Kiyoshi Takenaka)

2.2.5 Offering direct experiences with music

Guitar Hero's website announces a powerful slogan "Guitar Hero world tour is more than a game; It's the most complete experience of playing music together." Games like Rock Band and Guitar Hero do everything they can to give the players the feeling of being a protagonist. The identification with the personalized avatar, plus the virtual scenarios in which you 'see yourself' on stage, performing in front of an enthusiastic crowd, make the players feel fully immersed in a rock concert (See Fig. 6). For once, the subject is not only a member of the audience, but *becomes* the artist himself, the centre of attention. These elements are strongly accentuated, and form the key to the game's charm. According to Salen and Zimmerman (2004) the game is only valuable considering the experiences it creates. The value of experiences is highlighted in pedagogical gaming research.

According to Csikzentmilhalvi (1997), the experience of 'flow'' is crucial for students' intrinsic motivation to learn. Why do people spend so many hours playing a game? The author argues that what keeps them motivated is the quality of the experience. This feeling often involves painful, risky, or difficult efforts that stretch the person's capacity, as well as an element of novelty and discovery. When a player is immersed in a game and the challenges are in balance with the skills, the activity itself becomes the goal. An excessive difficulty of the rules could create attentional constrains that would stand in the way of enjoyment of the game (Keller, 2008).

What about the interfaces? The devices offered by games like Guitar Hero and Rock Band do sometimes share a clear resemblance with the original acoustic or electric instruments (electric or acoustic guitar, drums, bass guitar). With a 'real' instrument, the movement of the performers is very closely connected to a mechanical energetic interface that produces sound. (Leman, 2007b p.166) Is this the case, however, when holding a Wii controller as if it were a violin? (See Fig.7). Certain elementary gestures of violin playing are reproduced, but one does not always link the 'resulting sounds' to the gestures. Immediacy of feedback and a sense of control are features game designers are focusing on increasingly.

2.3 Famous music-games

Up to now we have listed some general trends that affect the design and experience of music games. But, what are those games, and how are they played? Let us introduce the most representative and popular ones:

2.3.1 Dance Dance Revolution

DDR (1998), focuses on the velocity and efficacy of the player feet while moving to the music. The instructions about the position of the feet are displayed on screen and conducted at the floor-path. One has to coordinate quickly in order not to miss one beat!
Although it could be categorized as mechanical and inexpressive, it has had a huge impact on music gaming. The large fan communities that surround it demonstrate some of the ways digital technologies are helping to shape how people interact and socialize through music. As from the standpoint of digital gaming, DDR and related games like ParaParaParadise use music and rhythm as a novel form of interaction with images on the screen: dance creates a new relationship between game play and the player's body. (Smith, 2004)

Figure 4 A Dance Dance Revolution ® contest; strangers meat, gather, compete and form new teams. The instructions on how the feet should move and the avatars appear on each arcade's screen.

Like karaoke, the cycle of music games that include DDR and PPP originates in Japan, where the focus on dance and movement is really strong. Hip-hop, for example, is not focused on the lyrics, but on the movements involved. Breakdance became a huge trend in Japan at the very beginnings of the discipline. Numerous websites all over the world contain a vast number of discussions about DDR, game play and music, and announcements for tournament(see Fig. 4).

The music plays a large role in the DDR experience. Closest in style to techno and house, fragments are short and sometimes simplified or even infantilised. The shortness of the songs have been object of discussion to fans, who prefer 'real music' to game with. To calm the players who feel that the game oppresses their dance expression, a new modality has been introduced by players themselves, and implemented in the game: the freestyle version. The steps are learned and memorized. Subsequently, the players turn around and face the audience, while reproducing the patterns backwards. Freestlyling is not so much about scores as about the spectacular elements introduced by the players.

2.3.2 Singstar

The object of Singstar (2003) is bringing classic karaoke to another level. The pitch detection system allows the player to see whether the line is sung correctly according to the original song. The group experiences it offers are what makes this game so attractive.

Figure 5 Easy to learn and manage interface of Singstar® . Lyrics are displayed below, relative position of 'higher' and 'lower' fragments are reflected on horizontal bars. The score is shown above From flagrant.net

The goal is to fill the bars on screen (see Fig. 5) by singing as accurately and rhythmically correct as possible. The mechanisms warn you of pitch errors: going flat or going sharp causes the colours to go below or above the bar. Higher levels garantee a bigger challenge for experienced players, while musical accompaniment helps smoothing the effect of a bad singer on the easy levels.

The 'Party Mode' is specially made for multiplayer experiences. Two main options: 'Pass the Mic' and 'Best of 3'. The latter offers a quick round of three songs for each player, while the former (and most celebrated on fan sites) is like a coach that gives direct 'orders'. Each player has to prove his or her singing skills through different 'missions', like duet or solo parts on difficult songs. In this mode, the surprise and variance factors are key elements.

The game is available in different music genres, that way the user can buy the one that best matches his or her tastes: Singstar 90s, SingStar Legends, SingStar Country, Singstar Rocks, Singstar Amped, Singstar 80s, SingStar Pop Vol. 2, Singstar ABBA. For PlayStation 3 owners, the SingStore offers a considerably large downloadable content, so players can also compile a soundtrack of your own.

On the Embodied music approach, singing is considered as a natural expression or navigation through diverse features of the music.(Leman, 2007). The subject's body gets naturally attuned to the music this way. Considering these aspects, the simplicity of this game's format might be a key to its success.

2.3.3Rock Band

The game Rock Band sold millions of copies of its first and second edition, and is still increasingly successful. International contests are held and fan sites share an increasing number of visitors. Why is it so popular?
It could be the feeling of immersion, the illusion of being a true rock star. Even though players are not playing real instruments, yet remake-controllers, imagination, concentration, and elaborated visuals help to achieve to the feeling of flow. One cannot afford to fail in front of the audience, even if it is a virtual one.

Figure 6 Rock Band® :The virtual audience and explicit movements of the avatars help to enhance a feeling of immersion. From www.oxmonline.com

This game stands firmly in the trend of 'active-games', in which players have to recreate movements physically in order to play. The mechanics are similar to the popular Guitar Hero: light circles pop up on your screen, marking the tempo and order to trigger different parts of the controller. The goal is to respond to these instructions as quickly and efficiently as possible, and at the same time "move like a real rock star". Having fun together, exaggerating and improvising moves are the key to the game.
This is a genuine multiplayer game, even though it offers a solo mode to practice.

2.3.4 Wii Music

When the creator of Mario Bros showed it for the first time, the audience was astonished. Half of it valued it ridiculous and naive; others thought it was worth a try. On fan sites, the bad critics are as numerous as the ones that consider it a revolutionary music game. Why does it differ that much from Rock Band or Guitar Hero? To begin with, instead of instrumental replicas, the Wii remote and its extension, the so called 'nun chuck', are used. Players can choose an avatar and an instrument. Each virtual instrument with its corresponding sound has

to be played holding the Wii on a certain way. The violin, for example, is 'played' holding the Wii under the chin while moving the nun chuck as a bow.

Other instruments are simulated accordingly. The graphics differ significantly Rock Band or Guitar Hero, suggesting a calm and friendly scenario, suitable for all family members. Different options range from solo to multiplayer jam sessions, the main feature being the reproduction of famous songs with all possible combinations of virtual instruments.

What kind of critics does this game get? Gaming forum users comment, for example:
"It's hard to hate a game that doesn't do anything particularly badly, but Wii Music also fails to do anything especially well. By trying to make a game that appeals to everyone Nintendo has ended up in a strange halfway house, neither appealing to complete novices who want to pretend to play good music or learn about the basics, or to experts who will find it overly simple" (Chester, 2008)

Figure 7 Wii Music® Graphics and use of Wii controllers has been criticised as too simplistic and boring.

3. Musicological case studies in the gaming context

3.1 The ‘Sync in Team’ game

In October 2008, engineers of the IPEM Department of Musicology developed the first version of a new game, ‘Sync in Team’, focused on synchronisation and entrainment. It is played in two teams, two players each and four in total. A varying number of songs are played; the dancers have to do their best to synchronize with the musical beat (moving their bodies) and with their chosen partners.

If only one team member is synchronizing well, no points are scored. Both partners of each team have to work together. The team that manages to synchronize the best with the beat, and with each other, wins. As a reference and to encourage competition, two coloured lights are projected on the floor, each one representing a team (see Fig. 8). The better the synchronization, the bigger the light. This was repeated under different conditions and on different locations.

Figure 8The Sync’ in team game. Two teams compete to synchronize the best.

The first experiment took place in the experimental laboratory at IPEM. 13 groups of four people (26 teams) tried the game. The main objective was to observe the impact of social and developmental factors on interpersonal synchronization. Some questions in mind were: Why did the winners win? What helped them? To what extent is co-operability measurable in a music game context?

Winning the Sync' in team game implies cooperation among team players. To achieve optimal results, they have to work together, and synchronize with the music and with each other. A good connection among the players is expected to be of a great importance. This research question implies the crossing of two fields, that of synchronization and that of social factors related to co acting and competing. Several authors relevant to this matter will be referred to.

Several authors deal with the social dimension of games. Common research questions are: What does it mean for games to have a social dimension? How do the social aspects affect the fun, immersiveness and marketability of games? How do players build on collective experiences, practices, and knowledge to shape their gaming experience? (Mäyrä, 2007)

The point of departure for the first experiment is the influence of personality and interconnection between players on the development of a gaming experience. The "externally derived interaction patterns" as Salen & Zimmerman call them (2004, p.462) or relations between the players before starting the game play a crucial role and affect the internally derived interactions or roles assumed in the game.
It is thus not only the roles you get during the game that count, but also the inexplicit relationships among the players that affect the gaming experience.

Can the relationship between players affect their synchronization? Do partners who know each other for a long time synchronize better with each other than teams consisting of complete strangers? These are the issues that matter for the first experiment. To resume: Do social factors have an effect on the way people deal with music in a game related experience?

The second experiment is consumer oriented. Different musical genres are applied to a great number of players of different age categories. To what kind of music did teams synchronize best? Which was the most chosen genre? How did people of all ages respond to the game? More than 150 participants tried it and helped determining further improvements.

Let us start with introducing the current literature concerning the first experiment followed by the procedure and results.

3.2.Experiment 1: Researching the impact of social aspects on the performance of 'Sync in Team' players

3.2.1 Literature: What has been written about interpersonal entrainment?

3.2.1.1 Decoding the music with movements

As mentioned in the introduction, musicological research is increasingly focusing on bodily movements. Music is considered an 'intentional actor' (Leman, 2007b). When we perceive an object or creature in our environment, we ask ourselves: What is it doing? And how does that affect me?
Broeckx (1981) affirmed that we experience music exactly the same way, as if it was an intentional organism with which we can communicate and engage to a certain level.
But: how do we decode its intentional character? How do we discover and attribute meaning to it?
We do so by filtering the music with our own movements, and therefore associating it with actions. Rough music (e.g. hardcore, metal) is often danced to while imitating movements of anger or despair. We 'understand' the music's intentional character by looking at our own reactions. And because we all filter it in a rather similar way, human social communication in musical activities is possible. (Leman, 2007b)

More authors, (e.g. Godoy, 2003), agree with the idea that we mentally imitate sound, conducting actions when listening to music. When Jeanenerod (1994), talks about the inner space, he also links interiority, perception, and body movement. We have a complete internal range of biomechanical possibilities and adopted movement patterns applied to music.

Music is therefore not just some external stimuli, but something we appropriate, we make ours. Through our movements we give meaning to it. This 'meaning formation' results from

the translation of ‘embodied understanding’ into ‘conceptual understanding’, or the transformation of sonic features into motor related features (Leman, 2007b).

So far, we have concluded that the body reacts to the music, and that, through these articulations, we attribute meaning to it. According to Cross (2001), however, the meaning of music is both culturally constructed and individually flexible. It depends, for example, on experience, social status, mood or context.

3.2.1.2 Synchronizing to the beat

What would be the most evident example of bodily reaction to music? The answer is simple: Synchronization to the beat. Many subjects tend to move body parts in synchrony with patterns present in the physical stimulus without being aware of it (Fraisse, 1963). The beat is the most natural feature to synchronize with as it appeals to our fundamental biomechanical resonances (Thaut, 2005; Leman, 2007b). We do have internal timekeepers, and synchronizing them is essential for musical joint action (Keller, 2008).

The beat has three main characteristics (London 2004):

1) It is maintained over time.
2) It is perceived unambiguously.
3) It has hierarchical levels.

Many natural, complex sensorimotor activities involve the integration of rhythm, spatial patterns, synchronization to external stimuli and coordination of the entire body. Such activities include old evolutionary adaptations such as hunting, fighting and playing, as well as physical labor, marching, musical performance and sports (Brown et al, 2005 p.1).

Human synchronization, for that matter, is a creative affair, that involves “different body parts, different temporal structures and rapid adaptations to tempo changes”.(Keller, 2008 p.1)

Metric frameworks facilitate rhythm perception and action by encouraging the listeners and performers to allocate their attentional resources in accordance with periodicities underlying the music's temporal structure (Keller, 2008). The perception of musical pulses involves engagement of the motor system in a way that potentially enables an individual to establish both fine and gross temporal control over ballistic and smooth movements (Bispham, 2006).

Simplified: It is natural to move with the beat, and it is also easier to coordinate with rhythmic patterns as reference. Rhythm functions are a common point of attention, and thanks to them we can synchronize with other subjects more easily. Repp & Keller (2006) have proved that subjects find it a lot simpler to tap to the beat than 'against it', in an anti-phase manner. Several natural tendencies regarding synchronization are yet to be explored.

For the players, the game 'Sync in Team' presents two main challenges:

- To stay in synchrony with the musical pulse of the song.
- To keep track of each others movements and synchronize them as good as possible.

Because this includes working together, adjustments between the partners socalled 'expressive timing' is required. But what does 'expressive timing' mean?

3.2.1.3 Expressive timing and imitation

So far, we can conclude that moving to the beat feels natural to us. But: what about more expressive levels of movement? According to Leman(2007b), 'attuning' is a higher state of engagement. Attuning with the music means 'navigating though it', moving along with its different features (e.g. melody, harmony and timbre).
Empathy is even a higher level. It means feeling the characteristics of the music as if they were ours. It can be also applied to human interaction, like when we 'feel' and share the sadness of a friend. Empathy relates to emotional identification and feelings of intimacy and social connectedness (Berthoz and Jorland, 2004). Music, which contains an intention for us, is decoded and appropriated. The hypothesis that will be proposed further on, suggests that the degree of personal evaluation of the music, and the context in which it is experienced may have a great influence in the degree of empathy. Groups of friends who were dancing

together, as we will see later on, moved much more intensively than unfamiliar groups. Video observation clearly shows that people that felt comfortable with the task were likely to do more than what was asked, not just following the beat, but jumping around, moving expressively and having a good time, instead of sticking to the instructions.

3.2.1.4 Dancing together

According to several authors (Sachs, 1937; Farnell, 1999; Brown et al, 2005) dance is a universal human behavior, associated with group rituals. Dancing may be as old as the human capacities for bipedal walking and running, which date back to 2-5 million years ago(Ward, 2002). Brown (et al, 2005) highlights the fact that synchronization not only occurs to the beat, but to rhythmical hierarchical patterns in general. Rhythm is crucial for dancing, enabling an optimal temporal synchronization among dancers. The social contextualization of dancing may suggest that it was functional at group level and in group ceremonies.

What happens when people dance together? Several phenomena may take place, for example, imitation. To play the 'Sync in Team' game, players keep track of each other's movements. A good comprehension of how the other person interprets the rhythm is essential to keep up with each other: nonverbal communication is very important. Imitation is therefore likely to play an important role.
According to several researchers, among Bargh & Chartrand, (1999,p.3), imitation introduces a phenomenon called the chameleon effect. It refers to "non conscious mimicry of the postures, mannerisms, facial expressions, and other behaviours of one's interaction partners, such that one's behaviour passively and unintentionally changes to match that of others in one's current social environment". The mere perception of another' s behaviour can automatically increase the likelihood of oneself engaging in that very same behaviour.

An experiment conducted by the two authors revealed that "dispositionally empathic individuals" exhibited this effect to a greater extent than other people.

Who are those "more empathical" individuals? According to the authors, these are the subjects that adopt the perspective of an interaction partner more easily (Idem, p.10).

According to Leman (2007b) empathy may largely depend on socially related forms of imitation, because it is through empathy that we may represent the subjectivity of another person. The degree of personal empathy between the individuals performing the experiment 'Sync in Team' can be of great importance.

As mentioned, participants had to synchronize together with the musical pulse to win; correlating their movements to periodically determined ones and adjusted to one another. But participants did not often limit themselves to follow the rhythm. When dancing, the subject expresses and 'describes' the way the music is felt; anticipating features of what is likely to happen next. Dance can therefore be characterized as a form of expression and anticipation.

Each person has their own style, depending on likes and dislikes, adopted patterns, experiences and values. Kien (2007) suggests that the world is approached as a reality formed by interactions, relationships, constellations and proportionalities. Choreography is seen as the aesthetic, creative practice of setting those relations - or setting the conditions for those relations - to emerge. Dancing is seen as a reflection of life, of interactions, though symbolic gestures.

3.2.1.5 Communicating through gestures

What about gestures? According to Leman (2007a) gestures are internal to the human subject. We may look at them as "distinctive mode of learned bodily comportment, [and] involve cultural learning" (Idem, p.27). This means that they can refer to others within the same cultural context. Through embodiment, a particular gesture can be understood as being culturally significant because it can be located in a framework of other gestures (Coker, 1972).
We can conclude therefore that gestures:

- Are very necessary in social interaction and social differentiation.
- Have often been associated with cultural habits.

Dancing means that the subject is capable of assessing his/her own corporeal behavior in relation to the music, which acts as a 'social agent' (Leman, 2007a). This brings us closer to

the social roots of dancing. According to Deecety and Jackson (2004), when the subjects dance they regulate their own actions; at the same time detaching themselves from the events.

Regarding the strategies of imitation mentioned earlier it becomes clear that copying and reproducing other subjects is the way to discover the meaning hidden in their movements. The social contextualization of dance suggests that it was functional at group level and group ceremonies.

3.2.1.6 Interpersonal coordination

Authors like Himberg and Keller focus their research on interpersonal coordination. On musical performances, subjects engage in mutually coupled/ affective exchanges mediated by expressive body gesture. The presented synchronization experiment will suggest that those expressive exchanges involve personal connections, and that synchronization is easier to achieve for subjects who are familiar with each other.

Not only the coordination of body movements is dealt with, also 'mental states' are referred to. Two subjects 'perform' better together if they share a common goal (Keller, 2008). Yet what causes two subjects to deploy the same strategies to obtain the goal? Could it be the fact that they share likes and dislikes, that they had a similar education or that they have experience performing together? These questions remain unanswered.

Before talking about the relationships among performers, two main mechanisms that make basic synchronization possible are to be explored: period correction and phase correction.

The first term refers to an adjustment of the duration of the timekeeper interval (i.e. make the rhythm go faster or slower). The second means correcting the phase, or adapting the point of the sequence from one timekeeper to another timekeeper with the same period (Keller, 2008). Phase correction takes place automatically, at least at tempi faster than 60 BPM, whereas period correction requires conscious awareness and attention, and appears therefore to be unique for humans (Repp & Keller, 2004; Bispham, 2006). In the game, ensemble cohesion may depend on the sensibility of the users towards these mechanisms of error correction. It is

through self-monitoring that we adapt our own expressive behavior in response to other social agents. (Repp & Keller, 2004)

As Keller points out, there is a natural tendency for people gained in joint musical action to develop mental representations of each other's tasks. But: What determines an optimal representation of this kind? Possibly certain degree of personal compatibility.

According to the author, communication between two performing subjects can be affected by personality, social stereotypes, size of the group and leadership. There are thus personality and interaction patterns (as Salen & Zimmerman would call them "externally derived roles") that may influence this musical communication. Even if the subjects do not know each other, certain behavioral compatibility improves communication.

Our capacity for coordination with another subject is based on anticipating the results of our own actions and those of the others. Thanks to 'forward models' we can predict and simulate other individual's behavior. The mirror system resonates strongly to actions that belong to the observer's own behavioral repertoire.

Next to the forward models, we also use the 'inverse models' to coordinate with our partners. These go from desired actions to the motor commands that give rise to these outcomes. They help us to produce *what we want*, choose a strategy to obtain the desired result. It also helps to coordinate the intended relation between parts. These models are based on social interaction states that predict external and internal behavior, and they are shown as the most efficient ones. (Repp & Keller, 2004)

This brings us closer to the game: The dancer is not only responsible for adjusting his own movements to the rhythm, but also to maintain awareness of the movements of the team partner, trying to achieve an optimal level of entrainment between the both. This is also called 'priorized integrative attention', or the capacity of dividing the attention between one's own actions and those of others. The notion of the 'self' and the 'other' is very important for empathy, a very important quality regarding expressive gestures. It involves explicit representations of the subjectivity of the other (Leman, 2007b p.36)

In several experiments conducted by Keller (2008) good coordination between pianists required at least one of the members to have good ensemble skills. A couple's maximum score was more important than the average of the two.

Three main mechanisms are involved in interpersonal coordination,

- **Anticipatory mechanisms** (being able to predict what will happen next, and work towards a goal)
- **Integrative attention** (being able to divide the attention between your own actions and those of the other players/dancers)
- **Adaptive timing**, (correcting the time discrepancies to keep up with each other)

These important processes may be influenced by social factors, familiarity with the music, and with the stylistic tendencies of the co-performers. Experiments with cooperative tapping led Himberg (2007) to conclude that the role of 'leader' and 'follower' were relative, and not fixed, for they changed as a course of mutual adaptation during the trials. The author insists on the importance of studying sensorimotor synchronization in its social domain, in which it occurs more frequently. The ability to entrain with social abstracted common pulse seems to underlie much of social music interaction.

Why the focus on a social context? According to Himberg (2006, p.1)

"The majority of rhythm production studies on sensorimotor synchronization and entrainment have so far focused on the cognitive abilities of individuals and have not taken into account the nature of music as a social activity. The communication and interaction between performers and dancers and the cognitive processes needed for musical interaction, achieving and maintaining synchronicity, perceiving intentions and setting and aiming for common goals have been studied relatively little within the cognitive experimental framework."

Entrainment refers to different participants adjusting their movements to each other, eventually 'locking in' to a common phase (DeBruyn, 2008; Leman, 2007b). This forms the key to the magical experience of sharing music. But how does entrainment work?
Two main processes characterize this phenomenon: (1) An exchange of the subject's corporeal articulations through different energy channels, which is accompanied by (2) a feeling of empathy and social connectedness.

Social aspects involved in entrainment are therefore important. The development of interactive music systems that can deal with group effects and social music cognition is one of the mayor challenges for music research. Bispham (2007) states that the key to rhythmic feature in human interaction is interpersonal entrainment.

According to the author, interpersonal entrainment is "a multifaceted and prevalent feature of all human interactions (…) from loose subconscious use of pulse as a framework (…)to a strict adherence to pulse (groove) in group behavior and synchronicity of outputs where participants are aware of the pulse framework and desire to maintain a degree of stability and group coordination (e.g., Music and dance)" (Idem, p.129)

From the side of neurology, researchers are interested in solving neurimaging constrains to further research interpersonal coordination. So far, it has been stated that entrainment in dance may simply depend on "low level beat processing, mediated by sub-cortical pathways" (Brown et al., 2005 p.2). The basal ganglia are activated in motor activities with a regular predictability. Dance, like other complex sensorimotor activities, requires the integration of spatial patterns, rhythm, synchronization to external stimuli and whole body coordination. The findings of Brown et al (2005) suggest that many of the brain areas activated for dance are also recruited in elementary sensorimotor activities.

3.2.1.7 Group behaviour

Music provides experiences that encourage social coherence and sculpt personal identity. To improve music technology, not only subjective factors of isolated individuals have to be taken into account, but also the social effects, different kinds of consumption and interaction situations (Hashimoto, 2007).

Individuals can fall back on several behaviour patterns; contextual influences are strong. This can be applied to music: the way we engage in it can influence the behaviour of other participants. Group experience centred research is therefore important, and the embodied approach can be expanded with a context of social interaction.

Sociology has a lot to say about the group dynamics. According to Allport (1962), there is no such thing as "group action". It is all about individuals who think of a group as an entity, and this false perception transforms their behavior. The author suggests that a group is all about the articulations or structuring of individual behavior. These do not involve the total biological organism or the total 'personality' of the subjects, but are patterns of 'specialized segments of behavior'.

Several experiments showed that working in the presence of others establishes certain fundamental attitudes. The theory of collective influence states that individuals tend to conform in a group-situation.

Humans join groups because they are social by nature. The function of groups has traditionally led to higher chances of survival. Joining a group might:

- Protect the individual against uncertain obstacles.
- Help defining identities.

"When subjects are together, there is a marked tendency to converge the judgments towards a central tendency" (Allport, 1962 p.9). According to Sherif (1956), this is due to an 'extension of the social field', in which the norm is circularly involved in the formation of the group itself. The standards become interiorized as a personal value of the individuals. This is how conformity works. In other experiments conducted by Allport (1962; 1924), individuals worked harder when they were together, but did make bigger errors, possibly due to the lapse of attention.

In the experiment done with the 'Sync in Team' game, subjects faced two conditions: a non-competitive one, -alone with the teammate-, and a competitive one -team- vs. team-. In post-surveys, the majority of the subjects answered that they were very distracted in the competitive social condition, by the stylistic variances and movements of other teammates. Sanders (et al, 1978) stated that subjects are often distracted by the presence of others. They want to impress them, and therefore pay less attention to the task. Other studies suggest the contrary: individuals are more concentrated when acting in a group, because they pay attention to the essential features in order to impress the rest (Bond, 1982). Everyone has a desire of consonance, but conformity in a group is more likely to arrive when there is a common goal. Keller (2008) suggests that the more similar the common goal is, the better the coordination between subjects will be.

What Allport defined as ‘collective reality’ is based on the idea that individual behavior is inter-structured with other subjects. The statistical effect of ‘convergence’ towards the mean appears more clearly in the co-working situations.

Convergence of individual behavior has to do with the existence of a common goal, and the strategy chosen to achieve it. This occurs when two individuals articulate the specific ‘life spaces’ of the into an inclusive order. According to Lewin (1936,1947), these life spaces are formed by boundaries; sub regions, experiences, valences and psychological forces. The individual life spaces overlap with others, conforming the life space of a group.

Cartwright and Zander (1953) studied group dynamics and helped to define the ‘locomotion of the group’: the pooled statistics of the behavior of the subjects acting under the pressure of the ‘field conditions’ (pursuing goals, competition, cooperation). Different theories of group perception state that the feeling of self-esteem largely depends on the identification with a specific group (Crocker & Luthanen, 1990; Tajfel, 1982). In the experiments, some groups are composed in advance, while others were formed spontaneously or arbitrarily. Ardts (et al, 2001) points out that the sooner unknown members can socialize in the group, the higher the productivity level will be.

According to Ardts, the following aspects determine the level of cohesion of a group
(1) The interrelationships and (2) The will to pursue the same goal.
Interrelationships are influenced by the potency of involvement of an individual. The will to engage in group activity depends on the amount of reward the individual gets from this close-working structure. Relevant personality trends (structures that are *in* the subject) affect how someone engages in a group. ‘Externally derived interaction patterns’-as and Zimmerman (2004) called them -have influence on internally derived ones, or Allport’s ‘segmented patterns’. One does not enter a group blindly, but carrying some ‘personal baggage’ that may certainly influence how the group works. Latané (1970) stated that the evaluation of other group members is crucial to determine the level of engagement and conformity. If we find the other members competent enough, we are more likely to conform to their opinions. The way group members behave depends to a large extent on their attitudes.

What happens when people examine each other in a group context? When we join a group for the first time, group members evaluate each other and the group as a whole. If the evaluation is positive, the group engagement will rise (Levine, 2004).

Robert Bales (1985) reduced to two the levels that rule a group:

- Instrumental (helps to pursue the goals of the group)
- Expressive (helps to create emotional outputs for the group)

According to De Cremer & Van Lange (2001). There are different approaches to interaction:

- People with a cooperative inclination maximize the common production
- People with a competitive inclination look for a reward greater than that of other group members
- People with an individualistic inclination look for a maximum of personal reward disregarding that of others.

The theory of Tubre and Collins (2000) states that the higher the role-ambiguity is, the lower the group's cohesion becomes. Players of the Sync in Team game who see each other for the first time may have difficulties 'finding' the cooperative strategies at first, knowing who is going to lead and who will follow; or finding out that this is not strictly necessary.

For tasks that demand interaction, communication, observation and cooperation, cohesion is of a great importance. The game involves this kind of cooperation: two micro cells (teams) compete, trying to adjust their strategies. Groups usually have members with similar attitudes or conceptions.

Personality characteristics of individuals are related to the groups they choose and to some degree the behavior of those groups. Above we discussed the fact that we are not likely to display our complete personality in a group. We rather choose to show the face that convenes more. The degree in which those segmented patterns on behavior or adaptation strategies function correctly, affects the productivity of pursuing a goal.

Social facilitation can be defined as "an increase in response by the sight of others making the same movement"(Strauss, 2001 p.238; Allport, 1924 p.262).

Zajonc (1965) dealt with 'dominant reactions' of individuals in a co-working context. If the tasks were easy, the subject would perform even better in public than alone. Exactly the opposite occurs when the subject was not comfortable with the task. Other authors argued that it is not the mere presence of others, but the fear (negative feedback, embarrassment, loss of face) of a negative evaluation, which causes the increment of activity or 'drive' (Corttrell, 1968).
Guerin developed the monitoring model. This model suggests that social facilitation does not take place when the subject feels comfortable with the situation. When we are positively familiar with the persons surrounding us, this effect will not take place. Arousal will increase with the level of uncertainty (Guerin, 1983). This relates to one of the hypothesis of the first experiment concerning the 'Sync' in team' game. The degree of 'uncertainty' will be smaller on subjects that perform the task with friends than those that do it with strangers. Participants that experienced uncertainty performed worse, according to Guerin.

Social attuning and emphatic relationships have to be taken into account when considering group behavior. The subjects, in view of social facilitation, will tend to adapt their expressive behavior to that of other social agents (Bargh & Chartrand, 2005). Therefore regulatory mechanisms take place and seem to play an important role in social contexts. The way an individual processes the music and moves to it is likely to affect other listeners. One of the hypotheses of the experiment is that mutual adaptive behavioral resonances or entrainment are likely to be higher in groups of people who are familiar with each other, or in groups of strangers that despite that fact do feel a strong level of social connectedness.

Repp and Keller (2006) present an important question: does the human capacity for error correction depend on the context? Himberg suggests that interpersonal music interaction and entrainment have a dynamic nature that changes over time, and can therefore not be researched applying inflexible methods. Contexts are likely to be important for expressive behavior.

The experiment itself compares groups of participants who know each other (from now on referred to as 'familiar groups') with others who don't (referred to as 'unfamiliar groups'). Recent research has shown that a 'social factor' regarding music can be measured and quantified (DeBruyn, 2007). In these experiments conducted by De Bruyn, participants -who had to move a Wii to the rhythm of several songs- did so more accurately and intensively in

the social condition than the individual. Seeing and interacting with each other provided a higher entrainment between the individuals.

The spontaneous reaction to music can, therefore and to a certain degree, be measured. Wireless sensors can be of a great use for this kind of research. Advantages are their transportability and flexibility, plus the speed of signal emission. That way, interactions between participants can be measured real-time. The understanding of this social music interaction be of use in fields such as music therapy, music industry and consumer behavior.

3.2.2 Hypothesis

The purpose of this experiment was to observe the possible impact of familiarity on synchronization, interpersonal entrainment and group behaviour. Does the personal relation between the subjects have an impact on any of the following aspects?

- Synchronization to the beat.
- Interpersonal entrainment.
- Intensity of movement.

The hypothesis states that due to a better personal connection and a lower degree of uncertainty, groups of subjects familiar with each other are more likely to cooperate with the team partner, interacting also with other group members. This will result in a higher level of interpersonal entrainment, better synchronization to the beat and higher intensity of movement. The groups formed by unfamiliar subjects will obtain lower scores due to a higher level of uncertainty and a lower verbal and non-verbal communication between the subjects.

The presence of others may determine how we feel and react to the music. Individuals do not have one possible behaviour pattern, this may depend on the context and the people surrounding them. The way in which we engage in music is influenced by the behaviour of other participants, and how we feel in the group.

3.2.3 Methods

3.2.3.1 Participants

50 university students participated at the experiment. They were all between 18 and 28 years of age. Each one of the 13 groups consisted of four subjects. The degree of familiarity between the groups differed: 6 of them were formed by close friends; the remaining 7 were formed by total strangers. The musical training of familiar and unfamiliar groups was balanced. The great majority had followed musical training at the Music Academy. A slightly bigger percentage of participants who studied music on an autodidact manner was present on the groups of familiar members. Conservatory students were equal in number for both groups. Although the percentage of participants with no musical training at all was slightly higher on the unfamiliar group, this was proved not to be significant. They were all voluntary participants, and received a small gift in return for their participation.

3.2.3.2 Material

Experiment done at the IPEM music laboratory. A semi-closed construction was made, isolated with curtains to give the subjects the feeling that they were not being observed directly. The game, that measured a priori the level of synchronization to the beat of the subjects, was made in Max/Msp. The processing of incoming an outcoming signal was programmed in Matlab. All subjects were equipped with one wireless sensor I-CubeX fixed around the waist. The wireless sensors sent acceleration data from three axes. This was processed into BPM data, compared with the BPM of the music files, and elaborating a 'score' for each team. This score of was sent to the patch processing the visuals in Max/Msp, and from there to a Sanyo PLC-XU105 beamer that projected lightening on the floor. The higher the score, the wider the area of the light-feedback became. Participants could hear the songs through 8 Altec Lansing MX5020 loudspeakers installed in each column of the construction.

3.2.3.3 Stimuli

8 songs were used; each one of them normalized at 125 BPM, but differed in rhythmical and melodical complexity. In some of them, the beat was really easy to follow, while in other songs the beat seemed to 'skip away'. This is possibly the result of for example rhythmic/melodic ambiguity or specific sound effect like reverberation or panning. A group of expert musicologists at IPEM evaluated and ordered the degree in which the beat could be followed in the 8 songs from easy to harder. To keep focus on rhythmic complexity only, strong stylistic differences were avoided. All 8 songs responded to the category of 'electronic music', diverging in sub genres. Here they appear ordered from easy to harder to follow.

Artist	**Song**	**Original BPM**
Sneaky Sound system	When we were young	122.00
Kraftwerk	Roboter	122.07
Les Rythmes Digitales	Dreaming	122.80
Les Rythmes Digitales	Hypnotize	127.86
Aphex Twin	Untitled	144.43
FPU	Ocean Drive	134.03
Dj Hellfish	Rampage	218,50
Dj Scotch egg	Acid boy	169.40

Table 1 Songs used in experiment 1, ordered from 'easy' to 'harder' regarding the clearness of the basic beat or musical pulse.

Songs were displayed in this order. One of the purposes was to observe if the subjects reacted to this increasing level of rhythmical ambiguity, or if they would experience it in another way.

3.2.3.4 Procedure

Groups of four participants arrived, and filled in a small pre-questionnaire regarding their age, musical training, and some general aspects of their personality (i.e. extrovert or introvert, competitive/not very competitive). This was not in order to make in-depth psychological distinctions, but to have a reference on how they perceived themselves at that moment.
The group had to discuss the formation of two teams, each of them containing two subjects. One team had to stay in the experiment room, while the other team was taken to a waiting room. The first team was introduced to the experimental set-up, and equipped with sensors. They stood in the middle of the dance area while the explanations were given. These consisted of several basic rules to play the game:
"You're going to hear 8 short songs, each one with a beat in it. You have to synchronize your bodily movements to the beat in order to play. But you have to do this *together* with your team partner. Both of you have to stay synchronized to the right beat in order to succeed. The result of how well you are doing is reflected on the floor, as a constant reference of your synchronization level."
When the first team had finished the first condition (from now on C1), the second team could perform the experiment while the first one was guided into the waiting room.
The second condition (From now on C2) consisted of exactly the same operation, but this time in a competitive manner. Each one of the teams was now familiarized with one color, and had to compete for the best score. The two colored lights on the floor helped to enhance this competitive feeling. Of course, looking at each other, imitating moves, talking, bringing the other team out of concentration and all imaginary strategies were allowed in order to win.
When the C2 was finished, participants had to fill in a post questionnaire regarding their experience during the game: difficulty of synchronization, possible influence of relation with team partner, strategies used, familiarity of the music, suggestions to improve the game, etc.


Figure 9 Two experimental conditions: one with just the team-partner (C1) and another competing against the opposite team (C2)

3.2.4 Analysis and Results

Two groups of familiar members had to be deleted because of missing data. 10 groups were then compared: 6 groups of unfamiliar members against 4 of familiar ones.
The data captured with the wireless sensors consisted of three acceleration time series, one for each axis of the local frame of the accelerometer. These data were sampled at a rate of 200Hz.
The point of focus was threefold:

1. The amount of time each participant synchronized with the music.
2. The movement intensity of each participant, and, by extension, of the groups.
3. The movement correlation between the team partners and, by extension, the group members.

3.2.4.1 Synchronization scores

Two possible ways were found to obtain the synchronisation score:

1. Focus on the BPM (BPM score): The number of seconds during which participants moved in the same BPM as the given stimuli (double and half tempo taken into account)
2. Focus on the PHASE of the acceleration (PHASE score): the result of comparing a sinusoidal signal of 125 BPM with the acceleration data of the participant. This

has a more direct connection with the profile and dynamics of the movement and not only with beat accuracy.

After performing several tests, it became clear that the acceleration data was did not have a normal distribution. To further analyse the data, non-parametric tests for two independent samples (Mann Withley and Wilcoxon) were applied because of their capacity for determining whether or not the values of a particular variable differ significantly between two groups (familiar vs. unfamiliar). These tests make no assumptions about the parameters of a distribution, nor do they assume that any particular distribution is being used.

BPM score

In order to analyze the synchronization to the beat, the number of seconds the participants synchronized correctly was systematically extracted from the acceleration data during the experiment thanks to Matlab and Max/Msp procedures. The mean of the BPM scores was calculated per participant and condition, so that a total score of each condition could be compared between participants. The impact of the songs and condition was checked, and no significant influence was found. This is perhaps due to the stable BPM of 125 for all songs. The mean amount of seconds that participants had stayed synchronized to the beat could thus be compared.
Subsequently the general results for the different conditions were compared (See Fig. 10). Although the BPM scores were slightly higher in C1 than in C2, this difference proved not to be significant.

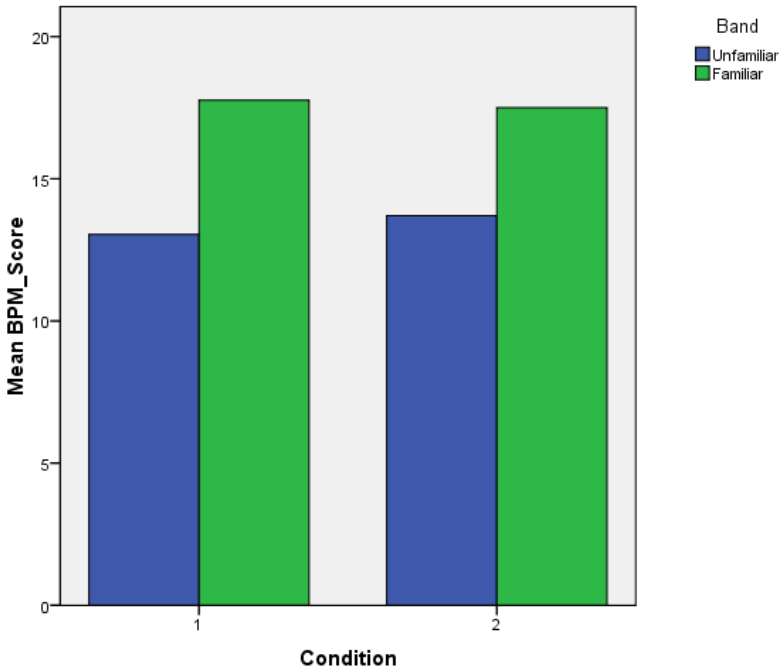

Figure 10: Mean BPM score; Comparison among conditions. No clear differences are observed between C1 at the left, and the C2 at the right. But familiar groups (green bars) do score significantly higher than unfamiliar groups (blue bars)

The results from experiments regarding group synchronization proved that individuals synchronize better to the music in the social than individual condition. (DeBruyn et al, 2007) Here, despite the expectations, the presence of others did not encourage the subjects to synchronize better to the beat, rather the opposite. The BPM scores, as seen in Fig. 10 and 11, do not show clear differences between the conditions. It has to be remarked, however, that the procedures were different. In de current experiment, C1 demands to perform the experiment alone with your teammate, while C2 involves competition against another team. It is not an 'individual condition', for subjects always operate in teams of two players. The competition factor may also be higher than in the experiments conducted by DeBruyn, due to the team-factor, color differentiation and changing light feedback. The competitive factor, plus the presence of other players, may cause a higher level of arousal or distraction.

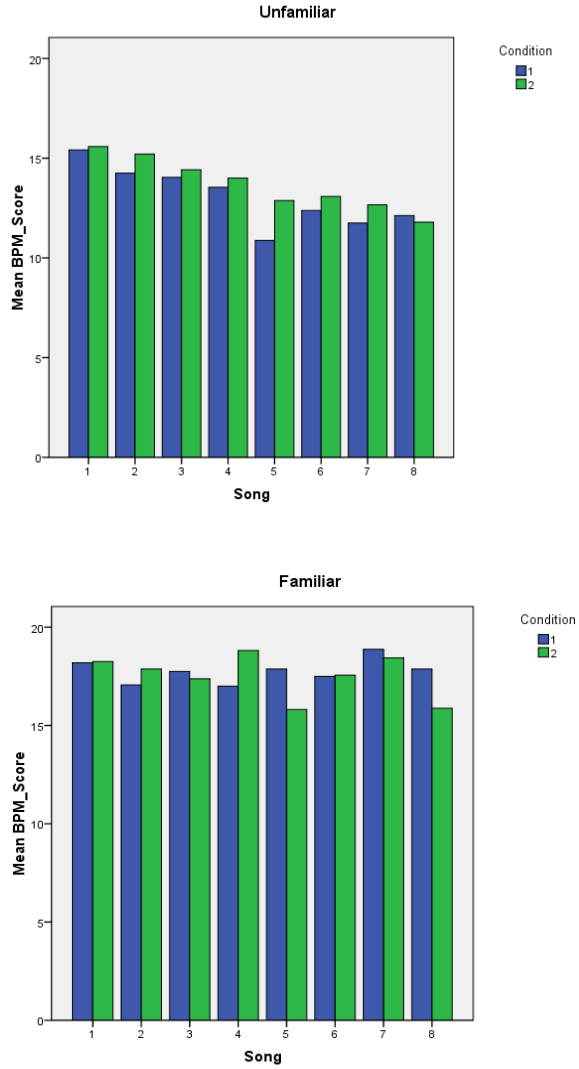

Figure 11 Mean BPM score. Comparison among familiar and unfamiliar groups. Unfamiliar groups, on the left, scored higher on C2 (green bars); Familiar groups, however, seem to score better in C1 (blue bars). Differences among conditions, however, have not proved to be significant.

Remarkably, a larger percent of the subjects responded to have synchronized worse in C2, 60% of them specified that this was due to the distracting presence of the other team. Their perception of the own performance was rather accurate.

The next step in the analysis, after checking for normality, was performing series of non parametric tests (Mann-Whitney, Wilcoxon rank-sum test and Two-sample Kolmogorov Smirnov) to compare the performances of familiar and unfamiliar groups in the non-normal distributed data. The Mann-Withney and two sample Kolmogorov Smirnov test were used to

compare results between bands. Wilcoxon rank-sum was used to calculate the probability was of familiar groups scoring higher than the unfamiliar ones.

The tests showed that there was a clear and significant ($\alpha<0{,}005$) difference between familiar and unfamiliar groups, confirming the hypothesis that familiar groups synchronized with the beat longer.

The U statistic was calculated using the Mann Whitney and Wilcoxon. Results revealed that participants who were not familiar with each other had a possibility of 74% to score lower than the members that were familiar with each other.

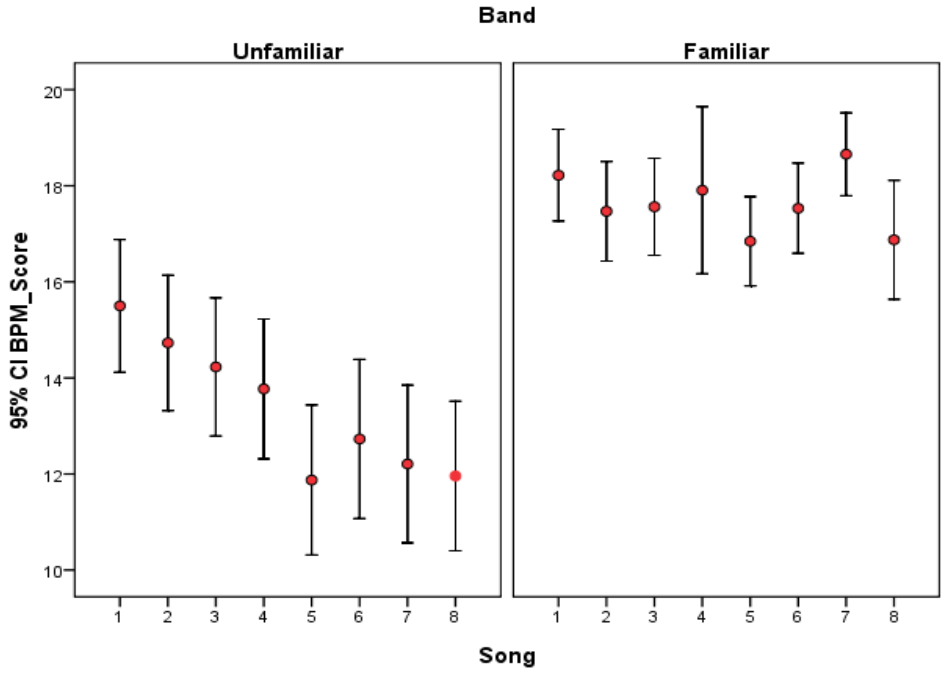

Figure 12: BPM score; General Comparison among familiar and unfamiliar groups. Mean taken of two conditions on the Y; X shows the development throughout the songs. Familiar groups scored significantly higher (right) than unfamiliar groups (left). The profile throughout the songs varies as well.

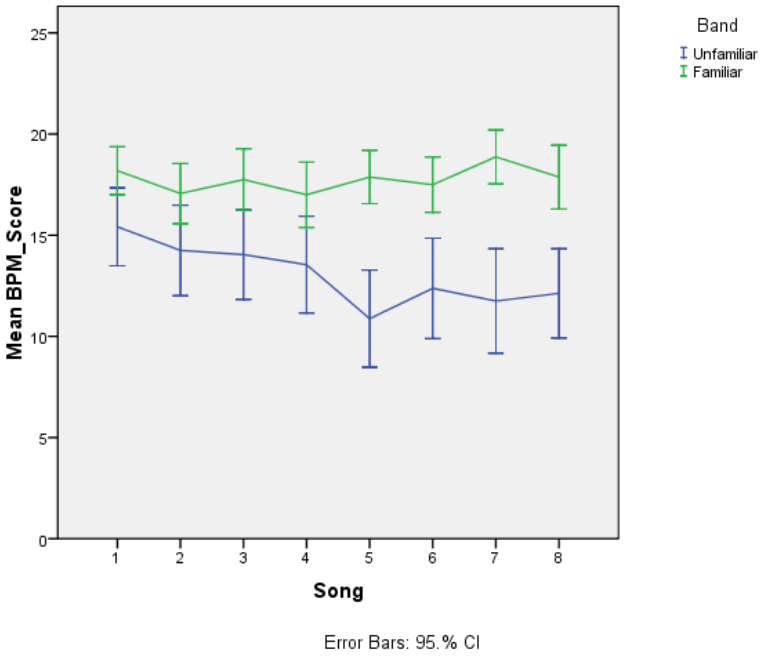

Figure 13 BPM scores for C1, Comparison between unfamiliar (blue) and familiar groups(green). Familiar groups score significantly higher. The expected increasing difficulty curve throughout the songs is apparently only present in unfamiliar groups.

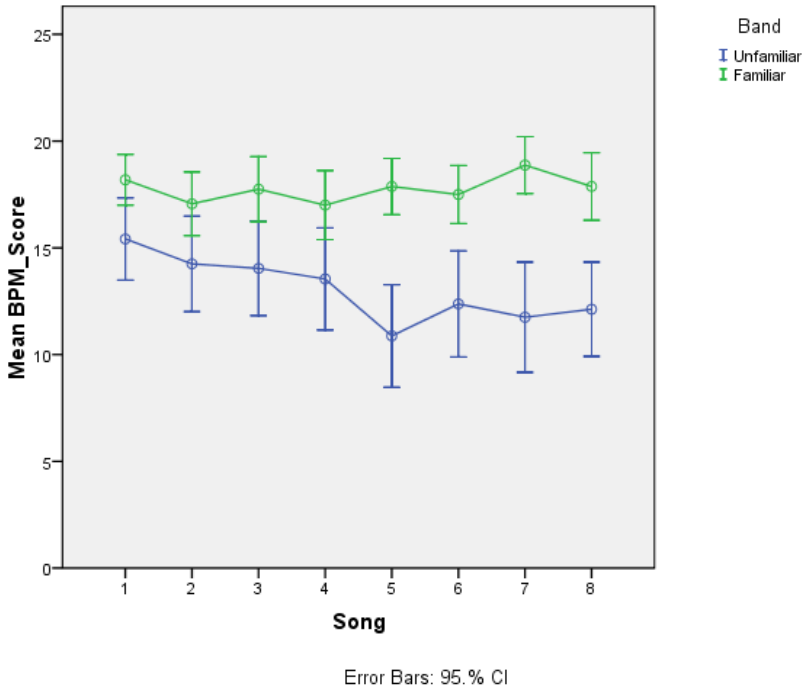

Figure 14. BPM scores in C2, Comparison between Unfamiliar and Familiar groups. In the C2 or competitive social condition, the familiar groups (green)still have the lead. Extremer ups and downs are shown throughout the songs, but only for the familiar groups. Unfamiliar groups (blue) present a lower score with the increasing rhythmical difficulty, as expected, but with a low peak on song 5.

As seen in Figures 12, 13 and 14, groups formed by familiar members had better results on the BPM-score. This means they stayed synchronized with the beat longer than members of unfamiliar groups. Similar results were found for the two conditions.

What about the evolution of the scores through the songs? Even though the tests revealed no determinant influence of the song, BPM score did show variation. Which songs were more difficult to synchronize to? Song 5 and 8 seem to cause most difficulties.
Interesting to see is that this changes with the conditions. During the first condition, unfamiliar groups only managed to synchronize to the beat 11 times, this slightly improved in the second condition (See Table 2).

	Condition 1 Mean seconds of synchronization/song		Condition 2 Mean seconds of synchronization/song	
Songs	Unfamiliar	Familiar	Unfamiliar	Familiar
S1	15''	18''	16''	18''
S2	14''	17''	15''	18''
S3	14''	18''	14''	17''
S4	14''	17''	14''	19''
S5	11''	18''	13''	16''
S6	12''	18''	13''	18''
S7	12''	19''	13''	18''
S8	12''	18''	12''	16''

Table 2 Mean number of seconds that familiar and unfamiliar groups were able to synchronize to the beat of the 8 musical stimuli (Songs 1 to 8).

The difficulty of song 5 (Aphex Twins' *Untitled*) may be attributable to a subtle shift effect that blurs the presence of the beat. Melody line and rhythm interact in this grey zone, introducing two slightly shifted periodicities. While some participants follow the melodic line, other focus on the percussive one. Assuming that imitation plays an important role during the task, discrepancies between the participants response may have enduced low BPM scores.

Song 8 (Dj Scotch egg's "Acid Boy") was deliberately chosen by the experts as the most difficult one, due to the different rhythmical layers that interact, distracting the listener from the basic 125 BPM. While unfamiliar groups show a clear decreasing line through the songs (See Table 2), familiar groups seem to have a more stable performance during the stimuli set.

Phase Score

The comparison of the acceleration data and a signal of 125 BPM provided information about the phase in which individuals moved more often. Vertical movements correspondent to the 'Y' axe of the sensor -like jumping-were the most popular ones.

Figure 15 Vertical movements are predominant, according to information registered by the sensors.

The acceleration data registered by the sensors was split and filtered into three boxes representing the movement axes (X, Y, Z). This was later compared with pure signals of 120 to 129BPM, to 125BPM. The resulted graphics showed which axis had been stimulated the most.

Generally, in order to keep the same tempo, players tried to attune each other's movement patterns. This is shown in the following figure (Fig.16), al participants activate the same axis (Y).

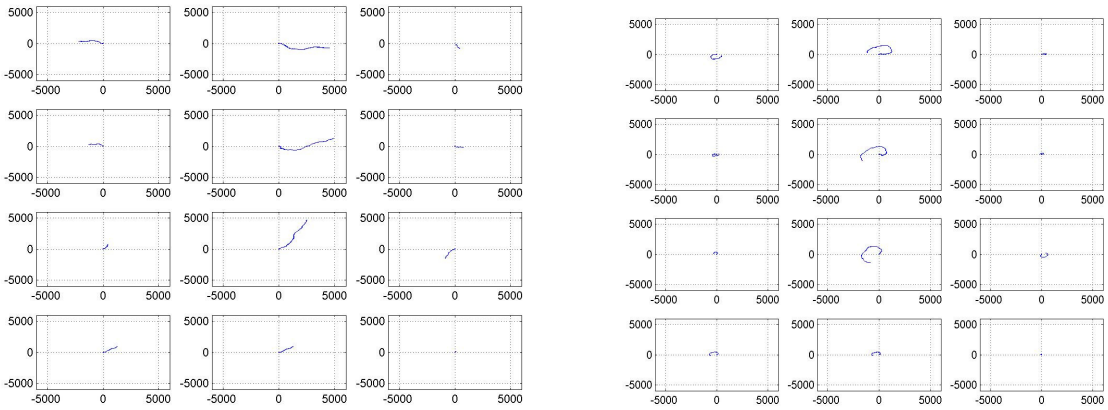

Figure 16. Phase analysis. The acceleration data corresponding to the 3 axes (axes) X,Y,Z, for the four participants (rows) of group 9 at 125 BPM. Activity in the middle-box (the Y axe) is clearly predominant.. All players were moving vertically.

3.2.4.2 Movement intensity

The quantity of movement: the total intensity was extracted from the 3 axes of the acceleration data. Each value was compared with the last one performing an extraction. The intensity levels of the three axis resulted in a Total Intensity Value for each participant/ song. Interestingly enough, the movement profiles show resemblances between the unfamiliar and familiar groups when adding up the two conditions. This means there are resemblances in how intensively the participants moved through the set. They started moving quite intensively during song 1, less during songs 2, 3 and 4; followed by a low peak during song 5 and high peaks during songs 6 and 8.

Song 5 has already proved to be a difficult obstacle, probably due to its shifting beat. This might have hindered the dancers to move more intensively, worried as they were to find a correct strategy. The high peak at song 6 (FPU's "Ocean Drive") might be applicable to the fact that the human voice is the most prominent in this song than in all other songs. The line sung might have a stimulating effect, especially after several pure instrumental-electronic songs. Another possible explanation is the relief brought by the end of problematic song 5, bringing more energy into song 6 (See Fig. 17)

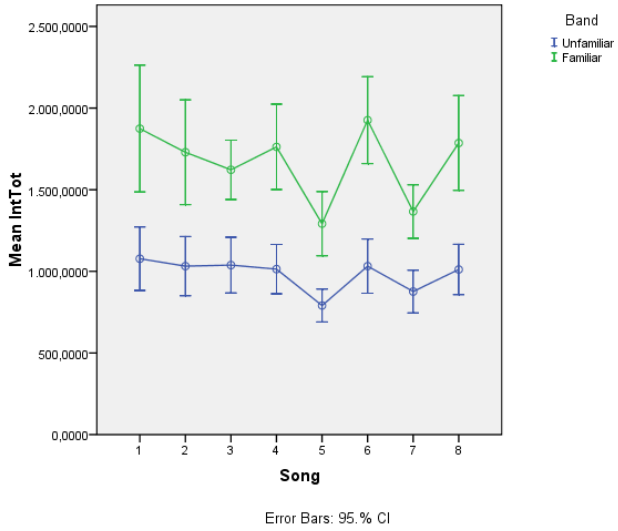

Figure 17. The general intensity profile through the songs is similar for unfamiliar (blue) and familiar groups (green); a slightly decreasing start, with a low peak during song 5 and 7 and higher levels during song 6 and 8.

From the BPM score we were unable to deduct that participants had synchronized better to the beat in the social condition. Intensity of movement, however, show a different picture. The Mann-Whitney test confirm that there is a significant difference between C1 and C2: individuals have moved significantly more when dancing in group than in isolated cells of two.

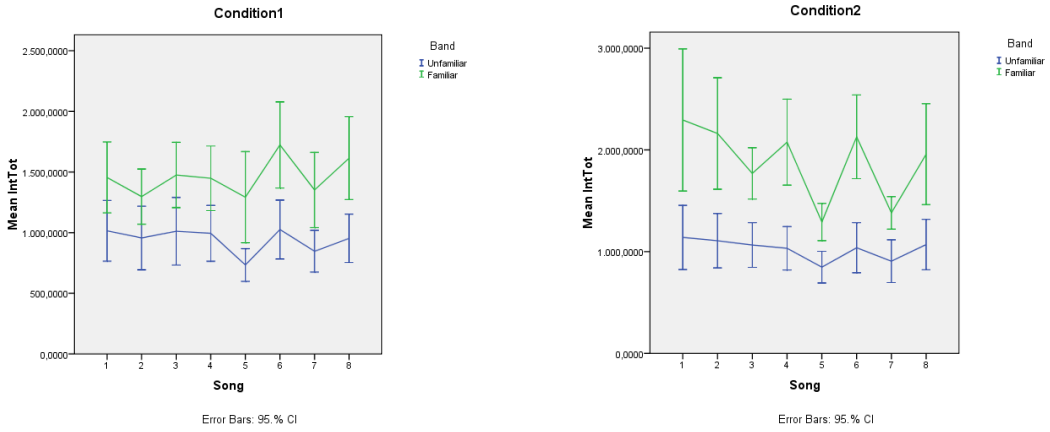

Figure 18. Intensity of Movement for both kinds of groups in C1 and C2. The social competitive condition (C2, on the right) shows accentuated peaks for familiar groups (green), while unfamiliar groups (blue) are rather stable.

As seen in Fig 18, familiar groups do not only move more, but change a lot from one song to another, possibly due to social factors. Unfamiliar groups concentrate on the task, without excessive movement, while familiar groups interact more lively and cohesively. Video data highlighted this fact. Participants that know each other are not only performing a task, they are having fun. They express this by moving more intensively than individuals of unfamiliar groups.

3.2.4.3 Correlation

In order to measure the correlation between the team-mate's movements, the acceleration files were systematically compared, introducing a margin for possible lags or delays between participants. Assuming that lag = 0 is the ideal (dancers are synchronized with each other without any delay), a correlation score was then obtained, counting how much the participants' acceleration patterns differed from each other within a pair. Departing from lag=0 meant gradually decreasing scores for the pairs of participants. The correlation analysis method was done in Matlab (Demey, 2008), based on the cross-correlogram technique developed in the Finnish Centre of Music Research (Himberg, 200; Toivianen, 2004).

A first look at the correlation scores revealed better results for the individual team condition than for the social competitive one (Fig 19.). Further non-parametric test confirmed this impression, revealing that teams had synchronised significantly better in C1 than in C2 ($\alpha <$ 0,05). These results correlate with those from the survey, in which circa 70% of the players characterized the social competitive condition as more difficult and distracting for the team, because of the presence of other players and the stress caused by competition.

Video monitoring reveals that participants –especially those formed by familiar members- react strongly to the presence of others, establishing different additional patterns of interaction, and therefore concentrating less intensively on the task.

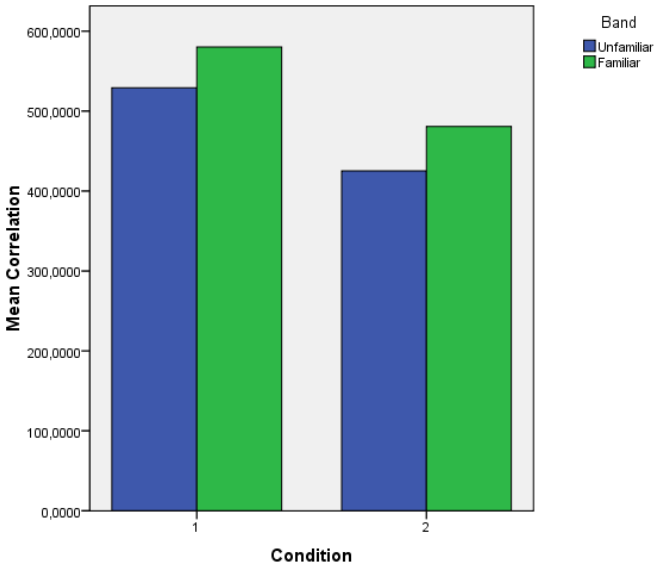

Figure 19: Mean Correlation between pairs of participants; when comparing C1 (on the left) with C2 (on the right), it is clear that teams achieved a higher correlation when dancing alone that when competing with the other team.

In regard of one of the initial hypothesis, stating that familiar groups were likely to achieve a higher correlation that unfamiliar groups, several tests were performed. A first box plot pointed in that direction; familiar teams had correlated better than unfamiliar ones. A Mann-Whitney test applied to the results found the difference to be significant, and therefore more pronounced, in the second condition.

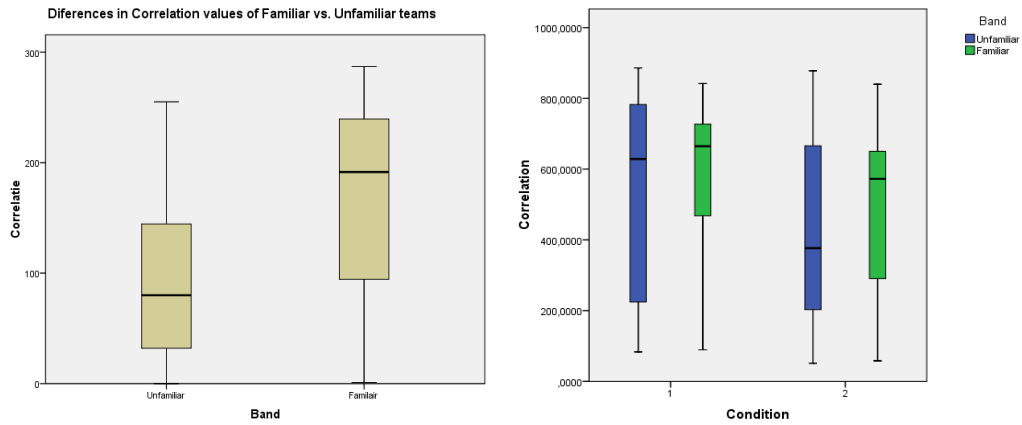

Figure 20: Correlation values; comparison between familiar and unfamiliar groups in the two conditions. Generally speaking, familiar teams correlated slightly higher. This difference, however, is more pronounced in the second condition.

3.2.4.5 Survey

As mentioned before, all participants filled in a pre and post survey, regarding aspects of their musical experience and personal inclinations. The goal was not to obtain an in-depth analysis of the participants, but impressions of how they perceived themselves at the time of the experiment. Bipolar questions, like introvert/extrovert, confident/unconfident were used as a mere indication. The point of the questionnaire was to investigate the possibility of correlating the answers with aspects of the acceleration data afterwards. This is an example of approaching 2nd person descriptions (questions regarding the team partner and their synchronization) and 3rd person descriptors (acceleration data obtained by the sensors), and see if they match. For questions regarding their personal involvement and self-perception, 1st person descriptions are correlated to the sensor data, in order to look for possible resemblances.

Confidence during the task

Participants had to answer if they had felt confident before and during the task. An initial hypothesis stated that individuals who perceive themselves as confident before and during the task would synchronize better to the music and move more intensively.
After checking for normality, a T-Test test was performed in order to compare the answers with the mean intensity levels and BPM scores. It proved to be significant (0,026 of $\alpha<0,05$): participants who had given a positive answer to the confidence questions had also moved significantly more and reached a higher BPM score.

Introvert/Extrovert

One of the questions in the survey regarded aspects of personality. Without the intention of finding an absolute characterization, answers to the question “Would you define yourself more as an introvert/more as an extrovert?” were used as indication of how the participants perceived themselves at the time of the experiment.
A first look at the scores revealed that these were quite balanced. Nor ‘introverts’ nor ‘extroverts’ had scored better. Although the extroverts reached a higher intensity, the Mann-

Whitney test proved the difference not to be significant. Separating the data into familiar and unfamiliar groups offered a different view. For familiar groups, it did not matter if members were ‘introverts’ or ‘extroverts’. For unfamiliar groups, on the contrary, it did matter. This applies especially for the first condition, in which unrelated partners had to dance together for the first time. In unfamiliar groups, extroverts dared to move more, and the difference was proven to be significant by the non-parametric tests.
This could be explained because of the level of arousal; dancing in an experiment with friends is less demanding than doing so with total strangers. Considering these parameters, the extrovert factor has much weight. Extroverts of unfamiliar groups did not necessarily score better, but they dared to move more, in both conditions.

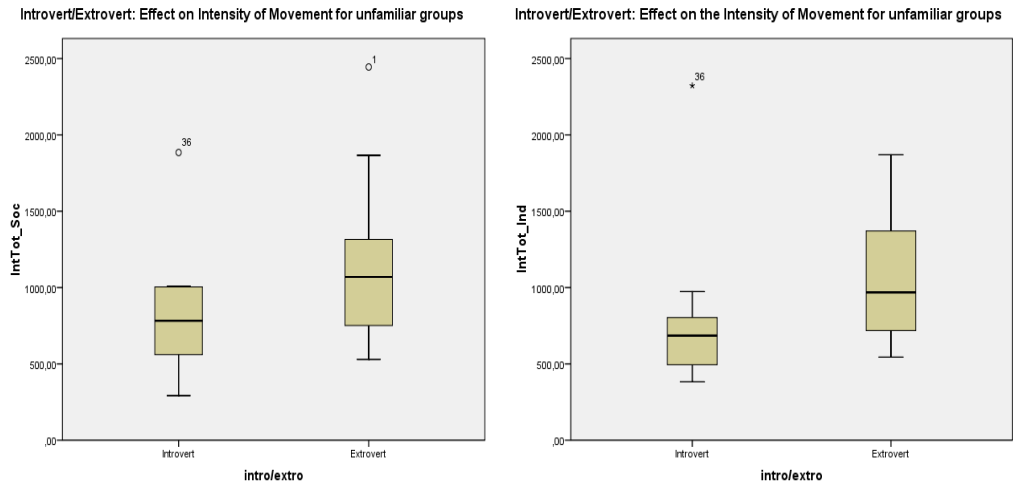

Figure 21 C1 and C2 for unfamiliar groups: Perceiving yourself as intro-or extrovert may have an effect on the movement’s intensity, particularly when dancing with unfamiliar members. ‘Extroverts’ moved more intensively than ‘introverts’ during the task.

Perception of synchronization

In an attempt to learn how people felt in reference to a second person (the team partner), several questions were asked, for instance:

- What kind of strategies did you use to stay synchronized with your team-partner?
- How difficult was it to establish/maintain synchronization?

- Who was taking the lead in the team?
- Do you think the relation with your team partner had any effect on the way you tried to stay synchronized with your team partner?

The main objective was to correlate these answers to findings in the acceleration data and video observations.

Regarding the synchronization strategies, some surprising results came up. 'maintaining eye-contact' was not a popular option, only chosen by 30% of the participants. 'Giving verbal instructions' was only selected by familiar teams. This may suggest that this strategy is too direct for unfamiliar team-partners. 'Accentuating the beat with movements that would make the team-partner follow' was by far the most popular option, selected by 80% of the participants. Other spontaneous answers were 'looking at each others sensor' and 'imitating each other's movements'. Video material supported this aspect: several teams tried to synchronize by performing very similar choreographic patterns, even if this was not strictly necessary. No link was found between any of these synchronization strategies and a higher or lower movement intensity/BPM score.

Figure 22 In order to synchronize with each other, team partners often chose to imitate each other's choreographic patterns.

Teams were quite accurate in evaluating their performance. The answer to the questions ¨How difficult was it to establish/maintain synchronization with the team partner? ¨correlated closely to the BPM score, especially for the first condition. The presence of light-feedback of course served as a reference, but it still is interesting to see how people perceive their own team- synchronization. Team-partners, who evaluated their synchronization as easy, moved more intensively than others who characterized it as difficult. Excluding one exception, the answers of the team-partners matched very closely. This suggests that a successful synchronization between two players is something perceivable by those who are a part of it.

The fact that the answers to the questions related to the leadership in the team and length of synchronization matched as well highlights this idea.

3.2.5 Discussion

Musical joint action is, according to Keller (2008) a rich domain in which to investigate the cognitive processes and neural mechanisms that support interactive enaction and intersubjectivity. Sensorimotor synchronization is being researched with several goals; and clarifying the link between social and musical interaction is surely one of them (Himberg, 2007).

Although no previous experiments have proved the link between familiarity between the subjects and an optimal interpersonal synchronization, the results of the experiment at IPEM point in that direction. They suggest that social and contextual aspects may influence the way we interact musically. As music is in its essence a social phenomenon, it is useful to investigate the underlying mechanisms of interaction in contexts, in which it plays a fundamental role. Participants who were familiar with each other, moved more intensively than those who weren't. They also managed to synchronize better to the beat, and, in a large majority of cases, correlate better with each other.

Video material gives a partial explanation of this phenomenon; unfamiliar groups are far more static and inexpressive (See Fig. 23). Knowing that the sensors are located on the hip, and that therefore arm movements were not strictly necessary, they tended to synchronize using short calculated movements focused on hips and legs, without using the arms. Familiar groups, on the contrary, move the arms, shout and laugh, even if this will not necessarily help to win the game. They add an extra aspect to the game, originated in interrelationships brought from outside the magic circle. They feel comfortable with each other, and that influences the way they approach the musical interface.

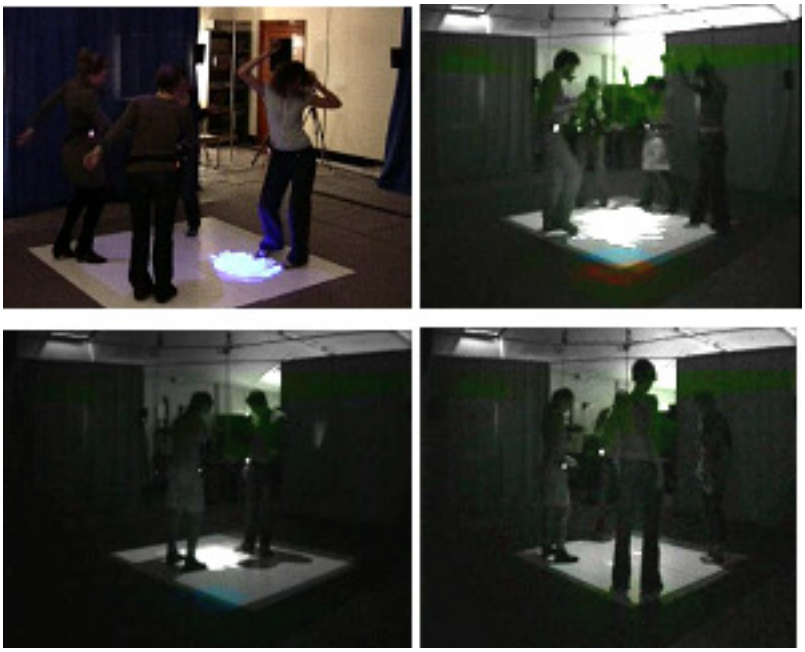

Figure 23 Difference in expressions: familiar groups (above) use their arms while dancing, even though the sensors are located on the hip. Unfamiliar groups (below) remain to the hardly necessary and avoid using the arms too much.

A greater understanding of the social factors that influence musical behaviour might help to create and develop new commercial and research tools, meant to made the barrier between humans and technology as little as possible.
Further experiments in this matter are needed in order to confirm the initial hypothesis; more and more subjects with different backgrounds should be tested. Future directions at the Finnish Centre of Music Research projects include, for example, applying the knowledge about social and musical interaction for cross-cultural investigation of rhythm production. Methodologies are to be improved in order to register movements as naturally as possible. Spontaneous reactions to music are the key to new developments.
Yet the question remains: what kind of movement features, other than velocity, should be measured? (Leman 2007a).

3.2.6 Conclusion

In this case the social gaming context was used to develop an experiment regarding sensorimotor synchronization and interpersonal coordination. Results suggest an influence of the familiarity among players on their synchronization and movement intensity. Further research is needed to confirm this initial hypothesis with a larger and more varied amount of participants. Information on social factors and its influence on music interaction is the key to the development of new transparent technologies.

3.3 Experiment 2: How the public reacted to the Sync in Team game.

3.3.1 General introduction to the events

The cited experiment ‘Sync in Team’ was re conducted in several scientific fairs, for a public of all ages. To encourage participation of as many subjects as possible, only the competitive condition of two teams at a time was employed. The focus of this research was pure observational: the goal was to register the reactions of the public, using video material and short interviews to plan future improvements of the game. Due to the variation of the public’s age and background at public science fairs, results have to be viewed within a broad perspective.

3.3.1.1 Material

The installation highly resembled the one used at the laboratory. The context of a science faire, with it large number of visitors, demanded a reconsideration of the setting and materials. Therefore, a few changes were made, including a better resistance, flexibility and presentation. The sensors, for example, were packed in small compact bags. The colour of each team was indicated as a big spot (see Figure 24), emphasizing the difference between teams, and therefore enhancing competition and participation of the public.

Figure 24 Each team was characterized by a visual element: a coloured spot on the sensor strapped around the waist. That helped the audience to recognize the teams en encouraged competition and fun.

Considering the presence of an audience, a screen was placed outside the tent, showing what was happening inside. Leaving big areas open to the public (see Figure 25), helped to transform the installation into an interactive one, which anyone could join.

Figure 25: Open areas made it possible for the public to follow the game and to encourage the participants.

3.3.1.2 Participants

160 participants played the game, with an average of 14,5 years of age. As shown in the figure below, participants consisted mostly of children and adolescents, followed by young adults. The formation of teams varied enormously, going from parents competing with children, classmates to casual friends or complete strangers.

3.3.1.3 Procedure

The visitors interested in the game teamed up in duos, four people per test. Sometimes, though, due to technical limitations or explicit request from the participants, the game was played one on one, or even individual-against-machine. Once selected, they had to split up in two teams. The next step was equipping them with a sensor-bag and giving them the necessary instructions. Before the game started, a number of basic questions regarding age and participants' names were asked. A list of several genres (see 'stimuli' below) was offered to them. The development of the game had an improvisational character, teams were formed rapidly and only the strictly necessary instructions were given. Visual feedback was projected

on the floor exactly like during former experiments. This time, though, the main instructions to the game were also projected on the floor between sessions to attract visitors.
Each game session lasted for approximately 5 minutes. Several participants were asked a few questions about their experiences afterwards.

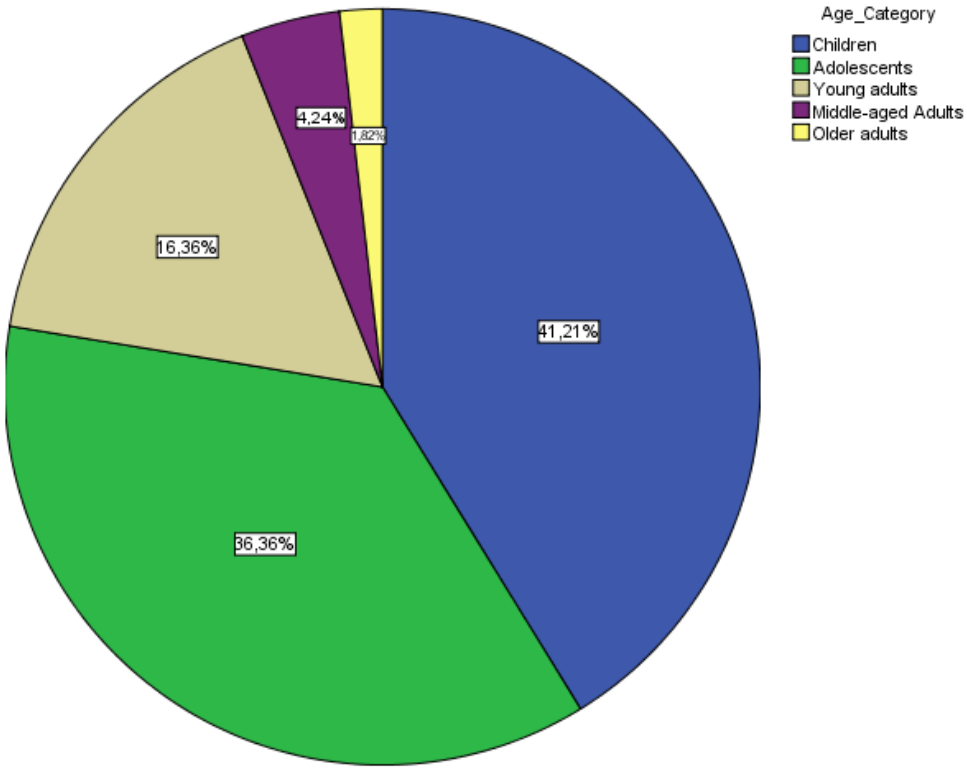

Figure 26: Distribution of participants at the events. Mostly, children (0-11) and adolescents (12-17).

Stimuli

To enhance variation, different musical genres were introduced. All teams had the possibility to choose from:

1. Latin
2. Classical
3. Rock
4. Hip-hop
5. Electro
6. Children songs

Quit often, though, both teams requested the same musical genre. This was possibly due to a sufficient number of musical excerpts. All songs lasted 30 seconds. The BPM for each fragment was calculated with specialized software (Van Aeken, Jackson 1.34) and varied from 90 to 172 BPM. The methods to compare the tempi of the accelerometers with the ones from the stimuli was the same as in the laboratory experiments; a combination of an algorithm in Matlab with Max/Msp patches that projected the visuals. This time, however, different musical genres were introduced, for whiche the patch was enlarged and adapted.

3.3.2 Analysis and results

The main object of the research on the science fairs was to observe the reactions of the public. Two lines of investigation tried to register which genres were more popular with which age groups, and also to establish some basic movements that the different musical genres could encourage. The choice of genres was noted, and could therefore be transcribed and analysed. The data coming from the accelerometers was automatically linked to a code that indicated the musical genre. Following this procedure, it became possible to see which genre favoured better results.

3.3.2.1 Genre preferences

As seen in figure 27, the most chosen genres were Hip-hop (36%) and Children songs (19%). Classical and Latin were less popular, respectively representing only 7% and 3% of all choices.

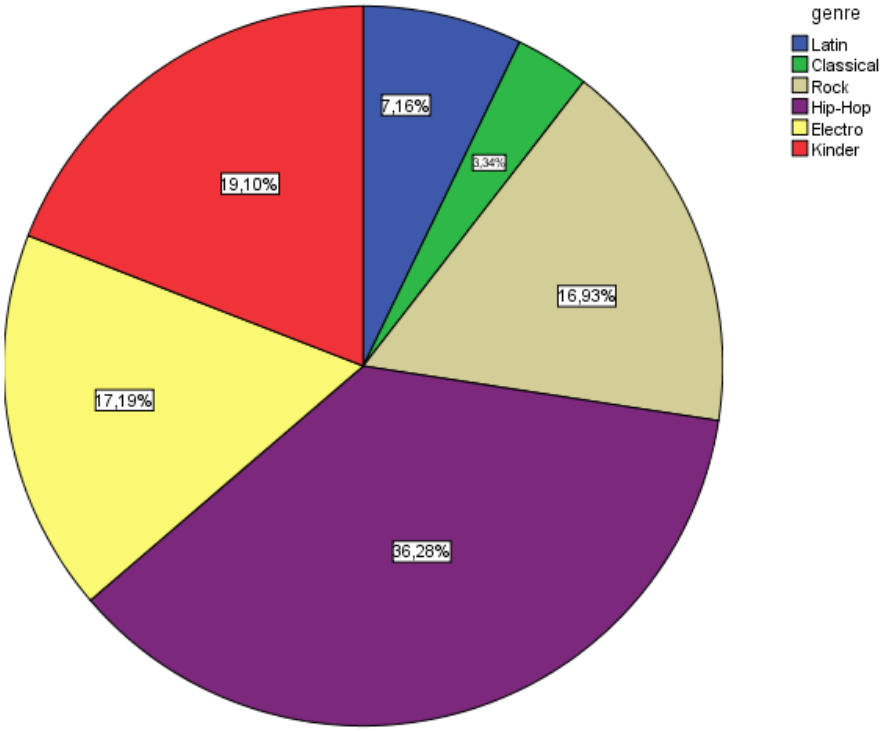

Figure 27 Popularity of different genres during science fairs. Hip-Hop (36%) was the most popular, followed by Children songs (19%) and Electro (16%)

To compare the different preferences regarding age, participants were divided into age categories during the analysis. Even though neither sociologists nor psychologists can define strict universal age categories (several factors may have an influence, e.g. culture or historical period) a general consent could be achieved regarding users categories in western countries (Bailey, 2002):

- Childhood: 0-11
- Adolescence: 12-17
- Youth: 18-39
- Middle-age: 40-59
- Third age: 60-85.

This general division, although never completely accurate, was accepted as a basis for comparing musical tastes for this experiment. The difference between these age categories was significant. An analysis per age category follows.

Children showed a preference for hip-hop (42% of them selected it to play the game); but other styles, like electro (29%) and of course children songs (17%) also enjoyed popularity. Figure 28 shows this distribution. All genres, excepting for classical music, were chosen by these young participants.

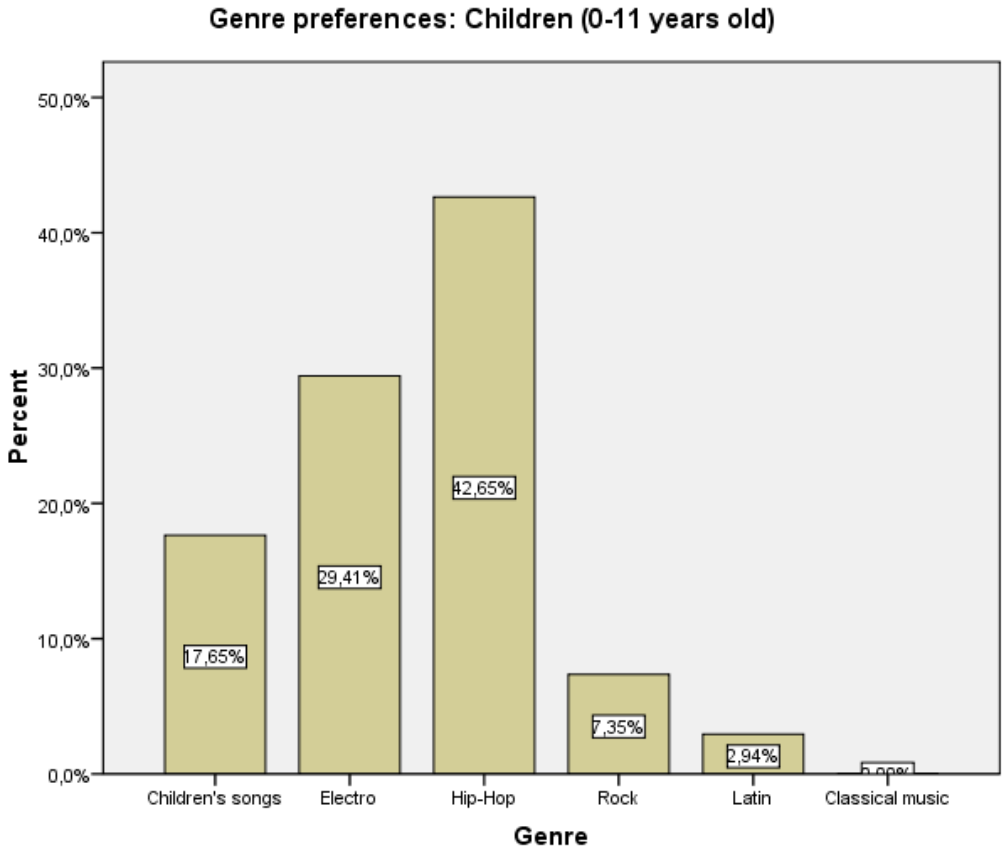

Figure 28 Genre preferences for Children at the science fairs. Even though Hip-Hop wins as the most chosen genre, all other styles are given a try, excepting Classical music.

The profile of preferred genres by the adolescents resembles that of the children (hip-hop is the most chosen one, with 43%), but this time the difference is the introduction of classical music (8%), and the rise of rock music (21%). Adolescents did not choose Latin at all. (See Fig. 29)

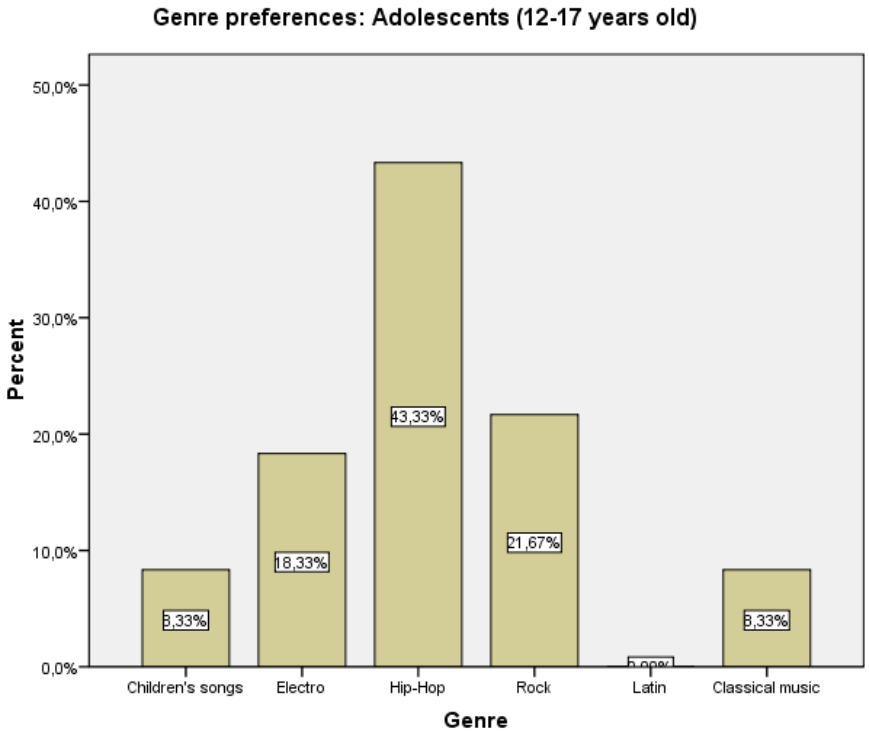

Figure 29: Genres preferred by adolescents. Hip-hop scores best; while rock and classical music gain importance.

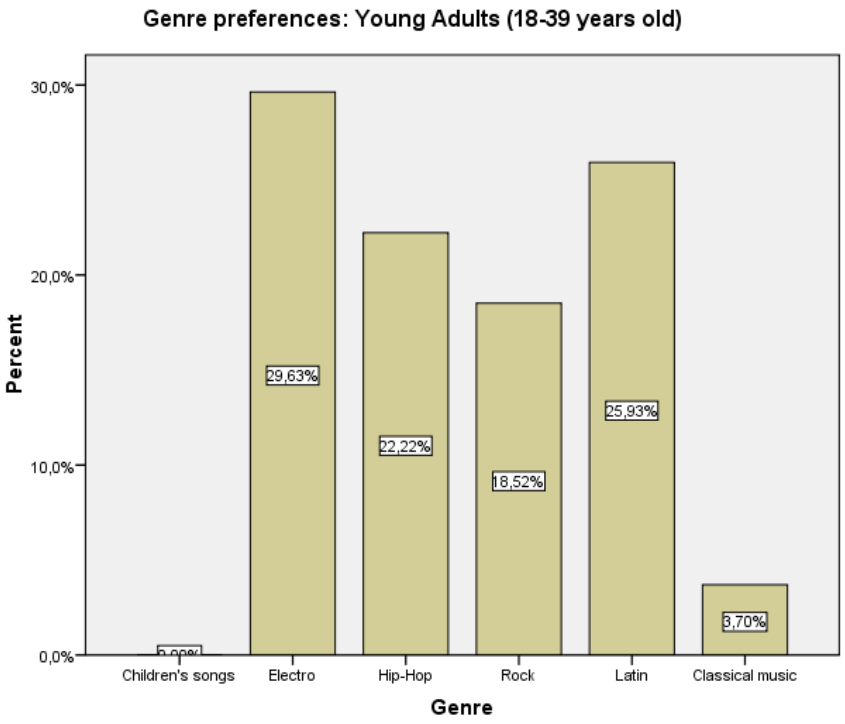

Figure 30: Genre preference with young adults. Electro and Latin take the lead.

A remarkable difference takes place with young adults. Hip-hop gives place to electro (29%) and latin (25%), ending only as the third most popular genre. Rock ends up fourth. Young adults completely denied the option of Children songs. Middle-aged adults (Fig. 31) were not as interested in hip-hop as they were in rock (57%) and latin (42%). This obvious tendency towards rock with middle-aged adults is at least remarkable.

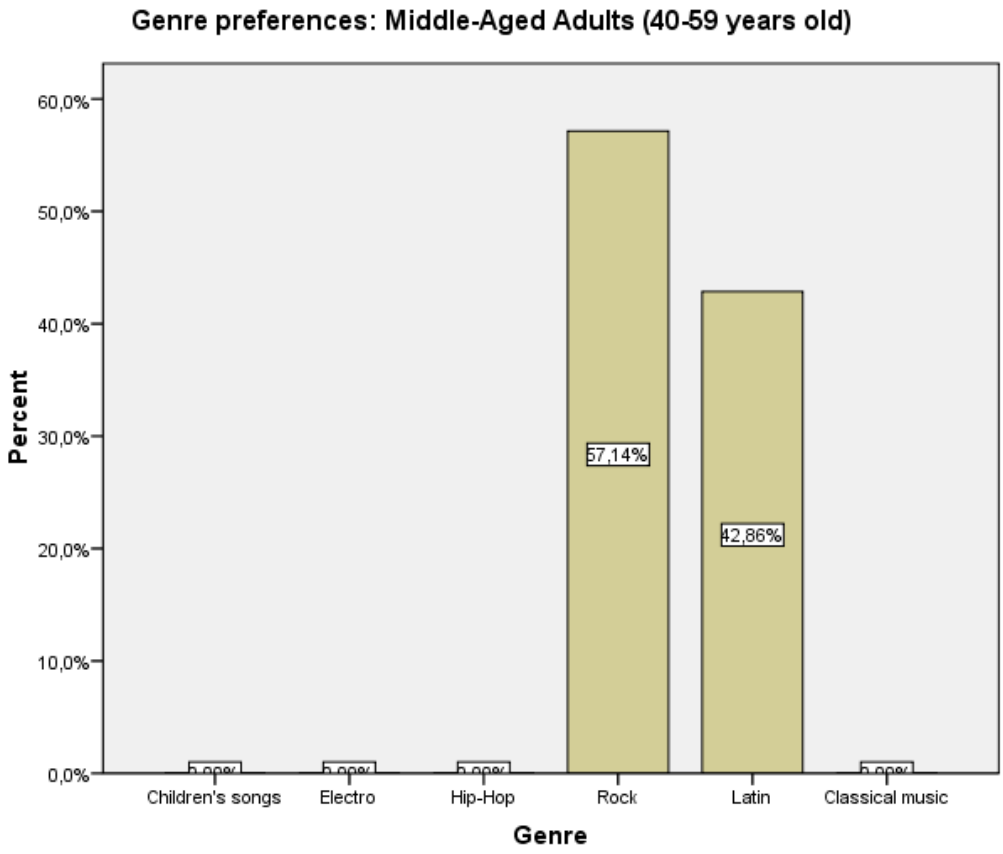

Figure 31: Genre preferences for middle-aged adults. Hip-hop disappears completely in favour of rock and latin.

The classical genre was the genre most opted for by participants older than 60. 66% of this age category favored the classical genre. Surprisingly enough, the only other chosen genre was hip-hop (33%).

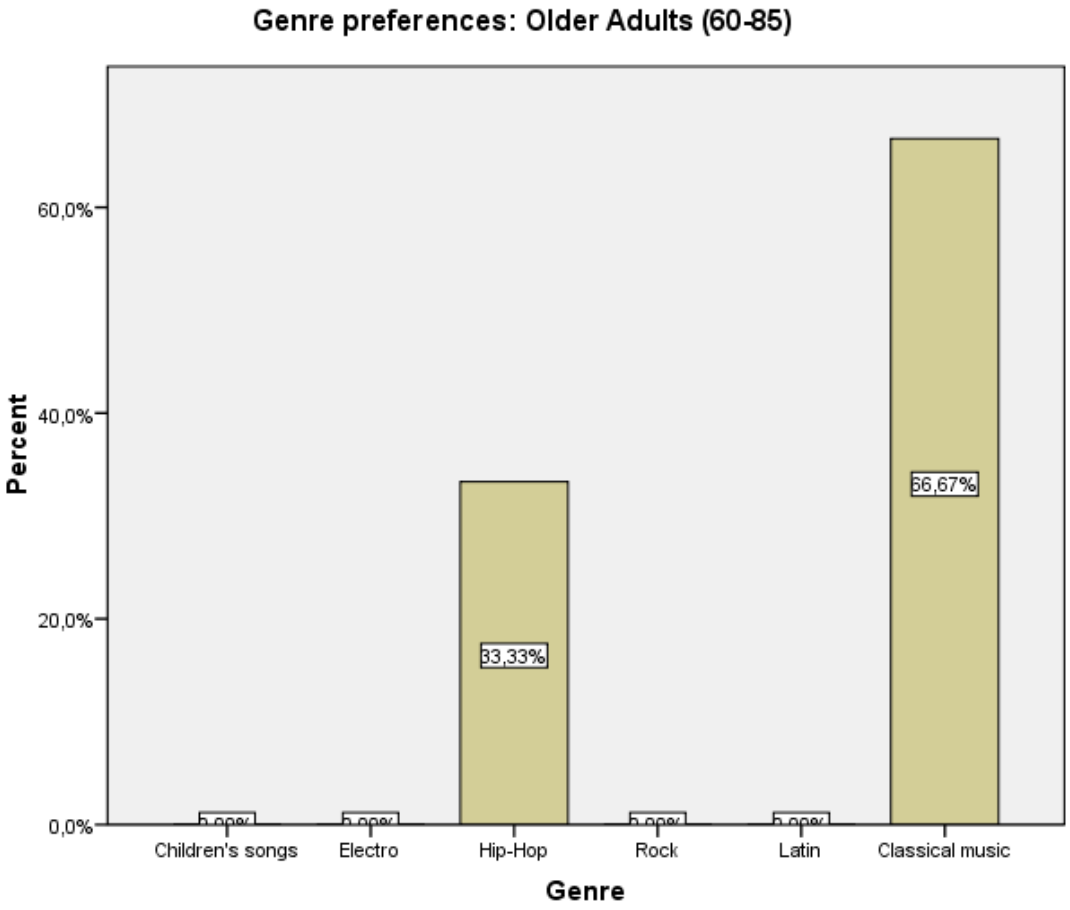

Figure 32: Genre preferences by older adults. Classical music is the most dominant genre, followed by hip-hop.

3.3.2.2 Acceleration results for each genre

3.3.2.2.1 Synchronization results

The participants' movements were translated into acceleration data during the game. This was automatically coupled to the corresponding musical genre. A score was calculated; counting how many seconds participants had synchronized correctly to the beat of each musical excerpt. This was done regarding the length of the musical excerpts, and comparing it to an ideal result for each song, considering the beat and the duration. The score obtained was normalized with the length of the file. Subsequently an average score for all played and repeated songs was deducted and grouped per genre.

After normalizing the data, a comparison between genre-related results was possible. Electro and classical music resulted in the best synchronization results. This means participants that had danced to classical music did so more accurately regarding the beat than those who had moved to hip-hop. Rock, despite its popularity, achieved the lowest results. Electro is the big winner. One possible explanation is the importance clear beats have in this genre, furthermore is it usually merely instrumental.

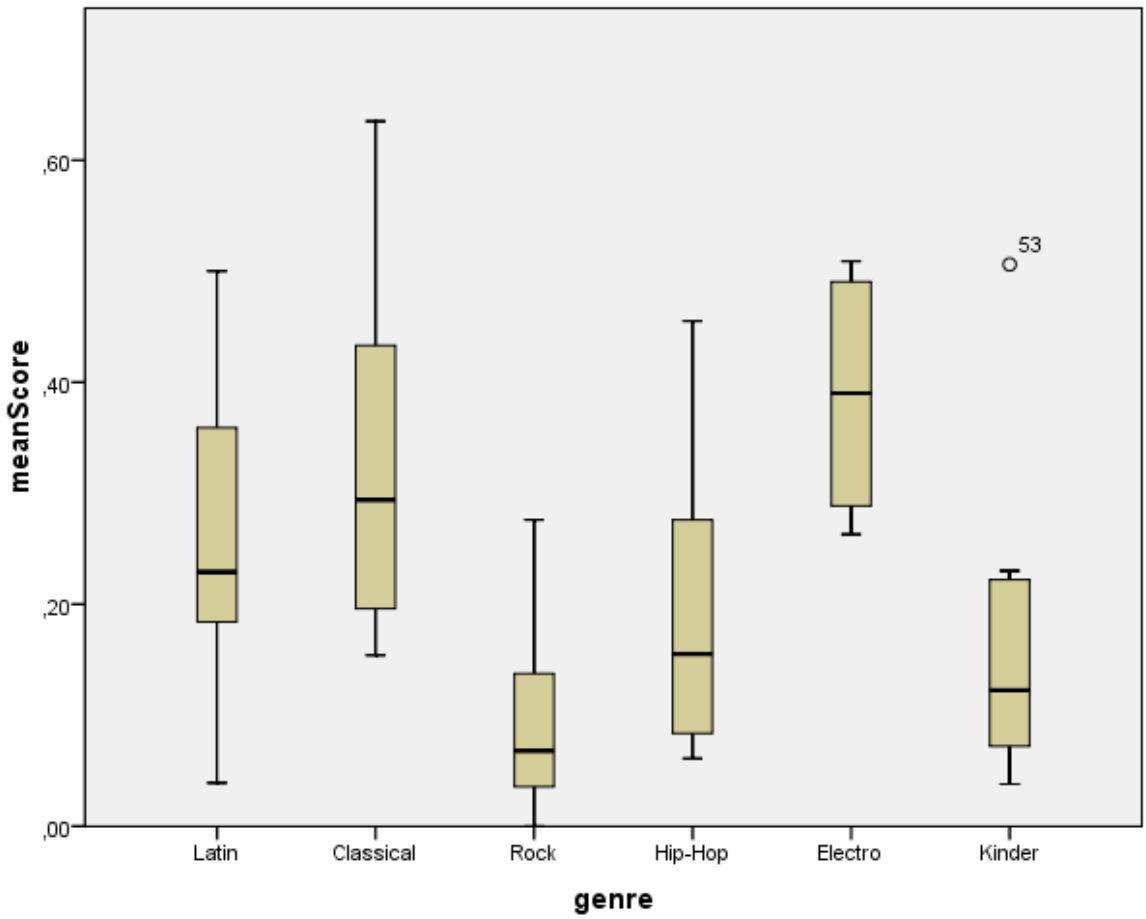

Figure 33 : Results from the acceleration data: general comparisons between genres. Electro and classical music favoured the best synchronization results.

3.2.2.2 Characteristic movements

Video-material offered a possible explanation for this phenomenon. Hip-hop and rock encouraged a lot more "additional movements" by the subjects. Often they were not focused on the goal of the game, but had fun copying famous movements from known artists and

interacting with other group members. Classical seemed to encourage the necessary concentration. The age of the participants may have played an important role as well.

Video material offered references for some recurrent movements that were present for each musical genre. When moving to latin music, for example, teams of participants tend to dance closer to each other, in coupled dancing postures (See Fig.34). The hips movements grew in importance, compared to other genres where arms and legs were more dominant. When dancing to hip-hop, participants often bended their knees and complemented this vertical oscillation with large arm movements. This served as interaction pattern between participants.(See Figs. 35 and 36). When dancing to rock music, participants chose for a dominant trunk-movement, where shaking the head took predominance instead of moving arms and legs (See Fig. 37). Classical music favoured vaporous movements, often close to basic ballet postures, with large and delicate arm stretching and dancing on the top of the feet.

Figure 34 Latin music: participants often chose to adopt coupled dancing postures. This rarely occurred in other genres.

Figure 35: Hip-hop. Common hip-hop movements (large arm movements, bended knees) served as an interaction manner between participants.

Figure 36: Hip-hop. Again large, curved arm movements and bended knees.

Figure 37: Rock encouraged vertical movements: arms stay rather central and heads shake vertically.

Figure 38: Classical music and children songs encouraged the same kind of light movements.

Results

Analysed data revealed different genre preferences for each age category. While children and adolescents seem to prefer hip-hop, this preference is less outspoken with young and middle-aged adults, in favour of latin, rock, and electro music. The basic analysis of the genre-related acceleration data revealed contrasting results. The average synchronization score for classical and electro music lay considerably higher than for hip-hop, despite the fact that this was the preferred genre. Observation of the video-material revealed what some basic movements or tendencies for each genre could be: Bended knees and large arm movements for hip-hop, jumping and head shaking one's head to rock music.

3.3.3 Conclusion

160 participants tried the game. Their game-play was filmed, and their acceleration data measured. General analysis was done on the material, obtaining results that reveal different tendencies and preferences that vary with age categories and musical genre. Observation material of how people moved to each genre can be useful to further develop the game interface. The varying genre-references can be of interest for de adaptation to different consumer-profiles.
Further research could focus on the specific issues of synchronization related to musical styles, and mark more specifically what those differences are.

4. How to improve the game

Participants were interviewed about their experience, and were also invited to suggest improvements to the game (Deweppe, 2009). A recurrent answer was making the game-environment more 'real'. Incorporating a disco-ball or projecting images of dancing people for example, would give the players the impression of a natural dancing context, and therefore encourage their spontaneity and participation.
Even though the goal of the game was generally well understood, people often had trouble finding the right strategy.
This is not surprising, for every game requires some time to get to know the features. The important thing is that it is fun to play. The answers, though, pointed at the importance of a good communication between the team-mates. Concentrating on the task did not guarantee victory; spontaneity and a good connection within the team was often a more determinant clue. The true challenge for many participants was not only finding the beat and moving to it, but being able to coordinate with the partner in an optimal and successful way.

The competitive factor was considered very important, stimulating a better performance and the fun-factor. The music, though, would be better with variations of styles and tempi. During the events, some participants asked whether it was possible to connect their own I-pods to the game, and dance to their own music. This complete personalization of the game is certainly a good idea, yet a big technical challenge for simultaneous beat extraction and visual-projection. Several players marked using familiar music as an important and stimulating option. More freedom of movements, though, should be achieved, by incorporating smaller sensors on different parts of the body. Each musical genre stimulates different kind of basic movements. Extracting one BPM, though, from different sensors located in the same body represents a big challenge. Finding the most accurate calculation is not a simple task.

The working of feedback visuals was rated positively, suggestions pointed at a greater responsiveness. Visuals should serve as the most accurate form of reference to the players; it certainly was the focus of attention during the laboratory experiments. The form and shape of the lights may be of a great importance; participants should capable of determining the their own light feedback as much as possible, referring to colours, forms and moving patterns.

Incorporating more participants is a must. Participants interviewed underlined their wish to play the game with more than four players at the same time. Larger groups competing against each other, with an audience surrounding them, could stimulate immersion and participation.

To resume, a greater flexibility of the game format can make it more attractive, accurate and fun to play. The didactical possibilities of the game should not be discarded.

5. General Conclusion

The present work does considerate game formats as adequate platforms to conduct research in the field of Systematic Musicology. Not only does this stand closer to the playful way people engage with music; it is also an alternative to the de-contextualization of a laboratory environment.

Through the work we showed two main lines: investigational and consumer-oriented. The same game was adapted to satisfy the needs of each approach.

Both lines held its particular challenges. Studying the impact of a personal bond between players on musical performance required gathering specific groups of members. The aim to observe reactions of a random public at science fairs required the adaptation of the interface, in order to make it more flexible and attractive to play.

Above, literature on synchronization and interpersonal entrainment was presented. Authors that link personal compatibility and musical performance were mentioned. Keller (2004), for instance, suggests that communication between two performing musicians can be affected by personality, social stereotypes, size of the group and leadership. There are thus personality and interaction patterns (which Salen & Zimmerman define as 'externally derived roles') that may influence musical communication. When Blaine (2003) mentioned the synergistic relationships that new musical devices help to create, he had in mind that the connection to the people you play with can strongly influence the performance. This coincides with Salen and Zimmerman (2004, p 462). They observe social interactions between the players at different levels as key to the game experience. Research cannot isolate individuals from their context, as each one of us has many faces, and many ways to deal with the same musical stimuli.

Even testing a small number of participants, we have been able to observe and measure a clear tendency towards stronger movement intensity and higher synchronization accuracy with familiar groups.

According to Granovetter (1973), focusing on small groups of participants is not irrelevant: small interaction groups form a pattern of the large ones. Understanding the heart of interpersonal coordination might lead us to comprehend broader social perspectives.

Creating a new game, and exploring its scientific and practical possibilities has been an interesting way to observe human reactions to music from a close distance.

A few lessons learned along the way. First: When making a game, the rules should be really clear from the beginning. Second: challenge and skills have to be balanced. In a dancing game, sensor-technology has to allow a larger potential expression of the subjects. Experience should be rewarded with the possibility of the subject to fully express itself with all kinds of movements during the game. Sensors should draw as little attention as possible. Third, players have to be able to personalize the game as much as possible, adapt it to the situation they are in.

Focus on the social aspects, technological naturalness and non-verbal communication is the key to conduct research in the music gaming context, but also to create new formats, new music games, new playful forms of musical interaction.

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