

MASTERARBEIT

Titel der Masterarbeit "Movement and Music: it is not a dance, but capoeira"

A motion capture analysis of capoeira's ginga

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Preface

The present work follows in its layout the subsequent settings:

Emphases are written in *italic* within roman type and vice versa. This applies to loanwords and words in another language than English which are not translated, as well as certain labels, for example names of genres. Double quotation marks are used for direct quotations and their possible translations in the corresponding footnotes, whereas single quotation marks are used in the running text for emphasis of such expressions as particular dicta, symbols, or colloquial phrases. All of the translations are by the author if not indicated otherwise. Abbrevations of languages standing previous to the translation indicate the original language. A single 'f.' following the denomination of pages in quotations denotes the single following page. To ensure gender neutrality in grammar, both male and female forms are used except where only one of the two is represented. For gender forms of Portuguese nouns describing groups of both gender, a common form of combining both male (-o) and female (-a) ending, the @ symbol is used, for example *filh@s* instead of *filhos* and *filhas*. A trend in Brazilian forms of writing is hereby supported. The following abbreviations are used:

bpm beats per minute	HS Hornbostel-Sachs	p. page
fr. french	MoCap Motion Capture	pt. Portugues
ger. German	\mathbf{ms} milliseconds	$\mathbf{s.}$ seconds

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In the end, I want to thank my family, for without them, I would not be where I am today. *Danke*.

Introduction

During the first presentation of my master thesis in a seminar, I started with a seemingly simple question: what is capoeira? It was then expanded to a more open question: what do you know about capoeira? The answers were the following¹:

game/play	Maracatu	Brazil	Salvador da Bahia
$\operatorname{circle}/\operatorname{\mathit{roda}}$	${ m music}/{\it berimbau}$	mode of existence	philosophy ²
sport	atabaque	'being' capoeira in	stead of 'doing' it

All of these subjects are more or less connected to capoeira in a specific way. Due to their relation to Brazilian culture the answers already were slightly more sophisticated than those from someone being not into any kind of sports or 'worldmusic'. So I looked out for other people's reaction when telling them about capoeira. The most common notion of it, if known at all, then was always relating to Brazil, dance and fight, in this order. But this way, important aspects are omitted. Trying to describe the whole phenomenon demands a multimodal approach from cultural perspectives including historical and phenomenological ones.

The multiplicity of terms used for the description of capoeira displays its numerous ways of personal understanding and interpretation: words one can always find for describing may be jogo, prazer, brincadeira, esporte, luta(-)dança, mandinga, malandragem, malícia or vadiação. Each of those expressions refers to another part of capoeira's complex construct. The bigger complex of ludic features also leads to the fact, that when capoeira is practiced it is typically said to be 'played' (jogar) rather than 'done' (fazer) or 'fought' (lutar).

The best way to both use a simple way of describing as well as encompassing most of the aspects constituting it, is to use the word art or artform. Usually it stems from the categorization of capoeira as a martial-art, which it also is, but still not solely. The attempt of Australian anthropologist John Lowell Lewis (1992:1f.) of describing capoeira as a "blurred genre" captures its essence best. Using the words of Geertz (1980) shows us the holistic approach which is so often aimed at by practitioners. It is a necessary merger of all involved parts that have evolved over time.

¹The group consisted of four musicologist in different states of their career; two Bachelor students, one Master student and one professor. Each of them has a connection to Brazilian music with the professor having her regional focus of research there, one who practices Capoeira and two playing in a Maracatu group (a musical tradition from the North-East of Brazil, mainly Pernambuco state).

²ger: Sport, Brasilien, Maracatu, Spiel, Kreis/Roda, Musik/Berimbau, Daseinsform, Capoeira 'sein' nicht 'machen', Philosophie, Salvador da Bahia, Atabaque.

CONTENTS

Capoeira

Chapter 1

The Evolution of Capoeira

1.1 History

For a better understanding of capoeira, especially in its contemporary forms, it is necessary to take a closer look at its history. Since this topic is among the most discussed in the capoeira world, scientific or by its practitioners, I do not want to engage in a thorough examination of historical sources, myths, legends, narratives or else. Rather trying to simplify main aspects of its development, especially the rapid accretion since the beginning of the 20th century by presenting those sources and sort them accordingly, will give an insight in the current situation of the historical overview.

Capoeira's early history is dubious and mysterious and strongly connected to Brazil's own history, particularly regarding the development of slavery and colonial issues. All speculations about sources dated earlier than the beginning of the 20th century are very vague. First written accounts as a sport or fight can be found in 1770 when Manuel de Macedo published some articles about a guard of the viceroy being the first Luso-Brazilian to be reported of knowing the art (Lewis 1992:43). Only in the 19th century came the first iconographic and descriptive written sources. Produced by artists, travelers or intellectuals like Henry Koster, Lieutnant Chamberlain, Jean Baptiste Debret, Augustus Earle, Harro Paul Harring or Johann Moritz Rugendas, their artwork and diaries provide an insight into colonial Brazil, depicting in great number slaves or indigenous inhabitants of South America and their cultural life.

Clear evidence of 'capoeira-like' movement can be seen in the illustrations of Rugendas (see Fig.2.5) showing slaves at a pastime activity, which may be accompanied by music, since musicians are depicted playing various instruments, but none of them seeming to be a musical bow resembling the *berimbau*.

In the texts of Rugendas "Malerische Reise in Brasilien" or "Voyage Pittoresque au Brésil"¹ (1835) he first describes capoeira, mentioning its actual name:

"Diese Tänze werden von den Negern oft ohne Unterbrechung ganze Nächte fortgetanzt; sie wählen dazu besonders der Sonnabend und andere Abende, die einem Feiertage vorhergehen. –Hier verdient auch noch eine Art von Kriegstanz angefürt zu werden. Es stellen sich zwei Parteien mit Stangen bewaffnet gegenüber, und die Kunst besteht darin, den Stössen des Gegenüberstehenden auszuweichen. Viel gewaltsamer ist ein anderes Kriegsspiel der Neger, *Jogar capoera*, das darin besteht, dass einer den andern durch Stösse mit dem Kopf auf die Brust, denen sie durch gewandte

¹ger./fr.: "picturesque voyage in Brazil"

Seitensprünge und Pariren ausweichen, umzuwerfen sucht, indem sie fast wie Böcke gegeneinander anspringen und zuweilen gewaltig mit den Köpfen gegeneinander rennen. Hierbei geschicht es nicht selten, dass der Scherz in Ernst übergeht und blutige Köpfe oder Messer dem Spiel eine Ende machen."² (Palmares & Briand 2013, original emphasis, grammatically corrected)

Exact information about what capoeira may have looked like and how it developed during the earlier colonial times in Brazil cannot be stated. Nontheless historical events in Brazil and the changes in slave society in earlier times and later in the Afro-Brazilian community coming along with that, had a great influence on the evolution of the art as we know it nowadays.

Step by step, several laws enacted over the passing of the second half of the 19th century gave slaves more rights. With the lei Eusébio de Queirós³ the on September 4th 1850, the transatlantic slave trade was, at least on paper, officially discarded. Within a conceivable time period, the first law involving the freedom of slaves was enacted on September 28th 1871. The lei do ventre livre⁴ states that all kids of slaves born in Brazil since the publication of the law are considered free. On September 28th 1885, also older people were freed in the lei dos sexagenários⁵, which was related to the population over the age of 60. This series culminated in the enactment of the lei *áurea* 6 on May 13th 1888, liberating all slaves regardless of the circumstances in which they were living. Thus, Brazil was the last South American country in which slavery was abolished. Only a year later, on November 15th 1889, the first republic⁷ was proclaimed and later was overtaken by Getúlio Vargas in 1930, who was the leader of Brazil up until 1945. He also tried to raise a concept of nationalism in the self-perception of Brazil. In 1964, the *golpe do estado*⁸ brought General Humberto de Alencar Castelo Branco to power, introducing 21 years of military regime in which cultural expression and diversity were suppressed, which affected many artists and intellectuals at the time⁹. Only in 1985 the new republic was announced, lasting until today.

As a practice deeply connected to slave culture, capoeira has always been located on

⁸pt: "*coup d'état*"

⁹The dictatorship pursued their enemies, putting them into prison and sending them into exile, amongst them such famous artists as Gilberto Gil, Vinicius de Moraes or Caetano Veloso.

²ger: "Those dances are often continuously danced by the negros entire nights without a break; for this they especially choose the Saturday and evenings preceding a holiday. – At this point, a form of war dance deserves to be mentioned. Two parties armed with sticks position themselves opposite to each other and the challenge is to dodge the opponents thrusts with the sticks. Much more violent is another negro war game, Jogar capoera, where the task is to knock down the enemy with headbutts on the chest, who dodge these with agile side leaps and parries, achieving all this by jumping at each other like bucks, occasionally colliding severly with their heads. It is not rare in this connection, that fun becomes serious and bloody heads or blades put an end to the game."

³pt: "the law of Eusébio de Queirós"

⁴*pt:* "the law of the free belly"

⁵pt: "the law of the sixty-year olds", also known as *lei Saraiva–Cotegipe*, referring to the place of enactment (DHnet 2013). Often treated people only over 65.

⁶pt: "the golden law", made possible by Princess Izabel (*Princesa Dona Isabel*) during the absence of her father, imperator Dom Pedro II. That is why her name and person is present in many of Brazilian, more precisely Afro–Brazilian, lyrics and poetry. Downey (2005:76) indicates an ambivalent attitudes of *capoeiristas* to this fact. It must be pointed out, as does Prutsch (2003:23), that with the *lei áurea* did not change as much as imagined, since slavery has lost its economic significance over the course of time.

⁷pt: "*primeira república brasileira*", also known as the 'old republic' (*república velha*) as opposed to the 'new state' (*estado novo*) of Getúlio Vargas since 1930.

the outer rims of society. With this attitude in mind, certain characters applied to the historical capoeira individual (usually described as a $capoeira^{10}$) have formed. These are formed from different narratives about the very first origin and consecutively the denomination of the art. Current discussions on this topic are full of blending of diverse facts and fiction. German historian Matthias Röhrig Assunção (2005) has published the most extensive work on these subjects up until now. In his comprehensive research all possible evidences are put together with the knowledge of an experienced insider, who is not trying to construct a history of capoeira, but rather to show the evidences that are facilitated by the possibilities rendered by the different sources. There are some, as he puts it, "core myths" (2005:5), which are recurring in this or any other form in the discours on capoeira and its history. His understanding of myth is "a rather simplistic view of some specific facet of capoeira history, which glosses over contradictory evidence that disproves what usually are essentialist claims" (2005:5). Fakes, the manipulation of evidence and/or sources, can be part of them. The myths can be separated by three different principles (Assunção 2005:5–7): reinforcing a national identity, where origin is searched for as an 'all Brazilian' one. Another opinion is the one about maroons inventing capoeira. Always mentioned in connection to this are the $quilombos^{11}$ as some space for resistance. Through a romanticization of the image of maroons they were therefore seen in two aspects: as close to nature or highlighting their African heritage. In the third variation, an African heritage is endorsed. Extreme beliefs find capoeira to be played as such already in Angola, Africa. There are no sources to prove this theory, but it remains a fact that there are many similarities amongst African practices and capoeira.

The myths all contribute to the establishment of the main master narratives about capoeira, forming in one way or another the art's history, which is not only one but consequently roots in different contexts. These are mostly in situations depicting the capoeira as a 'tough guy', the symbol of resistance with quite violent characteristics. The 'dancing character' for instance, often is asserted to be a kind of 'masquerade' used to cover up the actual fighting, or at least training for the former, which is said to strengthen possible physical resistance to violence on the part of the authorities. This is often heard in combination with the explanation of the few strikes of the upper extremities, that slaves only had their feet at their disposal, due to the fact that their hands were chained. Today, it is understood that this may have not been the case, since it would have been counterproductive for the landholders having to immobilize their workers main 'tool', leaving the feet unrestricted for running away. Different accounts are referring to already escaped slaves having to survive on their own, or later, together with other escapees. These include the idea that the movements of capoeira are based on natural movements from different animals found in the more abandoned outskirts in the inner parts of the country (Areis 1984, quoted in: Assunção 2005:6), or the use of capoeira techniques for defending the *quilombos* against intruders. In this notion, the ideal of the *capoeira* is getting a superhuman attitude explaining

¹⁰There are different names used to describe practitioners of capoeira. In this day and age, mainly the grammatically corrected personification as *capoeirista* is used. Still, the word *capoeira* can be used to label both, the practice as well as its practitioners. The former being called so, usually then often is associated to in a pejorative way, since the term was mainly used in earlier times, before the wider recognition of capoeira. I will therefore use it in this way, referring to a *capoeirista* as a coeval practitioner and a *capoeira*, written in italic, to distinguish it from the practice itself, meaning the practitioner historically speaking.

¹¹As a *quilombo* are described the communities of slaves being escaped from their masters. They gathered in the inner parts of the country, often protected by the forest, partly founding own villages.

how slaves developed the art to defend themselves against armed intruders (Augusto Ferreira, cited in Almeida 1986:15f.). No matter what kind of agility, dexterity and strength the practitioners may have had – and *capoeiras* already have been used in war situations as the Paraguayan War 1864-70 – resisting against firearms was not possible. A more widespread idea is, however, that capoeira may have already existed in some way in Africa, relating to an initiation rite of young men 'fighting' for the right to choose a bride. Jair Moura (cited in Almeida 1986:16) sees resemblance in the *n'golo*, the "zebra dance" from where today is Angola. He supports this idea not only for its mix of fight and dance styles, but also the circumstance that its practitioners held similar traits in behavior in the streets, using their learned techniques as a weapon.

The arguments about the origin are accompanied by the ones relating to the denomination. The theory of escaped slaves evolving the techniques in self-defense, adopting animal movements, leads to the idea of taking the name of the secondary growth, in which those escapees tried to hide, as a name for the practice¹². Theories I have encountered, told by practitioners, are often related to birds and poultry. The *capoeira* bird (spot-winged wood-quail) is known to heavily fight its rivals. More often, yet, it is to be heard that capoeira stems from *capão*, a rooster and its derivative *capoeira* to describe big portable cages in which the birds where carried. This is probably related to the most likely assumption that slaves, doing work on those markets using these cages, passed their time with activities such as capoeira. At the same time, to some people, the fight might have looked like the fight between two roosters.

All of these theories may contribute to the history of the art. The exact origin however will always be in discussion. What many researchers today agree on, is that external forces must have brought forward the development, situating its practitioners in situations of pressure. It must have been evolved in "high-density" areas (Browning 2001:167) always pushed forward by the need for resistance. This refers then not only to the times of slavery, but even more in the crucial part of capoeira's history, the first half of the 20th century, where it has been prohibited by law and relentlessly punished by the authorities. The first actual recognition of capoeira happened with its official statewide prohibition through the inclusion in the *código penal*, the penal code of the first republic. A whole chapter (Senado Federal, Subsecretaria de Informações:CAPITULO XIII) is addressed to *capoeiras* and *vadios*, in which the public execution of *capoeiragem*¹³ is penalized with imprisonment and equal to 'vagrancy' (*vadiação*) and unemployment:

"Art. 402. Fazer nas ruas e praças publicas exercicios de agilidade e destreza corporal conhecidos pela denominação capoeiragem; andar em correrias, com armas ou instrumentos capazes de produzir uma lesão corporal, provocando tumultos ou desordens, ameaçando pessoa certa ou incerta, ou incutindo temor de algum mal: Pena de prisão cellular por dous a seis mezes. Paragrapho unico. E [É] considerado circumstancia aggravante pertencer o capoeira a alguma banda ou malta. Aos chefes, ou cabeças, se imporá a pena em dobro."¹⁴

 $^{^{12}}$ The idea for that stems from early linguistic ideas about the term capoeira. In the late 19th century, a discussion about a potential origin in the Tupi language started between Henrique de Beaurepaire Rohan und Macedo Soares (Rego 1968:17–20).

 $^{^{13}}$ Just as using *capoeira* as a description for its practitioners, *capoeiragem* as an expression for the practice of capoeira relates to historical times and its penalization, it has therefore a negative connotation. This again is often used by modern *capoeiristas* to proudly show their connection to the history of their art as a tough and resisting one.

¹⁴pt.: "Article 402. Practicing exercises of agility and dexterity in public streets and squares known

1.1. HISTORY

Especially the *maltas*, gangs mainly consisting of *capoeiras*, in Rio de Janeiro were the main target of the authorities in relentless pursuits. Leader of security institutions as the head of the "Guarda Real do Palácio" Major Miguel Nunes Vidigal (who was already active in the middle of the 19th century), the first chief of police in the first republic Sampaio Ferraz, or Pedro de Azevedo Gordilho, chief of the Salvador police, better known as Pedrito Gordilho, were known for their ferocious actions against capoeira and other Afro-Brazilian cultural expressions that came along with slavery, such as *candomblé*¹⁵. It was a fact though that many of those, who denounced it publicly, were acutally experienced in the art of *capoeiragem* as well. This gave them the necessary abilities needed to fight those in pursuance.

The times of capoeira in the streets, its public denunciation and persecution was then about to cease, with two capoeira masters changing the course of its history and hence blazing their trail into the collective memory of the capoeira community: Mestre¹⁶ Bimba and Mestre Pastinha.

Born on 23 November 1900 in the neighborhood of Engenho Velho in Salvador, Manuel dos Reis Machado¹⁷ was the son of Maria Martinha do Bonfim and Luiz Candido Machado who was known as a famous *batuqueiro*. The fact that Mestre Bimba's father trained him in the art of *batuque* later had strong influence on developing his style of capoeira. There are different practices associated to the word *batuque*. What Bimba's father was exercising though was something similar to capoeira. In a music accompanied 'fight', the opponents had to try to trip or to knock down their adversaries by quick leg sweeps, therefore often also the name *pernada* ¹⁸. This and other fighting styles prominent at that time¹⁹ later shaped the distinct way of Bimba teaching capoeira, which he started to learn at the age of 12 with Bentinho (Nozinho Bento). Himself being excellently trained in the older art of which is nowadays known

under the denomination of capoeiragem, engaging in incursions, with weapons or tools capable of producing bodily damage, provoking tumults or riots, threatening known or unknown persons, or creating threatening situations: prison sentence from two to six months. Single paragraph. Belonging to any gang or malta, may aggravate the sentence of the capoeira. Leading the gang doubles the penalty."

¹⁵A belief system which is drawing from an African heritage. Akin to other such manifestations as *voodoo*, *Santeria*, *candombé*, etc. in South-American countries, in *candomblé* a pantheon of African descendent entities, called *orixás* are worshiped as archetypes for the human being. These 'saints' (*santos*) can come down and take possession of their 'children' (*filh@s*). The impact of the Catholic Church leads to an amalgamation of the two systems, linking Christian saints to each *orixá*. About the appropriateness of calling it a syncretic religion see Kubik (1991). For further general information about *candomblé* see for example Oliveira Pinto (1991), Becker (1995) and others.

¹⁶The term *mestre* (master) refers to a *capoeirista* who is most experienced in all aspects of the art, not only physical or musical play, but also its history and 'way of life'. In the past (and in rare cases still today), anyone self-confident enough could call himself a master. Since the systematization of capoeira, one is usually declared as one by another *mestre*.

¹⁷The nickname Bimba was given to him by his mother straight after his birth. The term *bimba* is colloquially used in North–Eastern Brazil as the description for a small or the infant penis. Since Machado's parents expected a girl, they named him so for their surprise (Almeida 1986:32; Downey 2005:9).

 $^{^{18}}$ pt. "a blow with the leg"; in Portuguese, by adding the suffix '-ada' to a useable object, the meaning becomes the action of striking someone or something with it, for example, a stab with the knife is a *facada* (*faca*: knife), or a special type of the dance coco is the *umbigada* (*umbigo*: navel) where the dancers try to bump together their bellies. The latter is just another example for how the action itself becomes the designation for a whole genre.

¹⁹Apart from *batuque*, Rego (1968:33) counts as well *maculelê*, diverse *folguedos*, Greco-Roman wrestling, *jiu-jitsu*, *judo* and the French fighting form *savate* as a repertoire from which Bimba combined strikes and other movements into capoeira.



Figure 1.1: Mestre Bimba meeting with president Getúlio Vargas, 1953 (http://www.historyoffighting.com/resources/Mestre-Bimba-and-Getulio-Dorneles-Vargas.jpg, 10.09.2014)

as capoeira Angola, he later began to expand the movement system, introducing new rhythms and trying to free the art of its negative connotation, by leading it into the confined limits of the *academia*²⁰. In 1932²¹ he founded the *Centro de Cultura física Regional*²² which was officially registered as a school for sports by the government on July 9, 1937²³. With the establishment of a more or less constricted way of learning and executing capoeira, it began to attract people from all different classes and statuses. This includes especially the white population in the middle- and upper-classes. Though the attitude of Bimba's older students still was more troublesome and violent, in the sense of *malandragem* (Almeida 1986:121f.), the transition into the *academias* facilitated the process of social acceptance. This reached its climax in 1953, when Bimba was invited to do a show for the president Getúlio Vargas on July 23. After the show capoeira got its official recognition also in the minds of the people by Vargas declaring it "the only true national sport" (Itapoan, p.44 cited in: Assunção 2005:141).This day is documented well, as can be seen in the following picture:

With Bimba's *academia*, which set the cornerstone for capoeira's social advance- $ment^{24}$, it took no time to find more and more institutions like that being founded all

²⁰pt. "academy, gym"

 $^{^{21}}$ Lewis (1992:59) names 1927 as the founding year for the center. Up until now there could not be found any evidence confirming this date.

²²pt. "center for physical culture and regional capoeira". The exact denomination differs slightly in the various sources. This is the most common used one.

 $^{^{23}}$ The official license cannot be found online. The official register number anyhow is known: 305/1937/AP/NCL (see for example Almeida 1986:32). Rego reprints the text of the certificate, showing date and the official inspector (1968:283).

²⁴An important role played the fact that in his *academia*, the first white students where officialy taught, which were followed by many more from all different social classes.

over. The most prominent one was in 1941 the Centro Esportivo de Capoeira Angola (CECA) by Mestre Pastinha. There is not much known about his personal life. He was born in Salvador on April 5, 1889. Exact information about his parents are not available, only that his mother was a Bahian black woman and his father a Spaniard with no job (Assunção 2005:152). He learnt capoeira supposedly from Benedito, an older man, said to be of Angolan origin. So, just as Bimba, he learned the older style of capoeira, often giving points of discussion about this style, seeing that the teacher was from Africa. Apart from that, Pastinha entered the Navy at a young age where he experienced more physical education and also music lessons. He left the Navy already at the age of twenty, providing for himself from thereon with different smaller jobs and began to teach capoeira. By inheriting the responsibility for one of the biggest rodas of traditionalists in 1941 (Downey 2005:68). Pastinha began to dedicate his life to the art of what was later to be called capoeira Angola. He tried several times to organize the center which he managed to do in 1952 with the official registration of the CECA, stating in its statue "to teach, to spread and to develop, theoretically and practically, the stylish capoeira ('capoeira de estilo'), the genuine 'ANGOLA', which has been passed on to us by the primitive [original] Africans that disembarked here in the Bay of All the Saints" (as quoted by Assunção 2005:155). This statement shows clearly the intentions of Pastinha and his followers, which arose as a traditionalist reaction to Bimba's endeavor to develope the art into a more 'modern' form.

With these two main representatives and their contrastive ideologies, the way for capoeira as we know it in these days was paved to develop and spread all over the world. The names of the each school respectively quickly became the symbol for different styles which developed in quite different ways. This led also to dispute between supporters of the respective styles. Prejudices and accusations were raised especially at Mestre Bimba by traditionalist with criticisms of 'whitening' the art^{25} . At the same time, the nearly stubborn determination of *angoleiros*²⁶ in referring the entire history of capoeira to an African heritage is more than often an argument for 'modernists' as a partial denial of the own local cultures and the refusal of progress.

1.2 Recent development

The recent history of capoeira actually includes roughly the last fifty years, from the time where it has considerably risen in its social acceptance and its dissemination across the world began with the first capoeiristas teaching outside of Brazil. This process was actually supported by the fact that between the two main schools of Angola and Regional, soon, a new and even more modern style of the practice began to evolve. How this was to happen is probably due to the rapid changes in the styles, leading devotees of the art to trying to find a new way of bringing the community back together.

Regional was advancing so fast, that on December 26, 1972, capoeira was officially proclaimed as a national sport under the *Federação Brasileira de Pugilismo*²⁷, holding the first national tournament (Lewis 1992:62, 71). This development was not intended by Mestre Bimba as an anecdote from Almeida tells:

 $^{^{25}}$ For a more detailed account on the issue of 'whitening' (pt. *embranquecimento*), see for instance Downey (2005) where he cites the critique that Regional's "distinct kinesthetic arose from the dispositions brought to his [Bimbas] academy by new groups of students – university educated, white or light skinned, well-to-do. Social traits are allegedely visible in movement" (2005:169f.).

²⁶Practitioners of capoeira Angola.

²⁷pt.: "Brazilian Federation of Boxing"

"In 1968 [...] Fersen Braga, another enthusiast of the art, took on the near impossible task of convening more than fifty mestres and instructors. [..] This meeting necessarily included some notoriously incompatible pairs who temporarily agreed to let down some of their barriers in order to work together toward the organization *i.e.* the organized systematization as an official sport of their art. Their interactions shed light in some areas, but cast shadows in others. A mistake was made in granting the same status to beginners as to great teachers. After a few days of work, Mestre Bimba's patience was wearing thin trying to listen to the sometimes naïve and inappropriate proposals presented by the newly-elevated young teachers. Late one night, after a tough day of discussions, one of these self-entitled mestres showed a new movement which he called *eu ia* (I could go). When he presented the strange attack with its funny name, the Mestre jumped up abruptly and asked, "What is the name of your movement, my son?" The young *capoeirista* said, "I could go, Mestre." Mestre Bimba immediately replied: "Well, you could go anytime, but ... I am going now!" At that point, he left the place without ever returning." (Almeida 1986:51, original emphasis)

So the current form of Regional was actually formed by other *capoeiristas* than Bimba himself, some of them though being a former student of his. On February 4, 1979, on these students, Bira Almeida, also known in the capoeira community as Mestre Acordeon, founded the World Capoeira Association (WCA), which today cannot be found, but rather was replaced by the World Capoeira Federation (WCF) in 2011. A connection between the two institutions could not be identified. The latter is still active today and organizes championships and conferences on capoeira, which include an regulated scheme for the event (see regulations on: WCF 2013).

On the other hand, one can see capoeira Angola as a development in different ways, though the efforts may not be as diverse as they seem at first glance. What both styles share, is that each one wants to distinguish oneself from the other and though there are not as strict regulations as they might occur in Regional²⁸, by establishing a border between them, Angola sets clear rules for their play as well. The accent on the individualistic aspect of a person's play is as much a normative rule, as the fact that in Regional one ought to wear white clothing. The first main point in the 'reevolution' of Angola was in 1966 when Mestre Pastinha did a presentation with four of his students, going "as part of the Brazilian delegation to the First International Festival of Black Arts (PESTAC) in Senegal" (Downey 2005:69). Though a greater attention was paid to Angola style now, Pastinha did not manage to go as far as Regional. This is probably also due to the fact that such a system may not be wanted by the *mestre*. With no support from the state or other institutions, capoeira was seen on the brink of extinction at his death. Through a "re-emergence of the Black Movement and the revaluation of the Afro-Brazilian heritage in Brazilian society" (Assunção 2005:186f.) Angola managed to experience a revival and the introduction to a wider audience.

Standing apart from these particular distinctions, some practitioners were not willing to give up neither the older traditional aspects of the game, nor did they want to stand in the way of an openness towards modern influences on capoeira. One of the first *mestres* to pursue his own individual style was Mestre Canjiquinha (Washington

²⁸Certainly the degree of regulations differs immensely from group to group and the written down rules apply only to the championship. Yet, some actions (a very low playing near to the ground for instance) are just not accepted in Regional.

Bruno da Silva), who learned under Pastinha, but soon was to stand against the radical beliefs of the revivalists:

"Eu ensino o aluno a jogar em baixo e em cima. Eu não ensino capoeira só em baixo, porque eu aprendi assim. Porque eu não sou angolano. Eu nascí no Brasil, em Salvador. Eu não aprendi capoeira na Nigéria. Então, esse negócio de capoeira de angola é ilusão. É tanto que em angola não tem capoeira."²⁹ (Moreira 1989:81)

Lewis calls all these, styles falling in between the two extremes of Regional and Angola, $atual^{30}$, using a characterization by Mestre Nô (Norival Moreira de Oliveira), who is a vanguard of the modern styles as well (Lewis 1992:61f.). What is more commonly used today is the name *contemporânea*³¹, which is basically understood as the idea of capoeira as "*uma só*", it is only one. Schools are this way often trying to dissociate themselves of rigid guidelines or traditional idealistic ideas (which are now present in strictly regulated Regional styles as well). Nonetheless, a certain tendency towards one or the other can be located in most of the cases present around the world, considering the teachers there often came from Brazil and from a generation in which the innovative trends were not as advanced as today.

1.3 Current situation

The enormous success of capoeira in Brazil was soon to be followed by fame all across the globe. The increasing popularity can still be seen today: the results of google search on February 21, 2003, score 229,000 hits (Assunção 2005:1). When I looked it up on October 15, 2013, they found 14,900,000 hits, more than 65 times than ten years before. Today (August 1, 2014) it already has 19,900,000 hits and will probably still be growing. One of the first, and perhaps most famous *capoeiristas* abroad, were Jelon Vieira and Loremil Machado. They both introduced capoeira in the United States of America, first in 1975 as part of a Broadway play and later on also started to teach (Assunção 2005:190). Many believe Jelon was the one to actually inspire the first ideas of break dance. Soon they were followed by other *capoeiristas* such as Mestre Acordeon (Bira Almeida) or the great Mestre João Grande. Europe was then soon a popular destination for many Brazilians trying to seek their fortune in teaching overseas, often people with little experience declaring themselves *mestres*. Yet, up until today, there have likely settled as much *academias* with support from a bigger *mestre* (be it locally or from Brazil).

With its history so closely connected to the art itself, the transmission into other, very different cultures may cause changes in the perception and practice of the art. That is one of the main things one realizes, seeing the difference between capoeira in Brazil and the more 'globalized' form. Students who do not have any connection to the extreme issues that were related to capoeira may perceive it as an utterly different expression of Brazilian culture. This is often even more so through teachers, who themselves, are not part of that culture, or may not bother to include this aspect into

²⁹pt: "I teach the student to play both high and low. I do not teach only a low capoeira, because I did not learn it that way. Because I am not Angolan. I was born in Brazil, in Salvador. I did not learn capoeira in Nigeria. So, all this business about capoeira from Angola is an illusion. There is just no capoeira in Angola."

³⁰pt. "current, present"

³¹pt. "contemporary"

their practice. In most cases though, students are strongly motivated to experience the connection to the Brazilian heritage in such a way that they begin to learn speaking Portuguese, learning about capoeira history, travelling far to participate in workshops, and, many a times take a trip to Brazil.

Today, the main reason of *capoeiristas* around the world is actually the fun of playing it; thus, it can be the joy of making music, the physical and mental training, or the comfort of being accepted in a group of people, regardless of social class, ethnicity, or else.

Chapter 2

Musical Structures of Capoeira

One of the particularities of capoeira, distinguishing it mainly from other martial arts, is the accompaniment and interaction of the movement with music. This usually happens only with live music, with the musicians consisting of only one musical bow player up to a whole orchestra of particular instruments that are characteristic in their formation for capoeira music. Nowadays, there exists more and more recorded music, mainly from *mestres* from Brazil and their groups. Seeing an actual game played to recorded music is very rare. Yet, in Regional, it has almost already become conventional to do warm-up exercises to recorded music.

But not every capoeira music is the same, it differs in a great variety. There are differences in the instrumentation, the used rhythmical patterns, tempo, song and more. The variation of the several factors mainly corresponds to the according style of capoeira. With the development of a new style – or new styles –, a particular understanding of music came up, which had to adapt to the new requirements of an entirely contrasting of playing capoeira. In the following chapter, I want to show the main aspects of the music, giving a short overview of the instrumentations, the rhythmical patterns, and put a focus on the rhythmical complex of the patterns.

2.1 Instruments

The fact that capoeira is accompanied by musical instruments is only known for little time, since the convention of playing with certain instruments only came up with the era of the *academias*. Whether music was in fact an element of the game in its very beginnings cannot be answered for sure. Rego advances this view, arguing with very scarce occasions in his time when capoeira is *not* played with music, adducing Mestre Bimba's practice of letting novices train without music (Rego 1968:58). This argument lacks consistency since Bimba was actually trying to change the way of learning the art, introducing a systematized program of training. It seems implausible that he would use this method as a vestige of early capoeira, but more as an effective way for the apprentices to concentrate only on movement.

The other argument (Rego 1968:58f.) uses the early iconographic sources and records of travelers in Brazil (see 1). This, on the other, hand may serve as a good clue, since none of them really can be said to show musical instruments in direct combination with capoeira movements. The pictures of Debret (Figure 2.1, 2.2) illustrate a slave playing a musical bow. The *berimbau* as the main instrument of capoeira today is one of its most characteristic and salient representatives.

With the origin of the instrument still not completely clear, the images are used to



Figure 2.1: Jean Baptiste Debret (1934): Le vieil orphée Africain Oricongo (http://www.capoeira-palmares.fr/histor/images/debr_o1.jpg, 02.03.2015)



Figure 2.2: Jean Baptiste Debret (1934): Negro Trovador (Shaffer 1977:5)

2.1. INSTRUMENTS



Figure 2.3: Lieutnant Chamberlain (1822): A Market Stall (http://www.newberry.org/sites/default/files/styles/lightbox-overlay/ public/text-pages/Ayer-1269-B8-C44-1822, -A-Market-Stall.JPG?itok=FLh_sR_d,11.03.2015)

proove the existence of the musical bow in Brazil. An earlier picture of Chamberlain shows the latter played by a slave on the market. The character is extracted from a picture of Joaquim Guillobel and placed in a new setting. It is sure to be the same, since both persons use the stick for playing the *berimbau* in a manner not possible, or at least very uncomfortable as a playing technique.

Despite the appearance of instruments today, which are related to capoeira, a connection in the sources usually cannot be found, except for one plate of Rugendas, showing a drum next to a couple of moving slaves, entitled "jogar capoeira".

Be that as it may, in the last century, the importance of musical accompaniment was steadily growing, with the consequence that a game of capoeira without music is virtually inconceivable. What instruments are used though differs in the various styles, depending on the school it comes from. But a set of potential instruments exists from which a *bateria*¹ can be composed. I want to present them with organological accounts and some comments about the playing technique. Furthermore I want to comment on their corresponding role in the musical structure. However, actual transcriptions and elaborations of the musical complex will follow only after this section for a better definition of the context and their interactions.

¹pt. "percussion", meaning the totality of musicians with their instruments, thus, the "orchestra" or "band"



Figure 2.4: Joaquim Guillobel (1814): Vendedores Ambulantes (http://1.bp.blogspot.com/-B1Z0CWYQGKo/T72YrfWxMWI/ AAAAAAAAEjw/p_g44GYrupw/s1600/ cestos-JCGuillobel02a.jpg, 02.03.2015)



Figure 2.5: Johann Moritz Rugendas (1835): Jogar Capoeira (http://upload.wikimedia.org/wikipedia/commons/1/19/Rugendasroda.jpg, 10.09.2014)



(a) Chapinga playing the *mbulumbumba*. (Kubik 1965:100)



(b) Hungu (Oliveira Pinto 1986:153)

Figure 2.6: Two possible prototypes of the *berimbau* found in Africa.

Berimbau

The musical bow $berimbau^2$ is the characteristic instrument of capoeira music. In Brazil, it is not only known in this main context, but already has exceeded this framework and is nationally well known. It is part of Brazilian popular music, and, besides within capoeira, also known in other music thanks to musicians such as Max Cavalera from the Metal band "Sepultura". Primarily responsible for its dissemination in Brazil were Airto Moreira and Naná Vasconcelos. But also artists as Dom um Romão, Guilherme Franco, Paulinho da Costa, Okay Temiz, Dinho Nascimento or Carolina Soares (who played with the background of capoeira) were conducive to the higher publicity of the instrument.

Just as the history of capoeira itself, the search for the origin of the *berimbau* is a most discussed issue, albeit it is scientifically more examined than the first one. Scholars of both Brazilian and African music are looking for the provenance in Africa, such as Richard Graham (1991), Kubik (1979; 1991), Pinto (1991) and also Rego (1968). This arises from the observation that no one of the few discovered musical bows of indigenous Brazilians has a resemblance to the *berimbau*. In addition, all iconographic sources presenting the latter, or any predecessor, always shows it in the hand of Afro-Brazilians (see Figure 2.1, 2.2, 2.3, 2.4). Closest resemblances of selected aspects of organology and playing technique are found in comparison with bows from Angola. The *mbulumbumba* of South-West Angola (Kubik 1979:34f.) and the *hungu* of the Luanda region (Oliveira Pinto 1986:151–153) both show astounding analogies with the *berimbau*, as can easily be seen in a graphic comparison (see Figure 2.6,).

The contemporary *berimbau* is a heterochord musical bow with a single string with a resonator attached. Whether the lace used to attach the resonator to the bow can be seen as tuning noose or not is under discussion. Since virtually all players tune their instruments with it, I will include it in the systematization of Hornbostel & Sachs (1999): 311.121.222. The bar is made from *biriba* wood (*Rollinia deliciosa*), which is

²Sometimes also written as *berimbao*, infrequently also as *berimbal* or *birimbau*.



Figure 2.7: Comparison of *mbulumbumba*, *berimbau* and *hungu* in the grafical systems of a systematic for musical instruments of Mantle Hood. In this grafical representation distinct differences are easily recognizable, such as the horizontal mode of holding the *mbulumbumba*.

(created by the author)



Figure 2.8: Basic position for holding the *berimbau* with all necessary equipment: *dobrão* in the left hand, blancing the bow with noose of the *cabaça* on the little finger; *baqueta* and *caxixi* in the right hand. (Shaffer 1977:66)

by its density and flexibility first choice. For the steel string old automobile tires are cut open to pull out the stabilizing wire. The gourd is a dried calabash (*crescentia cujete*, not the often used *lagenaria vulgaris*), emptied, with a hole on the distal side of the bow. To play it, a stick (*baqueta/vareta*), a coin (*dobrão*) or small stone to shorten the string, and a *caxixi* are needed. The latter is a small vessel rattle made from a woven basket with a piece of dried gourd³ at the bottom. It is filled with dried seeds or small pebbles and can produce either soft or hard sounds, depending if the particles hit the basket or the bottom. The basic posture can be seen in Figure 2.8, which is also mostly used by left-handed players.

By holding the *caxixi* in the same hand as the stick, the rhythm of notes played on the string get accentuations, just as individual embellishments can be played with the rattle separately. There are three main sounds that can be produced by striking the string with the stick in combination with the coin, of which all standard patterns are composed. Two notes with a distinct pitch can be achieved: a low note, by striking the string without the coin, and a higher note, by striking the string just above the point where the coin presses against it, thereby shortening it. The range is about a semitone up to slightly more than a whole step above the lower note, depending on several factors, such as the length of the string or the player's hand size. The third sound can be called a 'buzz' tone, since it is produced by striking the string closely to the coin, which is held only loosely to the string, creating a "diffuse field" from which all other musical events "seem to emerge" (Lewis 1992:144). The sound can further be modified by changing the spectrum of the harmonics. This is easily done by holding the resonator's opening closer, up to entirely closed, or further away from the body.

In capoeira, the *berimbau* presents the principal element in music. A game without a *berimbau* is just not possible. At least one is needed for play, and no more than three are commonly used in a *roda*. Those three are named accordingly to their tuning from

³This is often the piece cut out of the fruit used as the resonator for the bow.

low to high: gunga, medio, viola. If less than three instruments are used, the names can vary in their descriptive value and also a very low tuned bow can be called a viola. In case of three, each berimbau has a musical task: the gunga 'marks' (marcar) the rhythm with a basic pattern (sometimes called marcação), the medio plays the inversion of the basic pattern, while the viola is free to improvise above that. Only experienced players are allowed to play the berimbau during a roda. The importance of the instrument is obvious, since the leading player (in case of three mostly at the gunga) also leads the roda itself. The position requires experience and knowledge on how to handle different situations. The leading person (which is the leading singer in most of the cases) is responsible for the beginning and ending of games and the whole roda, and has to keep the energy of the entire event up.

Additionally, a close relationship exists between the player and the instrument itself. Downey (2002) describes that connection very well, linking the phenomenon of 'hearing' to an directly embodied experience. The *berimbau* is part of the individual's apprenticeship in capoeira and helps to understand the mechanics of the game. Players enter a deep relationship with the instruments by the direct connections of their bodies to it. In this way, they embody those feelings, experienced while playing the *berimbau*, also in the actual game, in the *roda*. The connection is consequently also present only by listening to the instrument. It can therefore not be omitted in a game, since it might literally tell the *capoeirista* what to do.

Pandeiro

It is one of the most popular percussion instruments in Brazil; the *pandeiro* is part of a manifold variety of popular and traditional styles. Beginning with capoeira, *samba*, *pagode* and *choro*, it is almost present in any of Brazilian musical genres: *partido alto*, *coco*, *forró*, *frevo*, *MPB*, and many more. It is a single headed frame drum (HS: 211.311) with metal jingles arranged in its frame. Since their sound-ideal is not to actually 'crash', but to sound as gentle as possible, normally two jingles are formed and put together biconvex with a flat disc in between, to impede any unwanted lingering noises, reminiscent of the sound of a hi-hat. In combination with a drumhead of natural skin, giving a strong bass up to high accentuated slaps, the *pandeiro* can easily be used as a substitute for a drum set, either in small acoustics ensembles or amplified on the stage⁴. Through its wide spectrum of sound, it was able to find reception in all the various styles.

⁴It also gets used in bigger ensembles, even when it might not be heard at all. In Carnival groups of Pernambuco playing *frevo*, you can see regularly *pandeiro* players between the superiority of wind instruments, such as trombones, trumpets, and saxophones.



Figure 2.9: Basic position of holding a *pandeiro*. The left thumb lies on the skin (from which it is possible to alter the skin's tension and therefore the resulting pitch), while the rest of the hand clasps the frame. The right hand rests on the hand relaxed in a natural flexed position.

(http://patflor.com/wp-content/uploads/2013/03/pandeiro-676x412.jpg, 02.03.2015)

The instrument is held with one hand on the rim, thumb up on the membrane. With different parts of the right hand, a multitude of sounds can be produced. The main ones can be seen in Table 2.1.

Part of the hand	Place to strike on <i>pandeiro</i>	Sound
		produced
thumb (inner length)	skin between center and rim	bass
fingertips (fingers closed)	directly on rim (no skin)	slight jingle
heel of the hand	directly on rim (no skin)	slight jingle
whole hand (loosely opened)	skin centre	high pitched
		slap

Table 2.1: Basic sounds with corresponding playing techniques of the *pandeiro* within capoeira.

The spectrum can be extended with muffled tones, rolls or altered pitches by changing the tension of the drum head with the left thumb. However, the four strokes, mentioned above, are sufficient for most of the basic rhythms.

The *pandeiro* typically provides an underlying layer of a steady pulse, generally according to the elementary pulse of the music. Depending on the technique, either the striking hand is lightly flexing the wrist or the holding hand rotates the forearm, hitting alternating the upper and lower part of the other hand. By replacing the strokes of fingertips and heel with slap and bass, basic patterns can be build. The notation of Marcos Suzano gives an example for this (see Figure 2.10).

The use in capoeira though, is much more simplified. There is no constant sound coming from the *pandeiro*. The standard pattern contains various strokes of bass and slap. Additional variations and embellishments can be played, but may be sometimes omitted. Players have to be very heedful with their individual playing, since the main task of the *pandeiro* lies in supporting the rhythm of the *berimbau*. It may not predominate, but still has to be heard. Experienced players may interact with the *berimbau* player, complementing their patterns with the variations.



Figure 2.10: Example of a modern approach for the notation of pandeiro rhythms by Marcus Suzano. (Suzano:2-6)



Figure 2.11: Zoom on the drum in Rugendas' "Jogar Capoeira" (see Figure 2.5)

Atabaque

The relation of the barrel drum *atabaque* (HS: 211.221.1) and capoeira changed over the course of time. It cannot be determined precisely, whether it was a part in the beginnings of capoeira, or if it only became more important in the last century. Rego states that it was originally used in religious processions and festivities of the Portuguese court, though African prototypes are imaginable (Rego 1968:85; Oliveira Pinto 1991:188–190). In Rugendas drawing "Jogar Capoeira", we can see a drum accompanying two persons in the centre (see Figure 2.5). It is uncertain, if the drawn instrument, de facto, represent an *atabaque*. When taking a closer look at the drum, it shows that there are substantial differences (see Figure 2.11).

The corpus was probably painted with a checked pattern; and it is more likely to be a cylinder than a barrel. The rim holding the drumhead is not mounted anywhere and somewhat elevated, which makes it impractically to play with the bare hands. The lower part is covered by a cloth so it does not lie directly on the ground or dirt, which in a free interpretation could relate to the contemporary custom in *candomblé* of decorating the sacred drums with different fabrics. All arguments are not playing well together for one or the other. It is most likely that the painter projected already existing conceptions of a drum onto the drawing, mixing several organological aspect of the different instruments (for example, the checked pattern and elevated rim of a European military drums or another Afro-Brazilian drum from the *batuque* style, which resembles the drawn one even more).

The important role of the *atabque* in capoeira music today, thus, developed only recently, which is corroborated by Lewis' argument of practicability: since the drum is quite large and heavy, it would have been inexpedient, carrying it around in times where capoeira only was played outside and *capoeiristas* sometimes even had to flee rapidly from the authorities (Lewis 1992:135f.); especially in times where any expressions of cultural identification of slaves were to be punished. It then seems reasonable to assume that the instrument only was added in times of fixed spaces, such as the *academia* (see 2.1).

Pol Briand refers to Mestre Pastinha as the one introducing the *atabaque* in the *roda*, according to older players (Palmares & Briand 2013:'musique de capoeira'). Often the entrance of the drum in the *bateria* is linked to its role within *candomblé*, suggesting an



(a) Two ways for mounting the skin with ropes on the left side and a more modern approach with hooks on the right side.(Oliveira Pinto 1991:191)



(b) Playing a slap requires to hit the centre of the skin at high speed with a loosely opened hand. Other sounds are produced closed to the rim, similar to the conga. (http://upload.wikimedia.org/wikipedia/ commons/thumb/8/8b/Atabaque.jpg/300px-Atabaque.jpg)

Figure 2.12: Different types of mounting the skin on the *atabaque* in Figure (a) and the hand positioning for playing (b).

interchange between the two cultural systems. Though there are no immediate connections determined (Oliveira Pinto 1991:34–36) between capoeira and *candomblé*, it can be said that both forms are "independent" from each other (Rego 1968:38). Still, many *capoeiristas* were, and still are, in some way affiliated to Afro-Brazilian belief systems such as *candomblé*. Mestre Bimba was one of them, while Pastinha, however, was not (Assunção 2005:158). In this sense, Bimba, as an experienced drummer, integrated also the stylized stick fight *maculelê*, which is accompanied by two *atabaques*, into his training, for students to improve their basic movements. Since he restricted most *rodas* to a smaller ensemble of instruments it is more likely that Pastinha is responsible for the drum's place in the ensemble.

The *atabaque* is used in *candomblé* in three different sizes, called from lower to higher sound: *rum*, *rumpi*, and *lê*. In *maculelê*, two of them are used, in capoeira, if at all, only one, but it does not matter which. It is made from wood and natural skin, which can be fixed on the head either by a rope tuning system or hooks with inserted nuts (see figure 2.12a).

The highly sophisticated techniques of playing in the *candomblé* context include various strokes with the hands or sticks. In capoeira, just as the *pandeiro*, only simple strokes are used for the standard pattern. These include a bass with the loosely opened hand between center and outer edge of the skin, and a high pitched slap in the centre (see Figure 2.12b). The patterns actually are similar or even equal to those of the *pandeiro*. Variations then may also be added, as long as the sound of the *berimbau* is not drowned. With its deep resonant bass, it provides a strong fundament in the ensemble.

Additional Instruments

Other small percussion underpin the accompanying rhythms to the *berimbau*. The double bell $agog\hat{o}$ (HS: 111.242.221) and the scraper *reco-reco* (HS: 112.22, sometimes



(a) Metal agogô.
(b) Wooden agogô.
(http://www.kalango.com/media/image/-2AGT-JAK-P544e2018e8777.jpg, 17.03.2015) AGOCAS_1544e202870ca8.jpg, 17.03.2015)

Figure 2.13: Two types of *agogôs*: the model in subfigure (a) is made from metal, giving a sharper sound, while the one in subfigure (b) is made from hollowed Brazilian nuts, resulting in a softer, but still clear sound.

called $ganza^5$) are the ones typically used. Contemporary agogôs are mainly made from metal, using two bells for different pitches⁶. The older construction of building them out of two hollowed out fruits of the Brazilian nut (*Bertholletia excelsa*). Both are played with a stick made from wood or metal. The wooden instrument is getting more and more popular, due to its softer sound, which better adapts to the rest of the ensemble.

The most used scraper, made from carved bamboo⁷, is played with a stick or a rod, scraping up and down against the notched surface of the cane, or is struck at the ends. Both instruments play similar patterns to the *pandeiro*, just as the *atabaque*.

Other instruments as an additional *caxixi* or the frame drum $aduf\hat{e}$ are mentioned by Rego (1968:80–88) but are not found today anymore.

Songs and Clapping

A good *capoeirista* not only is physically trained, well in shape and pursues the bodily play. He or she also has to be a musician who knows how to play the different instruments, can sing along in a *roda*, and is well versed in the different patterns used. Any participant in a *roda*, who is not playing an instrument, subsequently still takes part in the music by singing and clapping. All forms of song, but one, are built in the principle of call-and-response of the soloist and the chorus. The latter comprises all people participating in the *roda*. Even the audience can join in if they know the lyrics. The person, who is in charge of the *roda*, is to begin with the songs for the choir to answer, in most cases it is also the person on the lead *berimbau*. The soloist may also

⁵The term $ganz\acute{a}$ in Brazil usually refers to any kind of shaker, mainly vessel rattles (HS: 112.1 or 112.13). By using the word *reco-reco* people easier know that one is talking about capoeira.

⁶Instruments with up to six bells exist, but are not used in capoeira.

⁷Instruments, made of metal and synthetic material, such as fiberglass, exist, but are more common in genres like *samba*, where a louder sound is desired and needed.



(a) http://www.criarimagem.com.br/admin/ uploads/galeria/0361-03.jpg, 17.03.2015)

(b) *Reco-reco* industrial version. (http://www.musiclick.com.br/image/-produtos/bg_393.jpg, 17.03.2015)

Figure 2.14: Two different types of the scraper *reco-reco*: the classic version with a hollowed body and rippled surface (a) and an industrial block with a gap, cut in the middle (b).

change over the time, but mostly stays within the instrumentalists and more experienced players, since they have a wider knowledge of all kinds of different songs. The non-instrumentalists are supposed to clap along with the same rhythm as the *pandeiro*. They also have to be careful, not to dominate the instruments or cause a diminution of the all over energy.

The songs can be divided into different sections, regarding their composition, number of verses, relation of solo and chorus, and the moment in time, when they are sung in the *roda*. The terminology for these distinctions, may stem from capoeira vocabulary itself, but not all of them are used frequently. Still, they are fairly useful to know what one is talking about, also, since some of them are, again, dependent on the style. Not all literature agrees on the definitions, but on the whole, I agree with Assunção (2007:202) on the four main types⁸: *ladainha*, *chula*, *corrido* and *quadra*.

Just before beginning with the proper lyrics, the soloist exclaims " $i\hat{e}$ ", regardless of which songs will follow, to officially mark the beginning of a roda. This can either be a long sustained cry, which is sliding down in pitch, or a short energetic shout. With a ladainha, the roda then is to be opened. It literally means 'litany', which may come either from the topics dealt with in the song that only the soloist sings alone, or its partly long duration. The content may serve as a mode of transmission of knowledge or 'sung lessons', for instance, about the history of the game (or at least the singer's personal view about it), by telling stories about famous capoeiras and mestres (including the soloist themselves), referring to its African heritage or concrete historical events, such as the abolition of slavery in Brazil. Lewis also sees the ladainha as a preparation of the players, preparing to enter the roda, and as an expression of the singer's mood (1992:156). The lyrics ought to be improvised, but tend to be recited from a canon of popular texts from famous mestres. Since the contents of the lyrics are

 $^{^{8}}$ Rego (1968:216–259) distinguishes even more forms apart from that, grouping them under folkloric perspective. If this attribution still is valid, needs to be proven.

of significance for the listeners, the song is accompanied by less instruments, to clearly understand the words.

A direct transition from the ladainha to the chulas (also: canto de entrada⁹/ louvação¹⁰/ reza¹¹) is achieved by the word "camará"¹², followed immediately by the first chula, a call-and-response chant with a predefined structure. Every line starts with "iê", followed by different standardized verses. They can be varied by improvisation, but the essential idea remains the same. It is used to praise god, former capoeira heroes and mestres, or even to give advice or warnings to the players who are about to enter the roda for the first game. The response then repeats the line, adding the "camará" at the end of each sentence.

The most frequently used form of song is the *corrido*, which are short verses in a call-and-response scheme. Unlike with the *chula*, the answer of the chorus always stays the same. The songs and their solo stances draw from a vast repertoire of standards, though improvisation of the soloist is allowed and desired. By the means of the songs, the principal singer can comment on the running game, giving advice to the players in the middle, warn them, provoke, and tease them, and thereby, in some subtle way, even influence the game. A very simple example for this, is when someone may have been prancing around and then gets knocked over from a handstand. The soloist can comment on this with various songs, indicating the attitude towards such behavior:

Solo:Meu facão bateu em baixoMy machete struck lowChorus:A bananeira caiuThe banana tree fell

The word *bananeira* stands simultaneously for the banana tree as well as the handstand in capoeira. If the person that has been knocked over was even more unexpected to do so, due to a seemingly small or weak figure, one may sing:

Solo: Bem-te-vi botou Bem-te-vi put Chorus: Gameleira no chão The gameleira tree down

Here, the inconspicuous *bem-te-vi* bird (*Pitangus sulphuratus*) manages to fell a massive *gameleira* tree (*Ficus doliaria*). These are only two obvious examples. The interaction of players in the roda and the soloist may happen on all different kinds of levels, for example, directly, indirectly, or metaphorically, as the above.

The quadra is an innovation that had been introduced by Mestre Bimba and is widely known and practiced today, especially in the Regional style. It designates a quatrain dealing with all different kinds of topics. In Regional, it generally replaces the *ladainha*, with the soloist singing four lines and directly leading into the *chula* or *corridos*. It has developed to a somewhat free form in the present, where to four lines of individual verses, the chorus answers with a single line, just as in the *corrido*. The limit, however, is not set up to only four lines; also eight, or even sixteen lines may be found.

A special case is the *cantiga de sotaque*¹³, which Lewis describes as a "verbal dueling". Mestre Bimba did this by challenging an opponent in his *ladainha*. Another possibility is that one can directly point to an adversary while singing, during a game (Lewis 1992:169–172). This form may be derived from other, similar phenomenons,

⁹pt. "song of entry"

¹⁰pt. "praising"

¹¹pt. "prayer"

¹²pt. "comrade; buddy", it is an abbreviated form of the noun "*camarada*" which is often used to address fellow *capoeiristas*.

¹³pt. "song of the accent"
which are still present in contemporary Brazil, such as the *repentistas* from the North-East, who improvise poetry on the spot, while accompanying themselves on the typical guitar *viola*. When two singers challenge each other in a *desafio*¹⁴, they alternately try to mock the other with their words with even more complex rhythmical patterns, every time. This special kind of 'song contest' in capoeira is, as it were, died out. Only very few skillful and older *capoeiristas* still practice it from time to time. Within most of the younger generation, this style is more or less unknown.

All of the above are subject to change. Just as the *quadra* is a new form of singing, all other forms in this way, only came up with the advent of the *academias*. With the possibility of recording their own music, a huge amount of new songs came up, all of them individual in their making. The verses tend to be longer, as do the choruses, making it hard to easily remember it as the short concise phrases from a *corrido*. Up until now, not many of these songs have made it into the standard repertoire of capoeira music. The question is, how long it will actually take, until the older songs will be forgotten.

Bateria

The instrumentation, patterns and songs used in a *roda*, strongly depend on the style of capoeira that is played. Both Mestre Bimba and Mestre Pastinha tried to set up a predefined model for which instruments are to be used in a *bateria*. The first restricted the instruments after some time of tryouts to a minimum of a single *berimbau* with two *pandeiros*, which is still used today as a minimal *bateria*. A reason for this small group often is that one can better listen to what the *berimbau* has 'to say' (Almeida 1986:75). Assunção (2005:161f.) explains how Pastinha experimented with quite a lot of different instruments, even including guitars or even castanets, until he came to the setting which is today the most used, encompassing all kind of styles: three *ber*imbaus, two *pandeiros*, one *agogô*, one *reco-reco* and an *atabaque*. In this combination, the ensemble "clearly was an innovation, and did not realte to any capoeira tradition in particular, although one could argue that Pastinha invented it within a broader Afro-Bahian tradition" (Assunção 2005:161). The basic disposition of the roda and the emphasis of the roles of each instrument remain the same. In Figure 2.15 we can see the classic arrangement of the circle.

The position of the outer instruments, that is, $agog\hat{o}$, reco-reco and atabque, are variable and are not of utter importance. The *berimbau* however always takes the spot in the very center, flanked by the two *pandeiros*. In this way, a certain orientation is given in the roda, since all games start (and often also end) ao pé do berimbau¹⁵. The instruments also enter the music in a certain order, starting with the *berimbau*. The gunga (if more than one musical bow) starts alone, either accompanying a *ladainha* on its own or followed by the *medio* and the *viola*. After that, the *pandeiros* are added and only with the beginning of the corridos or any consecutive songs, and generally with the first response from the chorus, the remaining instruments join in.

Since, in a *roda*, not only capoeira takes place (though it is usually its core activity), but other activities with music are often practiced by *capoeiristas*, the combinations of instruments in the *bateria* are different, but come back to the body of basic instruments. In the danced stick-fight *maculelê*, two *atabaques* playing interweaved patterns, are accompanied by the *agogô* and sometimes two *caxixi* or a *pandeiro*. The rhythm gets

¹⁴pt. "challenge"

¹⁵pt. "at the foot of the *berimbau*"



Figure 2.15: Arrangment of a typical capoeira *roda* with different parts for each participant. (Lewis 1992)

accentuation	stressed	unstressed		
sound	high / low	buzz		
resonator	open	closed		

Table 2.2: Basic connection of the *berimbau's* sound qualities with playing techniques in standard *toques*.

further highlighted by the two sticks (*esgrimas*), dancers hold in their hands, striking them against each other, producing a click sound on two ensuing beats. In the *samba* de roda, a form of samba, people can dance in the roda to the sound of an entire bateria, or even its minimal version, basic samba steps.

2.2 Musical Structure

Musicological literature with thorough research on capoeira music is rare, especially in non-lusophone languages. The standard literature (for example, Lewis 1992; Assunção 2005; Downey 2005) may deal with the music, since it is an essential part of capoeira, but more profound investigation on musical structures cannot be found here. Brazilian researcher Kay Shaffer (1977) probably was the first one to notate the patterns of the *berimbau*, which are most often cited. The German-Brazilian musicologist Oliveira Pinto (1991) then did the first (ethno-)musicological analyses. Presently, there is probably more literature circulating, especially in Brazil; unfortunately I could not find any of them up until now. Anyhow, other fields of research are providing basic means for the analysis of the music, as already Oliveira Pinto (1991) did, when he used findings from African music research as the fundament for Afro-Brazilian music. Especially Kubik's output about timeline-patterns serves this purpose well (for example, Kubik 2004, 2010).

The musical parts in capoeira are pattern-based, which in Brazil are called *toque*. Yet, this name bears more than just the understanding of a musical cell. The conception of a *toque* may vary; as the lines to be played by an instrument, such as a riff, a motif or indeed just a pattern, which is a standard understanding of it. But in capoeira it is also connected to a distinct kinesthetic quality. By hearing a certain *toque* on the *berimbau*, the person playing in the middle knows, what kind of game (*jogo*) and, therefore, what type of movement is expected to be played. In this section, I will cover the rhythmical and tonal realms of the *toques* of the different instruments. They are all based on a steady elementary pulse with two "Kategorien" to be respected as Oliveira Pinto (1991:71) pointed them out: a "rhythmische Impulsfolge" and, in addition, the *berimbau*, the "tonräumliche Veränderung"¹⁶.

The sounds of the *berimbau* used in the standard *toques* can be fitted into a framework, where one can get the basic tones that are used, as seen in Table 2.2.

The three distinct sounds are then in the following order: pitched sounds are usually played with an open resonator away from the body and are more stressed than the buzz sound, which is played with a closed resonator, held tightly to the torso¹⁷. All basic patterns are built from the named sounds in a certain manner. There are, however,

¹⁶ger. "rhythmical series of impulses" and "changes in tonal space"

¹⁷This may also come from a practical approach, since by closing the resonator, the harmonics are getting muffled as well, and clear pitch is less audible, giving the snare of the string more space to be heard.

only a few *toques* on which most of the *capoeiristas* agree, and on how these ought to be played. In a comparison of the *toques* listed by Almeida (1986), Downey (2005), Oliveira Pinto (1991) and Shaffer (1977), many of them drawing from the repertoire in Rego (1968), and the experience in listening to a lot of capoeira music live and recorded, some recurring patterns with a structure that is more or less agreed on can be named as follows: Angola, Cavalaria, Iúna, São Bento Grande (de Regional), São Bento Pequeno. Other famous *toques* like Santa Maria, Panhe laranja no chão, Banguela / Benguela, and the many variations of all these patterns will not be treated here, since a common opinion on their construction cannot be established and differ greatly in their use in the different schools.

In the transcription of Shaffer (1977) from the *berimbau*, a tendency towards to the author's individual interpretation of the heard is seen. One can see the basic structure in these notations, but all of them surpass the informal lines, limiting a *toque* to a basic core of rhythmical and melodic progress. Certainly, we cannot acquit them from more complex meanings and conceptions, as already mentioned, but for the mere musical recognition the above mentioned categories of rhythmical impulses and changes in tonal space are suitable for defining a pattern.

For the transcription of the patterns different systems are used. In the first part, I want to use the Time Unit Box System (TUBS) as applied by Koetting (1970), who developed it from the ideas of Philip Harland, and the standard notation for timeline patterns as used for example in Kubik (2004; 2010), which are a form of impact notation ("Impaktnotation"), as used by the latter in 1983, only referring to the mere moment of the event producing the sound (for example, the contact of a stick on a string). With these stripped down systems, one is able to capture the basic temporal occurrences, independent from the resulting sound, or any bias of accentuation implied by a classical Western 5-stave notation. Using TUBS, the notated patterns can be immediately compared by writing one below the other.

A connection to Africa in capoeira can be seen, as in many other Afro-Brazilian genres, in music. We can apply the findings of Kubik, based on Kwabena Nketia's research, about the time-line patterns and elementary pulsation to describe capoeira music (Kubik 2010:21–84). All *toques*, understood as patterns, then are "cycles", divided by beats or a "gross pulse" consisting of multiple elementary pulses, which serve the musician as a grid for orientation in the music. If the cognitive processing and the understanding of capoeira musicians take effect in the same manner as in Africa, may be questioned. The fact that time-line patterns and the appendent framework are present in contemporary Afro-Brazilian music, however, is highly visible and has been proven (Kubik 1979; 1990 et. al.). With this in mind, the structure of the *toques* can be defined, setting the starting point for the patterns in a cycle and thereby one knows where to place possible reference beats. For this, the crucial evidence is the following time-line pattern:

Even though the original purpose as a 'time keeper' – people clapping in the *roda* have to listen to the *berimbau* – is not pursued anymore, the structural components still adapt in the musical form. This pattern comes from the broad genre of samba, more precisely the *samba-de-roda* from the Recôncavo area in Bahia , and furthermore the genre of *batuque* (cf. Oliveira Pinto 1991:110–113), while it is used by several groups as the pattern for the accompanying clapping in capoeira as well. This form is known

all over Brazil, accompanying every kind of Brazilian music, especially by the audience clapping this pattern. Its presence was already mentioned by Debret:

"Presque toujours ce chant, qui les électrise, est accompagné d'une pantomime improvisée, ou variée successivement par ceux des spectateurs qui désirent figurer au milieu du cercle formé autour du musicien. Pendant ce drame fort intelligible, on voit se peindre très-énergiquement sur le visage des mimes le délire dont ils sont possédés. Les plus froids, au contraire, se contentent de soutenir la mesure, marquée par un battement de mains composé de deux temps précipités et d'un lent. Les instrumentistes, aussi improvisés et toujours en grand nombre, ne sont armés chacun, à la vérité, que de deux tessons de vaisselle, ou de deux petits morceaux de fer, ou bien encore d'une coquille et d'une pierre, ou enfin de ce qu'ils portent à la main, comme boîte de fer-blanc ou de bois, etc."¹⁸ (Debret 1835:128f.)

He describes it with two short claps and one long clap, which is to be mistaken with an untrained ear, confusing the actual beginning of the cycle (Oliveira Pinto 1991:110):

```
8 [X.X.X.]
```

Transcribed with the TUBS, it looks like the following:



Figure 2.16: TUBS notation of the 3-3-2 timeline.

Written in this manner, the first box concurrently means the beginning of the cycle, disregarding the moment where one actually starts to clap. This is indicated by an arrow \downarrow , showing where people usually start. The first box and pulse, then, also is the first beat or gross-pulse. Matching it with more common patterns of clapping in capoeira, can show us one division of the reference beat. This is due to the (macro-rhythmical) isometric distances between the claps. It is either three claps in a row, or two¹⁹. The latter is more common within Angola style, while the first one is not restricted to a certain form, but very widespread. Clapping only two times is probably related to the structure of the *toque* Angola, emphasizing the two distinctive notes constituting the pattern (see on page 44). Comparing the different patterns within the music, the following relation can be set up:

¹⁸fr.: "Almost everytime this chant, electrifying them, is accompanied by a improvised pantomime or varied by those spectators who want to act out in the middle of the circle shaped by the musicians. During this difficultly graspable drama the delirium occupying them becomes apparent in their facial expressions. The simple minded, however, limit themselves to keeping the time, marked by clapping their hands two times fast, one time slow. The instrumentalists, also improvising and always in appearing numerously, actually are armed only with two clay shards, or two small metal piece,s or a shell and a stone, or just what is at their hands, such as a tin can or a piece of wood."

¹⁹Very frequently seen in Angola *rodas* is that there is no clapping at all, leaving only the *bateria* to produce music. In the analyses, this can be disregarded, since the music is not changing and all auditory examples are with clapping.



Figure 2.17: TUBS notation of the three distinct capoeira clapping patterns.

This further leads to a division in two elementary pulses of the gross pulse, resulting in the following distribution of the beat (as indicated with boxes shaded in grey):

Figure 2.18: Extendend TUBS notation of the three clapping patterns with grey shaded boxes indicating the gross pulse.

This version is a common one for cycles with eight pulses and is very likely to be used in capoeira as well. Since the beat is subject to individual perception, the possibility of only half as many can also appear, dividing the gross-pulse into 4 segments:

Figure 2.19: Extendend TUBS notation of the three clapping patterns with grey shaded boxes, indicating the referencial beat.

Both versions are useable with the first, seeming more functional as an analytical grid. In the embodiment of a referencing pulse, for example, stepping on the beat, the second one is more likely, seeing that in slow music, stepping all four beats would be to fast-paced, seemingly hectic. In very fast music, then again, it is the same problem, but referring to the body. In the audience, one would not 'go with the beat' four times in a cycle, since it would be very uncomfortable at such pace. This is why at very high rates of pulses, I will refer to the two-beat-cycle, while for the analysis and slower music, a four-beat-cycle is more appropriate²⁰. In further TUBS, I will mark all four beats, with the additional two in a lighter shading, for reference:

 $^{^{20}}$ This subdivision into "slow" beats and faster ones in this "timing system" is very common, for example, in African music, see Kubik (2010:41).



Figure 2.20: A combination of Figures 2.18 and 2.19 Extended TUBS notation with graded grayscale shading. Colored boxes indicate the gross pulse. Darker colors stand for the referential beat.

The two- and three-stroke isometric clapping patterns also depict the overall rhythm of the accompanying instruments of *pandeiro*, *atabaque*, *agogô* and *reco-reco*. Now, the *toques* of the *berimbau* are built in an analogue manner within their temporal distribution on the pulses. Whether those developed from the drum patterns or vice versa remains open. One example of a *toques* about which almost every *capoeirista* agrees on its basic structure is Angola²¹. In the TUBS notation, its strong relation with the clapping patterns of Angolan *rodas* is easily seen. Here, only sounding events on the berimbau are shown, that is, when the stick hits the string²². Written above the pattern are the two claps:

Figure 2.21: TUBS notation with beat locations of the rhythmical sequence for the *berimbau* of the *toque* Angola on the lower row, with a common clapping pattern in Angola *rodas* added in the upper row.

But to really capture the defining complex of a *toque*, we now have to introduce the dimension of distinguishable sound to the transcription, since the mere timepoint of production of the sound does not suffice the purpose. Therefore, new symbols in the notation are added, showing the different pitches and the buzz tone, as well as diacritical marks, which show changes from the earlier mentioned system of when to open and close the resonator (see Table 2.2 on page 39).

 $^{^{21}}$ The notated pattern interestingly is called "Banguela" by Mestre Bimba, saying he did not know the *toque* Angola. Lewis explains this with Bimba's intentions of "restructuring capoeira", trying to "distance himself from traditional" styles (1992:149).

²²Some also people like to play an accent of the *caxixi* on the first pulse. This stroke is not determinant for the *toque* to be recognized and very often gets omitted, building a strong tension, since the *toques* usually built up towards that first beat. That is why I only take strikes of the *berimbau's* string into account for the constitution of the *toques*.



Figure 2.22: Legend for the system used in the present transcriptions of *berimbau* toques. A indicates the buzz tone; B and C stand for the low and the high tone, respectively; D denotes an immediate transition between the two neighboured sounds; E and F show if the resonator is either closed (E), or open (F).

In the legend above, we can see all the components necessary, to illustrate all basic playing techniques for the core structures of the *toques*. All signs are chosen by their slight iconic value projecting onto the instrument itself, imagining a horizontal line dividing the box in the middle as the line where the coin meets the string. The first symbol \mathbf{A} , a small cross, then stands for the buzz tone coming from holding the coin very lightly against the string, allowing them to vibrate together, creating a 'clanking' sound with undefined pitch. The stick should meet the string very close to the coin. Symbol \mathbf{B} and \mathbf{C} show the low and the high tone respectively, represented by triangles showing up and down, equal to the stick hitting the string usually above or below the coin. An already advanced technique is presented with \mathbf{D} , where two sounds are directly connected through the coin only. Possible pairs can be the buzz and high sound, either stopping the low sounding note with the coin to achieve the buzz or pressing it against it for an uninterrupted/continuous transmission between the two sounds. As for example in the following:



Two additional markings, which only appear in conjunction with one of the sound symbols, show whether the resonator is to be held against (closed, symbol \mathbf{E}) or away (open, symbol \mathbf{F}) from the body. The boxes only are marked in the moment of hitting the string, where there is a more or less strict convention to do so, since in reverberating it is a question of individual preference of how to have the resonator.

With this system we can now notate the above mentioned *toque* Angola, written under the two-stroke pattern for clapping or the accompanying percussion characteristic for the style:



Figure 2.23: Transcription of the *toque* Angola.

The toque São Bento²³ already has different interpretations, though these, again, are more or less uniform and can be split up into three different types: São Bento

 $^{^{23}}$ This is referring to Saint Benedict of Nursia. Relating to Christian saints is common in capoeira language, which arises from the practice in *candomblé* of their 'syncretisation' with the orixás. São Bento is one of the most referenced saints in capoeira, often being associated with snakes, as explained by Lewis (1992:179f.).

Grande (Angola), São Bento Grande (Regional), and São Bento Pequeno. The 'small' São Bento Pequeno, in its most known form, can be seen as an inversion of Angola:



Figure 2.24: Transcription of the *toque* São Bento Pequeno.

The 'big' São Bento Grande exists in different versions. Coming from the Angola style, it is mainly encountered as the following pattern, which is the São Bento Pequeno with an additional down stroke on the beat:

	Χ	Х		

Figure 2.25: Transcription of the toque São Bento Grande.

The unique *toque* of the Regional style, however, is a two-cycle pattern, invented by Mestre Bimba, which is why it is often called São Bento Grande de Bimba/Regional, or simply Regional. The order of notation is not too important, since the cycles can be swapped. Here, the more distinctive pattern of Regional is placed first.



Figure 2.26: Transcription of the *toque* Regional / São Bento Grande de Bimba.

In the first pattern the typical structure of the one-cycle patterns can be seen, where the buzz tone is followed by pitched tones on the beat, whereas in the second pattern the buzz and the high/low sound are alternating on the beat. The buzz sound in brackets is often heard to be omitted, especially at very high speed, making it difficult to articulate the two consecutive strikes clearly. Also the second buzz tones of the other beats can be absent, but are more likely to be played than the marked one. In many schools, not following strictly Bimba's teachings, only the first cycle of the pattern is played as São Bento Grande or Regional, equally to the São Bento Grande found in Angola and more traditional styles.

I want to transcribe one more *toque* which will be used later on this study. Though there exist quite a lot of discussions about the origin of the Iúna, it has nevertheless established itself in the capoeira repertoire and is played in a somewhat conform manner today. It was invented with high probability by Mestre Bimba, or at least his version made it popular. It is said that the sound is supposed to imitate the singing of the Iúna bird (*Anhima cornuta*), though there is no proof for that²⁴. The pattern is somehow different in its structure from the one that has already been mentioned, but the buzz tone can be used as a reference, and on a close look, a resemblance can be seen. It is composed of different patterns which are built of two cycles at a time. The special

²⁴For an interesting comparison, look up the following video on YouTube: https://www.youtube.com/watch?v=Ejq_beIWRVc (21.08.2014)

characteristic is that the high note is trying to be avoided, thereby generating a sort of tension for an experienced hearer of capoeira musicm who is used to the polar tonal structures of the *berimbau*. The first pattern can already be seen as a compound of each two cycles A+B:



Figure 2.27: Transcription of the *toque* Iúna. Shown is only a wide spread variation, as used in the study.

Cycle B can be seen as an appendix in a fixed form, always attached to the many variations of cycle A. The two notated lines are the most basic way of playing, and learning the *toque*. B is a recurring structure, which is less altered, providing the base of the *toque*, since here lies the characteristic deviation of the standard where the two low tones are played with a closed resonator, resulting in a more 'muffled' sound, due to less audible harmonics. If B gets varied, it is always done in such a manner that this part is still perceptible. In Iúna, there is usually no accompanying clapping and no singing leaving the space for the sophisticated elaborations of the *berimbaus*.

There are many more *toques* which are widely known but differ greatly in their execution. These are for example (A)panhe laranja no chão tico-tico, Aviso, Banguela, Cavalaria, Idalina, Jogo de Dentro/Fora, Miudinho, Muzenza, Samongo, Santa Maria, and many more, with all of them having individual qualities, often referring to a special kind of game or an emotional content. Here are some of the most important *toques*, which appear repeatedly in most schools:

- (A)panhe laranja no chão tico-tico: "Pick up the orange from the ground, tico-tico"; the tico-tico is a rufous-collared sparrow (Zonotrichia capensis matutina). The particular about this toque is the strong resemblance of the metrics and melodic contours of the voice and the berimbau. Lewis surmises a connection to African drum language here, whether as a "vestige" of original musical structures or a "playful imitation" (Lewis 1992:151f.), both ideas are quite vague and would need more detailed research.
- Aviso: This is not actually a *toque* as a structured pattern in itself, but more of a signal to draw attention to the *berimbau* player, for example when a *roda* is about to begin or during a game, the two persons playing in the middle should stop and come kneel down at the *pé do berimbau* again. For this purpose a long sequence of a steady pulse is played on the bow, often a single tone, mainly the lower, sometimes changing to the upper. Aviso literally means 'warning', or 'notice'.
- **Banguela:** As mentioned above, this is used to describe the *toque* Angola by Mestre Bimba. It is also often known today as what Bimba calls Banguela compassada²⁵, where a second high tone follows the first on the next beat. This is also often called Benguela, referring to a (sea)port in Angola. It was, just as Luanda, one of the main harbors in Angola for the import of slaves.

 $^{^{25}\}mathrm{pt.:}$ "measured"

- **Cavalaria:** This *toque* is said to be used to warn the people about the approach of the mounted police, the 'cavalry', in times when capoeira was still prosecuted. The *berimbau* imitates the sound of the horses' hooves coming closer.
- Idalina: A woman's name. It was invented by Mestre Bimba, today also often played in a simplified version, the game is often played in Regional *rodas*.
- **Jogo de dentro/fora:** The inside/outside game. It is one of the routines done in Angola, referring to a certain movement style, either closer together, inside, or looser apart, outside. Often this is induced by playing the corresponding *toque*, but there is no consent about its structure and in many schools, no such pattern actually exist.
- Miudinho: A modern *toque* created by Mestre Suassuna. He wanted to go back to the 'older', closer style of playing together.
- Muzenza / Samongo: Very little is known about these *toques* and they appear only scarcely. Sometimes they are played the same, sometimes different. They were probably created by Mestre Canjiquinha (Lewis 1992:150).
- Santa Maria: It is often sung with the lyrics of "Apanha laranja no chão tico-tico", giving the rules for the game: a small amount of money is placed in the middle of the *roda*, which the players have to pick up with only their mouth, in order for them to keep it.

With the transcriptions above, I offer my view on a possible perception of the beat in capoeira music, although this is an issue that can be strongly debated on. Since it is not usual in capoeira to learn the *toques* in a written form, but by oral transmission (often with the help of onomatopoetic syllables), notating them comprises an individual interpretation, influenced by the notator's perception of the music. Though in global times of capoeira, musicians try to learn it by notational systems. I see the main use in them for analytical purposes. That is why I tried to deduce the form of the *berimbau toques* with the use of an already established structure such as the time-line pattern. A reference to other attempts of transcribing the *toques*, however, shows some discrepancies. The methods, I was able to find in more recognized literature, include those of Lewis (1992), Oliveira Pinto (1991), Onori (2002) and Shaffer (1977).

Piero Onori uses a classical Western 5-stave notation, including the treble clef, measures, and bar lines with additional marks for the resonator. The unchanged system, however, does not cope with actual structures of the music. In a modified version it can be useful, though, for readers not familiar with TUBS, or similar schemes, as used by Lewis and Shaffer. The first endeavor of a notation of *toques* were done by Shaffer, who used a one-stave system with additional signs for the caxixi, the buzz tone and the resonator. Most of the patterns are divided into a $\frac{2}{4}$ bar with a basic pulse of eight 16th notes, which result, then, in two beats, each a quarter note. Shaffer transcribed the music mainly from CDs, resulting in long transcriptions of entire 'pieces', rather than structural formulas for each toque. This then leaves us with individual interpretations, where one needs to extract the needed parts. Lewis does this, with a notational system, similar to Shaffer's. He calls these basic patterns a kind of "theme with variations" (1992:146), counting explicitly two beats in one measure, with, therefore, eight 16th notes in it. Oliveira Pinto approaches the subject on a musicological level, using the TUBS as well. He introduces multiple signs for each sound and combines it with a onestave notation in Western notation, for easier understanding. An additional notation,



Figure 2.28: Comparison of the several transcriptions of the *toque* São Bento Grande. Each author uses his own kind of notation.

I want to present and use is found on Wikipedia, where, unfortunately, the author is unknown (Wikipedia 2014). The advantage of the system is the easy legibility through a 2-stave percussion scheme with the right conceptual ideas, shown by small boxes which indicate the pulses in a beat. This, for example, allows a clever way of writing the *toques* in combination with simplified melodic lines of the chorus.

In a direct comparison of the *toque* São Bento Grande (Angola), one essential disparity can be seen with all, but Lewis' transcription: the beginning of the cycle is actually seen on what is the second, or the third beat, as the case may be in Lewis' and the transcriptions that are presented here. Those writings may show us the actual perception of the patterns by the author. For a structural analysis, concerning the beat, this does not turn out to be a big problem, but still gives interesting insights of the many ways, the music can be perceived. I derived the presented forms from the original clap pattern, which lead to only one way of notation, but of course there are many possibilities of writing it down. The first four pulses could be placed at the end, or the elementary pulsation may actually be twice the number, a total of 16, since in rare cases also more rapid sounds are achieved than those registered here. The aim, however, was to define a beat, which, though a subjective unit, possibly all practitioners

of the art experience similarly, especially coming to its embodiment. Here the 'general' beat, 'what you would tap your foot to', is in two parts, while probably the 'reference' beat or gross-pulse may add up to four (as also sees it Oliveira Pinto 1991:71). But a necessary aspect to bear in mind with these beats is that they do not have a metrical accentuation only on the basis of their order in the cycle, but rather are all of equal value. The actual metric pattern, in sense of stressed and unstressed beats, is somewhat more difficult to define. Most likely to be heard is the playing towards the first pulse in this work's transcriptions. A light, sometimes even explicit, accent is put on the note by striking the string harder. This is why some people do not like to make a sound with the *caxixi* on this pulse in patterns like Angola or São Bento Pequeno, saying that it would take away the tension. A good example for this is also the *toque* Iúna where one can actually hear a buildup during cycle A, with an ease of tension on the first pulse of cycle B, only because the rest of it is softer. This is also intensified by slowly removing the resonator from closed to open during the first cycle, increasing the sound in intensity. The actual accentuation, however, is in a deep relationship to the phrasing of the lyrics. With most songs, there exists some sort of convention of where to start within the musical structure, and one easily gets chided for entering on an 'erroneous' cue. This gives a clear idea of where to place an emphasis, synchronizing the meter of the lyrics with the pulses, which is also often the already mentioned first pulse. But in quite a few cases, the lyrics have to adapt to the *toque's* structure, especially in the ladainhas, where the improvised stances have to fit easily to the played patterns. The probably most famous *capoeirista*, known for his strong rhythmical twists, inversions and metric bending, is Mestre Caiçara (Antônio Conceição Moraes), who changes the cue at will. An example is the *corrido* "Camugerê", which usually is, according to its pronunciation, sung as the left rhythm in opposition to Mestre Caicara's version on the right:



Figure 2.29: Transcription of the song "Camugerê", used in stimulus 1 of the study. Rhythmical idiosyncracies are found in the right version Mestre Caiçara, going against the usual interpretation of the song.

This shows us a small bit of the deep and complex interrelations of music and language in capoeira and poses a lot of open questions that are subject to closer examination and research. Since this vast topic does not precisely link to questions of beat perception, I do not want to go to deep, but rather leave it at this general point, so, to have an overall understanding of the underlying musical structures.

Chapter 3

Motional Structures of Capoeira

The movement system in capoeira is as result of its history. It developed from idiosyncratic esthetics of a cultural group into what it is now, and absorbed many different influences along the way. Coming from an African background, the Portuguese reign put suppression upon slaves as practitioners of their cultural practices that were transferred to the New World, which forced it to adapt. When it finally became free, these practices where then formed and modeled by ideas from other European and Asian martial arts. What still has to be examined is, in what context the practitioners actually are moving, or if they embody the music in a certain way. Are they 'only' fighting with each other, or are they moving within a framework that guides the system?

What one can learn from capoeira is the so called *malícia*, literally just meaning malice or cunning. Its essence, however, is much more complex and is associated in a different way in capoeira. First thinking of cunning, probably does not evoke only positive feelings. It could be related to trickery and deceitfulness, to an improper way of getting the things in life one wants to possess and achieve. Simultaneously, this may then be of value to some people. The identification of *capo*eiras in earlier times (and sometimes even in contemporary society) as *feiticeiros* and *mandinqueiros*, both people related to supernatural practices as what we would call witchcraft or sorcery, also already linked them to somewhat 'unnatural' means of having one's own way. Getting, somehow, further away from such tags, *capoeiristas* today are still famous for their behavior in a game, or a fight. With *malícia* you lure your opponent into your arms, just to give him or her a kick in the guts; you embrace the other just to throw that person on the ground. One of the most famous examples of insidiousness is a front kick movement called *benção*, the blessing, described by Lewis as follows, who connects the *malicia* and its essence to the 'outside world', that is, the society of Bahian *capoeiristas* in times of slavery and today:

"On his first day of class, the instructor offers his hand to a new student for a handshake in a gesture of welcome. When the student reaches out to take the hand, the master unleashes his 'blessing', knocking the student to the ground or against a wall. The lesson to be learned, amid gales of laughter, is something like, 'Never let down your guard,' or 'Never trust anyone too far.' The harshness of the lesson is compatible with the harshness of the system, both past and present, in which behind each blessing is a potential kick in the gut.

In this concise, nonverbal scenario, capoeira players express the hypocrisy of the social system, both past and present, by unmasking the friendly handshake. I believe it is probable that the kick got its name from the blessing practices of slave society and that the scenario got its force from a wealth of similar interactions, highlighting the hypocrisy of a church that sanctioned systematic dehumanization." (Lewis 1992:32)

Though in modern, more competitive styles, the aspect of a comprehensive attitude of living, as in 'traditional' styles as Angola, is less pronounced, it still remains one core value in the embodiment of capoeira experience. Downey approaches this topic on a phenomenological level in his book *Learning Capoeira* (2005) and shows thoroughly how the process of learning capoeira changes a person's way of 'moving in the world'. But even if capoeira may not be incorporated by a practitioner as a *jeito de ser*, a 'way of life', as Mestre Pastinha puts it, the core aspects of cunningness always is present in the movements and their application in the *roda*. This is probably one of the reasons why capoeira cannot be recognized as such systematized martial arts from South-East Asia, or even a regulated sport, when the rules, that do not even exist as such, are only made to be broken. Yet, there exist ideas about how physical interactions in capoeira should take place. The first one to put some of it in words was Mestre Bimba with his rules from the first vinyl record he published:

- 1. Quit smoking. It is prohibited to smoke during the training.
- 2. Quit drinking, alcohol is bad for your metabolism.
- 3. Avoid show off (sic!) your progress to your friends outside the roda. Remember, the element of surprise is the best ally in a fight.
- 4. Avoid conversation while training. You are paying with your time and by observing the other capoeiristas, you will learn more.
- 5. Always practice the ginga.
- 6. Practice the fundamental exercises daily.
- 7. Do not be afraid to get close to your opponent. The closer you are, the more you will learn.
- 8. Keep your body relaxed.
- 9. It is better to get beat up in the roda than on the streets.

(Vitamina Web)

He furthermore established principles for teaching:

- Gingar sempre (to keep oneself in constant movement when fighting)
- Esquivar sempre (to dodge away from the opponent's attacks)
- All movements must have a purpose
- Preserve a constant fixed position on the ground
- Play according to the rhythm determined by the berimbau
- Respect a player when he/she can no longer defend an attack movement

• Protect the opponent's physical and moral integrity (during the practice, the stronger will protect the weaker player)

(Vitamina Web)

Those were some quite specific rules, but some of them appear again in a listing of Lewis, who distinguishes them according to F. G. Bailey in normative and pragmatic rules, pointing out that these rules are very vague and their limits diffuse (Lewis 1992:92).

In the normative rules, we can find what actually sets up a *roda* and what defines capoeira as such. There is the constitutive factor of music, but also the common understanding that it has an almost equal meaning of 'losing' a dispute when one falls, or involuntarily touches the ground with other than the usual supporting body parts. From all these rules, only number 4 is absolute valid for any kind of style or school in every *roda*. The others are the case most of the time, but often are even expected to be broken.

These ambiguities are manifest in the movement system and its repertoire where actions have to be flexible and expandable to fit to any kind of situation. A good impression about it is already given with the pragmatic rules of Lewis, who shows essential aspects: "be prepared", "keep moving" or "deceive your opponent". To successfully achieve this, the understanding of isolated movement patterns, such as strikes, kicks or stances fluctuates. So, any movement can actually act in a reverse reaction opposed to what its actual primary function was intended to be, for instance, the kick with a high foot becomes the initial position for an escaping cartwheel, using the momentum of the leg to get away from the opponent. This stretching of meaning, which already happens in the lyrics, is embodied in the diverse uses and combinations of movement patterns. And though, improvisation is an important part in the game (many actions arise and are executed *ad hoc*), the *capoeirista* relies on a common pool of predefined movements far spread in capoeira. What is considered to be adequate of being performed in the *roda* of a special style varies a lot, but there is an intersection from which all players can draw.

To understand how all this motion can interact and even have some kind of flow, it is necessary to describe it. In the sense of this work, searching for the dance within capoeira, it is also necessary to describe and reflect on it from a choreological point of view. And it is the same here that, as already stated by van Zile, the discussion of movement is a crucial part of dance research (1999:85). But also in this discipline, most different kinds of means to describe movement exist and actually draw from different methods and theories as well. In how far it concerns the descriptions given here depends on what is to be explained. The aim is to keep it simple, but still the already existing methods can be present in descriptions. These can include, in later parts, the actual biomechanical terms for actual motion of the body, or uses of commonly known names for movements from diverse martial arts. In dance research, however, many attempts to describe 'dancing motion' already exist, such as by Luiz Naveda & Marc Leman, who describe them as "music-driven action-oriented explorations of spatial regions" to create a concept that fits into their analytical approach(2010:93).

Adrienne Kaepplers "Method and Theory in Analyzing Dance Structure" (2007), however, is a well-known and acknowledged access towards the understanding of dance and furthermore, movement systems akin to dance, since its first publication in the mid-1960s. Maybe not all parts, especially very detailed structures, referring to a certain concept of the structure of dance, are universally applicable, but the theory of

CHAPTER FOUR

TABLE 4.1 Some Capoeira Rules for Physical Play

A. Normative Rules Active play is between two contestants inside the ring. 1.1 Obey the conventions for entering and leaving the ring. 1.2 During play, don't move outside the ring. 1.3 Shake hands with your opponent before and after the bout. Try to take your opponent down. Only feet, hands, and head should touch the ground. 2.2 Don't try to injure opponent physically. 2.2.1 No strikes with closed fist are permitted. 2.2.2 No pushing allowed, except as part of a takedown. 2.3 Emotional, psychic, and/or prestige damage are okay. Always be ready to defend against an attack. 3.1 Don't turn your back on an opponent. 3.2 Keep your hands up for protection. 3.3 Keep your eyes on your opponent at all times. There is no play without music (berimbau). 4.1 Music starts before physical play. 4.2 When music stops, play stops.

B. Pragmatic Rules

Don't block attacks (except before they mature, or in extremis).

5.1 Escape, then counterattack.

5.2 Be prepared to escape from most common attacks.

5.3 Be prepared to attack most common escapes.

Keep moving (ginga).

- 6.1 Try to increase your freedom of movement while decreasing that of your opponent.
- 6.2 Never come to a complete stop.

Try to deceive your opponent into becoming vulnerable.

7.1 Establish patterns, only to break them.

7.2 Pretend to do one thing, then do another.

NOTE: Normative rules are not usually written down, except for tournament settings, when they are much more explicit and point awards are specified. This distinction comes from Bailey (1969), but the boundary is extremely fuzzy in capoeira (see chapter 7).

> Figure 3.1: Normative Rules according to Lewis. (Lewis 1992:92)

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the approach is. In analogy to linguistics, she states that dance is, just as a language, not universal, thus, the meaning is not inherent. But subsequently, dance can also be learned and it is inevitable to do so in order to understand it. If one can discern differences significant from an emic, a cultural internal, point of view, it is possible to achieve a "communicative competence", which allows to 'orient oneself' within that movement system (Kaeppler 2007:55–57). The basic cell with all its variations, which is still recognized as one, is called a kineme, and is analogous to the phoneme in linguistics. The principle of kinemes is not unfamiliar within dance research, but it is to be understood in a wider sense of an isolated motion. This is also the case with the most used dance notation form, the Labanotation (as for example Laban & Perrottet 1995; Knust 1997), and also Kubik applies this idea already in the 1980s, where , for example, he defined so called pivot turns ("Umkehrpunkte") within a movement to isolate it (Kubik 1983). These explanations and very short presentations of some ideas about bodily movement serve the purpose of giving an insight into what fields influenced this research.

3.1 Ginga

Considering capoeira movements, they can be analyzed just as described above, leading to several movement patterns. We can then see a few "movements which belong solely to one style of play and [are] considered highly inappropriate if used in another" (Fuggle 2008:210). Those can be, for example, the acrobatic jumps and soloistic performances of players in Regional. Also, on a stylistic level, the very upright position and the idea of predefined sequences (as Mestre Bimba taught them) are often subject of ridicule, and even a feeling of hate with traditionalists. At the same time, you can get yelled at by Regional teachers for moving to close to the ground, doing such movements as a cartwheel with the head on the ground. Some examples of the common movements are the meia lua (with different variations), benção, bananeira, aú, negativa, rolê, tesoura, cabeçada, esquiva, macaco, and many more. The denomination for these actions are the same in most cases. Their primary intention stays the same, though their actual execution may vary. Those intentions may vary, as already mentioned above, but the preexisting, labeled movements do serve a purpose, or have primary functions. These can be divided into the dichotomy of attack and defense in the first instance. Further sub-divisions can be heard of, such as attacks, used to disequilibrate, overthrowing or directly hitting the other player. An additional function, which may strongly relate to conceptualization of capoeira as a dance, are movements that do not actually serve an immediate purpose within the interaction of the two *capoeiristas*, but are just considered to be 'embellishments' (floreios).

The composition of all the movements and actions in the ring, in contrast to most martial arts, are not executed from a fixed position or a stationary stance, with a clear beginning and ending of the correspondent actions, but rather emerge from a flowing movement that connects everything within the physical realm of the *roda*; and is what one could call the 'basic step' in capoeira: the *ginga*. To explain this in simple words: what is encompassed within it, is a difficult task. First of all, the *ginga* is the unique movement pattern of capoeira that defines the art. It is, I dare say, the essential movement pattern that every *capoeirista* agrees on, acknowledging it as the to and fro on which the physical play is built upon. It is what allows a player to use *malícia*, and may even be thought of as the embodiment of *malícia*. This is thanks to the idiosyncratic motional qualities inherent in the *ginga's* character, which is often associated with the sea and the balancing of the waves (last but not least for the strong connection of capoeiras to the docks of Salvador da Bahia). In translations of the word *gingar*, which literally just stood for 'rowing', all kinds of balancing motions are included, today describing a certain way of bodily 'sway'. It is an attribute connected to the individual style of corporal looseness associated with Brazilians, coming from the movement style of capoeira. It is what Brazilian Laban Movement Analyst and dance scholar Cristina F. Rosa describes as "an undulating corporeal ebb-and-flow", comparing it to the "kinesthetic sensation of standing on a small boat over water", which comes from the profession of a "*gingador*", the person who is in charge of rowing, controlling the oar, called *ginga* $(2010:17-18)^1$.

It is in this special movement, where one easily can observe a relationship of motion and music. This is probably the main reason, based on which one may come to the conclusion that capoeira is a dance. This, actually, comes as the easiest way to characterize the ginga and can be found also with practitioners, as Downey describes it: "In the roda, capoeiristas are in almost constant motion. Swaying and bobbing, back and forth, they appear to dance as they fight." (2005:118). Although the often heard description of *capoeiristas* as, to some extent, also a dance, the *ginga* encompasses still much more: "Schließlich ist die schon erwähnte ginga zu nennen, der wiegende Wechselschritt, aus dem sich jede Bewegung, ja selbst die schwierigsten *qolpes* entwickeln. Der ginga wegen wird die capoeira von vielen als Tanz interpretiert. Capoeiristas verstehen die *qinqa* jedoch nicht als Tanz, sondern als Grundlage des Spiels.² (Oliveira Pinto 1991:50). It is, however, an event of structured motion after all, which allows us to describe it, analyze it, and use it for the understanding of the art and its practitioners, knowing that this corporeal manifestation can show different experiences of the body as the relation to heard music. To examine this relation, the 'anatomy' of the ginga and its multifaceted appearance in use has to be established.

The execution of this 'basic step' can differ immensely from person to person, notably when it comes to styles following the ideas of Capoeira Angola. In the Grupo de Capoeira Angola Pelourinho (GCAP), a group which is known to set somewhat of a 'standard' in Angola style, the individual interpretation always gets pointed out, which Downey knows first-hand: "Although the ginga is initially learned as a simple four-count box step, we were encouraged to vary it until little remained of the original pattern except its sinewy texture." (2005:23). Breaks in the middle of the ginga are normal here, while in modern capoeira, a more upright and uniformly performed movement is usual. As a basis, though, every *capoeirista* learns the same "four-count box step" in the beginning. How far individualism is allowed, however, needs to be known, so the movement pattern can be defined as a *qinqa*. I am not referring to the above mentioned corporeal attitude of swaying, but rather want to define kinemes, the smallest unit of significance (Kaeppler 2007:57), from which the *qinga* is built. Knowing how far these units can be changed without altering the essential movement that they constitute, gives us the framework for what Kaeppler calls the allokines of a kineme. For this purpose, we can use an already existing notation of the *ginga*, provided by Lewis, as a first lead. It is known that in every notation, also in dance notation, the

¹Another reference made by Rosa is of an African background taking into account the "Bakongo queen *Nzingha Nbandi of Matamba* (1582–1663), in the region known today as Angola" (2010:18–20), which seems very vague. Though the spelling of her name in Portuguese sounds similar (*Jinga* or *Ginga*), an explicit connection to the movement style appears to be implausible.

²ger.: "Finally, the *ginga* itself has to be mentioned, the swaying alternating step from which every movement evolve, even the most difficult *golpes*. Owing to the *ginga*, the *capoeira* is considered as dance. *Capoeiristas*, however, do not see the *ginga* as dance, but as the foundation of the game."

perception of the individual, producing the transcription, may be affected and can influence the output itself. Still, these notators are trained to catch what the eye sees, which should be as 'neutral' a perspective as we can get, allowing "to freeze an activity that occurs in time" (van Zile 1999:85).

The system in which Labanotation is written down already divides the body into sections that are appropriate to distinguish the $qinqa^3$. The single column has to be imagined as a subdivision into 4 equal columns, just as musical 5-stave notation, turned around 90 degrees (Knust 1997:2). Outside of the drawn lines, an infinite number of additional columns can be added by drawing imaginary lines. The middle line designates the center of the body, thus symbols on the right side of that line correspond with the right half of the body and vice versa. The middle columns represent the body as whole movement or rest; that means steps or jumps, or sometimes called the support, showing where the main weight of the body is lies. Then, movements of the legs follow, still inside the drawn lines. Outside of these lines, further notation can be added in the following order: trunk, waist/chest, arm (with elbow), hand and a single additional column for the plane (viewing direction) of the face or head. In between all columns, subsidiary smaller ones can be imagined to add symbols, defining the movements in more detail. Everything is read from the bottom upwards. The 'box' at the very beginning shows the starting position, which is always based on an upright standing position with feet closed and arms hanging loosely on the side, eyes looking front. After the double line, the movement starts. The length of a sign actually shows one principle of Labanotation, depicting the duration of a movement. For now, I want to exclude this aspect because it is part of later analyses and does not change the meaning of the symbols.

The basic 'stance' of the ginga is shown in the starting position graph. It is sometimes referred to as the 'basis' (base) or is called the 'chair' (cadeira). The notation shows that the support is on both feet equally, with knees bent low, standing apart (to the left and right) and facing to the front (arrows to the left and right, resulting in the rhombus: \blacklozenge), so the legs are not twisted in any way (1). The trunk (1) is tilted slightly forwards, indicated by a forward sign on a high level (1), this is maintained during motion. The elbows, and thereby the arms, are bent, hanging low, but not entirely, deviating slightly outwards (1, 1). The face (a) is always facing forwards on a straight level (i), which is kept throughout all motion. The movement itself is composed of mainly three steps, to keep it simple. A step back with the right foot, left foot forwards and then right food to the right, back in starting position. This is repeated with sides swapped (\div) . The additional signs show that the right foot tries to constantly touch the ground with the toes and ball, while the left is on the whole sole of the foot, back to starting position, with both feet flat on the ground. The upper part of the torso, from waist to chest (2), is indicated to turn slightly, to a not precisely defined angle during the first two steps (\mathfrak{k}) , which is probably to show that the upper part of the body should face straightforward all the time, explaining thereby why the sign to turn right back to normal position is included (\mathbf{w}) . The arm is counter-balancing the movement, going up in front of the face, shown by the elbow going forwards on an intermediate level (\mathbb{P}) and the hand going high and left (\mathbb{P}).

³For a more detailed account and further information on Labanotation see, for example, Laban & Perrottet (1995) or Knust (1997). These were the books this research worked with. Idiosyncrasies in the notation cannot be interpreted. The notator was contacted, but unfortunately could not remember exactly the situation. The multiplicity of symbols already existing in Labanotation makes it difficult to read it meticulously, figuring out distinctive characteristics, especially when it comes to style, but

APPENDIX A

Laban Notation of Capoeira Ginga



Notation courtesy of Ilene Fox, with the resources and personnel of the Dance Notation Bureau, New York City.

Figure 3.2: Labanotation of the *ginga* as presented by Lewis. The notation is based on a live performance by Lewis himself. (Lewis 1992:221)

Sec. 10



Figure 3.3: The picture shows the two main positions derived from reading the labanotation. The basic stance and the step back. (http://streetsmartbrazil.com/wp-content/uploads/drupal-files/userfiles/image/-capoeira04.jpeg, 14.03.2015)

The notation already gives a good description of the movement all in all. In the pictures above some snapshots of pivot points are shown. But not all of the above mentioned, are constituting elements of the *qinga*. The head, for example, plays an own role for itself. It is one of the things most heard in training by teachers, telling their students to 'always keep an eye on your opponent', to be prepared. So, *capoeiristas* try to look at the other player even in contorted maneuvers; during a backbend, a flip or the handstand. At the same time, it is one of biggest feints of an experienced *mestre*, and an expression of *malícia*, to pretend not to watch, to lure the other into attacking, with the *mestre* already having prepared a counterattack. The head, therefore, does not play a major role in the *qinqa*. Other parts as the feet, with their characteristic formation of steps, play an important role, acting in a counter movement to to the arms. But it is also important to know how far the movements can be changed until they are not recognized as such anymore. The hand is not that important in its position, though it should not hang loosely, since it is meant to protect the head. The arms, however, have to move diametrically opposed to the feet: if the right foot is back, the left arm should be as well, with the right one up in the air, always in guard. This counter movement simultaneously serves for equilibrating. The exact motion of how to change the arms and level on which they are held is free for personal proclivity. The lowest level possible is around the chest, which already is considered as 'sloppy', since there is no protection. The height of many body parts varies a lot, particularly in the different styles: from the low, closed ginga of many Angola schools to the more upright position of very fast Regional styles; with practitioners of the first tilting their torso forwards, sometimes up to 90 degrees, as opposed to the more upright position

the overall conventions allow the isolation of single movements appropriate for this work.

of very fast Regional styles, demanding quicker reactions and, therefore, less space to overcome. The knees should always be bent and never stiff, which is a requirement for the 'bouncy' and swaying attitude of the *ginga*. The feet try to stay close to the ground; whether their scuffed or not, depends on the individual. Their positioning in the steps is nevertheless important. Often, one can see a description of the feet marking a triangle, like in Figure 3.4a. The actual pattern can expand up to a slight crossing of the feet. Often it is the feet in parallel lines, drawing a 'box', about hip-width apart. What can be observed is that, the closer the back foot is to crossing, up to actually crossing, the higher is the tilting of the body, which leads to a more swaying appearance of the *ginga*. This 'bouncing' movement, a quick shift of balance, is seen in a swift down- and upwards motion of the heel of the back foot, usually not touching the ground, so the weight remains on the ball (also described in Figure 3.4b).

Narrowing the movements down, gives the main kinemes of the ginga. First, the steps that mark the floor pattern: foot backwards, foot forwards to the side. Second, the counter movement of arms with the feet, which includes a balancing with the arm during the change. And most important: the shift of balance in the back step. It is questionable how to interpret this special aspect, since it is the factor that actually identifies the ginga as such⁴, but isolating it as a single kineme would be difficult, just as it is difficult to define the beginning and the end. It, therefore, actually makes it possible, only now, to set the pivot points of the other steps, seeing that the quick downwards movement obviously looks like a bodily stressing of points in time and space. In the figure 3.5 we can see the basic positions of the ginga, with the red clouds around body parts indicating the scope in which they are allowed to be arranged, in order to still be recognized, that is, the spatial scope for the allokines.

3.2 Interaction with Music

In chapter 3.1 on page 55, the connection of musical and physical play already was adumbrated to some extent. Knowing more about both, musical and motional structure, allows to have a rough look at the interaction of those two important domains in capoeira, which create a third, complex sphere in the game. The already mentioned dimensions of the concept of a *toque* plays an important role here. It is that they "affect how the game unfolds, control the severity of competition, and set the style of interaction" as Downey (2005:87) describes it. He explains furthermore, that each *capoeiristas* has own associations in mind when hearing distinctive rhythms, most of them connected to a certain way of playing in the *roda*, given that every *toque* possesses "kinesthetic and emotional traits" (2005:93). Many of these traits already have been brought up in reference to the different styles within capoeira. A practitioner of Angola, commonly known as an *angoleir*, may use movementes to one pattern of the *berimbau* that differ from the ones of a strictly Regional educated *capoeirista*. There are, again, many controversies about the different *toques*, not only in how far it concerns playing them on the musical bow, but about their character in the embodiment in the roda. It is similar within both parts that some *toques* are more agreed on in their physical aspects than others and some less, but for contemporary capoeira, it is, in general, easier to find a common view for the latter⁵. For instance, Angola, in its movement,

⁴In the following study in part 4 on page 77, this importance is easily described when one of the test persons intentionally does a 'wrong' ginga, resulting in the absence of this balanço.

⁵Simple but yet particular examples are the *toque* Amazonas and the 'money game'. In the first, the players try to imitate the jungle and the 'scenery' around the Amazonas river with animal movements

1. Die Ginga

Die *Ginga* ist die Grundlage des Spiels im Stand.

In der Ginga versteckt sich der Capoeirista, weicht aus, fintiert und bereitet den Angriff

vor. In der Capoeira-Angola ist die Ginga individuell und drückt die Persönlichkeit des

Spielers aus. Die *Ginga* der *Capoeira-Regional* ist strukturiert. Sie wird auf unseren Zeichnungen gezeigt.

Übungen

- a) Laufe die Ginga alleine entsprechend den Zeichnungen (Spieler links), bis Du sie gut gelernt hast.
- b) Laufe die Ginga mit einer anderen Person, die sich Dir gegenüber befindet und folge dabei der Ginga des anderen, als würdest Du das eigene Bild im Spiegel sehen.
- vergiß die Ginga, bewege Dich frei der anderen Person gegenüber; versuche auf jede Bewegung des Gegenspielers "eine Antwort zu geben", ohne Tritte oder Schläge auszuführen.
 d) Mache die Grund-Ginga, improvisiere
- Mache die Grund-Ginga, improvisiere dabei die Bewegung nach vorn, hinten und seitwärts; wandle die Grund-Ginga ab.
- e) Mache die Grund-Ginga mit einer anderen Person. Improvisiere auch gelegentlich Bewegungen seitwärts, vorwärts, rückwärts und um den anderen herum, indem die Grund-Ginga verändert wird. Während dieser Übung soll der Gegenspieler im Gleichklang mit dem Partner improvisieren.

(a) The floor pattern of the *ginga* in a narrow triangle form. (Capoeira 2008:62f.)



Figure 2: Typical foot placement of the Ginga, the basic swaying movement of Capoeira. The weight of the practitioner is maintained on the front foot and the ball of the back foot.

(b) The ginga as pictured by Mason. (Mason 2013:5)

Figure 3.4: Two graphic and schematic approaches for describing the ginga.



Figure 3.5: Basic stances of the *ginga*, parallel and step backwards, with red clouds indicating the scope of possible movement of the arms and feet in vertical and horizontal direction of their placement respectively. More intensity shows the usual position of the body parts, these are parallel feet and elevated arms, for rotated feet do not ensure stability and the arms are necessary for defending and balancing during the swaying by counteracting the step backwrads.

(http://streetsmartbrazil.com/wp-content/uploads/drupal-files/userfiles/image/-capoeira04.jpeg, 14.03.2015, edited by the author)

is normally closer to the floor, the torso is tilted more forwards and the players are generally moving, within a closer range, with each other, while in Regional, the opposite mostly is the case, that is, an upright posture, movements that are 'open', like a cartwheel (au) with straight legs, and more distance between the players. Though in Regional, there is actually a lot more immediate contact between bodies, for example, with throwing the other, the relationship is different here. It could be stated that in Angola, the distance is sometimes so low that persons are interacting within the intimate spaces of the other⁶, resulting in an overlapping. This is what Laban Movement Analysis calls kinesphere, the area of motion of a body, a person pays attention to. Nevertheless, in Regional, and more competitive styles, players often do not even cross the personal space of the adversary during the *ginga*.

The influence of the music on the behavior of the *capoeiristas* during a game may reach from directly addressing a player in the lyrics by choosing an appropriate song (for example the song "Devagar, devagar", literally "Slowly, slowly" as an appeal for someone who may have gotten to excited and rushes in every action), or choosing a distinct *toque* to indicate a change of game style. These are, however, apparently intended and one-directional influences that happen at will. An interaction of music and movement, or maybe even the musician and the moving person, is sure to exist

and sounds. In systematized forms of training, many movement patterns have a name, and lots of them refer to an animal, such as monkey (macaco), scorpion (escorpião), or a crab (caranguejo). In a game where a small amount of money is placed in the center of the roda, however, it is only allowed to use the mouth, to pick up the money, which leads to a completely different movement style, most of the time inverting the usual body position to a 'heads down'.

⁶The description of personal space and the approximate distances follow those presented in

in some way as well. There is a connection that justifies the description of capoeira as a dance in its own way. The search for a basic relation is not apparent and not easy to learn from the practitioners themselves. Even when learning the art, one merely knows about the existence but not the consistency of this relation. Asking capoeiristas about it, does not tell you how to move in the qinqa, but more results in what has been explained above do: the importance of *toques*, and how one style does not fit the other. Yet, one thing that has popped up a few times, is an explanation of temporal perception, which tells that especially beginners, are doing the *qinqa* too fast or too slow. The focal point in the relation seems then to be the relation of the ginga and the music in temporal relation. It is in the ginga, as Oliveira Pinto stated: "In ihr finden sich die Akteure nach einer raschen Folge wieder in Übereinstimmung mit der Musik. Auch zu Beginn der capoeira wirkt die *ginga* als die von der Musik abhängige Regulierung des Bewegungstempos.^{"7} (1991:50), while Rosa explains it in a more abstract fashion, but stills shows a 'rhythmical' component: "to move with a syncopated rhythm to an individual logic that sets a person apart, while responding to a given environment or context" (2012:147). The idea therefore is, that there has to be a dependency on a temporal level of the movement of a *capoeirista* and the music that is not arbitrary. Since these ties, after all, are not verbalized in capoeira, it must be examined in the expressions of the body directly. The most basic level to establish a connection to the music is to determine the body's behavior in moments of what the person perceives as a beat. That is why the referential pulse had to be extracted from the musical complex, since it is the first point of contact that determines also most dances in Afro-Brazilian culture. In which way it becomes manifest in the ginga, is to be analyzed in the following study.

⁷Ger.: "its is here where the players find concordance with the music again after a rapid sequence"

Motion Capture and Dance

Chapter 4

Methods and Theory

When sound premises human motion, it is, together with music, "the shadow of movement" (Mason 2012:7). This is how Australian scholar Paul H. Mason, neuro-anthropologist, depicts the deep bonds of sound and movement. The study of these interrelations can offer an insight into human behavior itself:

"How dancers respond to musical stimuli can inform researchers about culturally patterned somatic responses to sound. How musicians express their response to dance through sound can demonstrate how cultural enskillment influences their perception of moving bodies. Studying sound-movement interactions illuminates the role of culture in shaping human expression because '... Exact relations between music and movement are unstable and subject to all sorts of cultural relativism' (Toepfer 1997: 321). Simultaneously, investigating these relationships elucidates perceptual processes in the embodied brain because 'The power of music to motivate unusual, aesthetically interesting bodily movement is a strange, hardly understood neurophysiological phenomenon ... ' (Toepfer 1997: 321). Thus, the ways that music and dance are put together offers insights into the intersection of neurophysiological and cultural processes." (Mason 2014:217)

One area of research, working on that matter, trying to establish itself for the last half decade or so, is choreomusicology. It originates in the writings of composer Paul Hodgins (1992) who tried to establish factors that can determine the relationship of music and dance, applicable for both sides. The discipline evolved from ideas concerning especially the Western bias of separable concepts of music and dance itself. Anyhow, it can be useful to think about those relations in any kind of pairing of what may be typified as music and dance, or furthermore sound and movement as both produced by humans. Understanding it can ultimately "illuminate kinaesthetic and perceptual processes of the embodied brain as subjectively experienced and manifested by individuals who are immersed in, subject to and the producers of cultural activity in naturalistic settings." (Mason 2014:225). To achieve this, a multimodal approach from different disciplines is requested, in which especially empirical experiments and investigations can help to corroborate anthropological theories and concepts. This is why in the current study, new technologies are used to study human motion, which is too complex to just try to describe it by mere observation. It shall explore the possibilities that provide technology and natural sciences, and in how far it can actually help scholars, unfamiliar with such mechanics, without demanding profound knowledge of the like.

Motion Capture

The ability to visually capture specific moments in time and in great detail had its first milestone with the development of photography during the 19th century. Making it possible to 'freeze' motion or a visual experience in time, or even preserve an entire time span with the later technologies of video recording, allows the accurate analysis of the recorded. A method that remarkably aids within these analyses is Motion Capture, commonly called MoCap. This implies the capturing of any kind of motional data, including static ones, used in a wide array of fields: "music, fine art dance/performance, sign language, gesture recognition, rehabilitation/medicine, biomechanics, special effects for live-action films, and computer animation of all types, as well as in defense and athletic analysis/training" (Furniss 2004). The manifold possibilities of application depend on the purposes. The probably most famous sector today is within the entertainment industry, using Motion Capture technology for computer generated (CG) objects within movies, including such movies as Peter Jackson's The Lord of the *Rings* Trilogy or James Cameron's *Avatar*. But the potential of technique also is used in the sciences, for example, within biomechanical analysis of the human body and, consequently, within medicine for such things as gait analysis.

The definition of Motion Capture today includes and highlights the use of digital technologies for the process. It is provided by representatives of an animation studio. The objects of interest, therefore, can be even expanded more when it comes to the investigation in human motion and the body:

"Motion capture involves measuring an object's position and orientation in physical space, then recording that information in a computer-usable form. Objects of interest include human and non-human bodies, facial expressions, camera or light positions, and other elements in a scene." (Dyer, Martin & Zulauf 1995)

Still, the history of Motion Capture does not necessarily begin with digital data processing, as also the Motion Capture Society states (Fischer & Gordon 2014). As milestones within the history, they list early attempts, beginning in the 18th century with Swiss scientist Johann Heinrich Lambert¹ and including all different kinds of approaches. Amongst others, the work of Edward James Muybridge on motion through (sequential) photography and those of Étienne-Jules Marey on chronophotography. Their research is often said to be the cornerstone of the study of animate motion, with the famous example of the horse and the question whether there is any point in time it has lifted all four hooves up in the air (see Figure 4.1). The technologies used today, then began to develop in 1970s, first within the military, but quickly was discovered by the entertainment branch during the 1980s (Furniss 2004). Since around the new millennium, it has developed always further, in such a way that several standard methods have evolved up until today, which are still in constant development.

Several types of Motion Capture have formed until now, each one with individual advantages and weaknesses. The data produced by a system can be represented in different ways: "Position/displacement data can be measured in two dimensions (that is, on a plane) or in three dimensions (that is, in a space). Additionally, motion data can be described in terms of three-dimensional orientation (referring to an object and its orientation in space). Such data is usually denoted in the form of six degrees of freedom (6DOF), that is 3-dimensional position and 3-dimensional orientation data."

¹He is better known for his findings about the irrationality of the number π .



Figure 4.1: A chronophotography of a gallopping horse by Edward James Muybridge in 1904. He used this early kind of motion capture to proove that all four hooves of a horse in gallop are airborne at a same time.

(http://upload.wikimedia.org/wikipedia/commons/c/c9/

Muybridge_horse_gallop.jpg, 11.03.2015)

(Burger 2013:30). I want to present some of the methods in reference to their use within the analytical study of dance and human motion. Some of the systems can be combined to deliver even more accurate data. Since it is a matter of expense, only one cohesive system, including all additional soft- and hardware, is typically in use.

Mechanical systems are some of the first to work immediately on the body of the captured person. It includes some sort of mechanical exoskeleton (see Figure 4.2 on the following page) to be mounted on the proband, which 'moves' similar to the body's motion. It has many disadvantages, such as having no relation to position in space or to the ground and it heavily limits the freedom of movement through its construction and several cables that lead to a computer. It is therefore not appropriate in any way for our purposes. It can be seen today in a simplified form as 'controllers' for video games.

Magnetic systems locate their position within a magnetic field by sensors attached to the body (see Figure 4.3 on page 71). Those are connected to a control unit which filters the signal and calculates the position and orientation data. This includes cabling on the body to an external apparatus, which is again inexpedient for free movement of the body, and which gets further restricted by a fairly small area of capturing. For detailed analysis of fast movements, the sample rate² often is too low. It is, however, in use for animation, owing to its capturing in real-time and comparatively low price.

Inertial systems work with small gyroscopes from which sensors can measure how (in which direction) the body is moving and additional speed measuring (see Figure 4.4 on page 72). A computer translates the data into simulations of the body. Absolute position, thereby, is not given without any supplementary instruments. Its advantage lies in the very quick real-time transmission and, due to its construction, gives the person wearing a suite, the comfort of more or less free moving within a theoretically not confined area.

Optical systems are, together with magnetic systems, the most used technology, especially when it comes to scientific research in human motion (see Figure 4.5). There are different ways in their mode of operation. One is working with two-dimensional

 $^{^{2}}$ The sample rate describes how many samples per second are captured, that is, for cameras, how many pictures are taken per second.



Figure 4.2: An example for a mechanical motion capture system, realized by a mechanic exoskeleton.

(http://arcadeheroes.com/wp-content/uploads/2012/05/scishoota2.jpg, 11.03.2015)

video cameras and recordings from which a body model then is calculated afterwards. In the case of such video game consoles as Xbox Kinect, the calculation is executed in real time. The more accurate method, however, is a marker based technique. The basic principle here is that several different localized cameras determine the position of markers within their observational area. The cameras work on infrared basis and capture the light that comes from the markers, which are either active, that is, emitting infrared light themselves, or passive, covered in reflective material, such as special tape, which makes them retro-reflective markers. In the latter case, the cameras themselves have to emit the infrared light for the markers to reflect it. The collected data then consists of three-dimensional coordinates for each marker, for every recorded sample, depending on the quality of the camera up to 1000 Hz, which allows precise analysis of even very fast movements. The optical system, thus, only delivers position data, which can be disadvantageous, depending on what is needed. The results allow such detailed data, from which almost everything else can be calculated, such as velocity, angles or momentum. Predefined body models also can reconstruct animations of the captured persons. It is the system most in use for big movie productions and biomechanical research. Disadvantages, though, are grave: since it works optically, the system is susceptible to the slightest changes in lightning conditions and other reflections. Moreover, intensive manual postprocessing is required for the material.

The system in use for this study is an optical system with retro-reflective markers. There are some aspects within it from which choreological analyses may benefit. The output is first of all an almost exact reproduction of the body's movement. This can vary in its range of error, depending on the number of cameras, material worn by the test person, positioning of the markers on the body, and else. It is certain, however, that the accuracy of such a system exceeds that of a conventional video camera by far. Having measurability to the extent of millimeters and milliseconds, even permits investigation in microtiming with an easy and proper approach. One



Figure 4.3: A magnetical motion capture suit which does not require cables to an external device.

(http://www.sfu.ca/~yma15/iat445/magneticgirl.jpg, 11.03.2015)



Figure 4.4: A suit for an inertial motion capture system. This form provides the most range of motion, but the full body suit is required. (http://www.xsens.com/wp-content/uploads/2013/12/ xsens_mvn.jpg, 11.03.2015)


Figure 4.5: An advanced optical motion capture system as used for the movie Avatar, by James Cameron. An additional tracking system is used for facial expressions. (http://oyster.ignimgs.com/wordpress/stg.ign.com/2014/07/Untitled-1.jpg, 11.03.2015)

example here may be the research of the Brazilian 'swing' (*suingue*) as has already been conducted on the level of audio analysis (Gerischer 2006; Thalwitzer 2013). By reducing the sound of an instrument to the mere movement of its generation, the motion of playing an instrument may be captured, for instance, with markers on the stick of a snare drum, from which pivot points can be easily calculated within the given position data, indicating strokes. It is the same principle that has been elucidated in chapter 3 on page 51 as for dance and human motion, which is easily performed by computational support. Having captured an entire flow of movement from a human body, lets us reconstruct virtually every aspect of motional behavior. The level of detail naturally depends on what equipment is used. The more markers are on the body, the more detailed the virtual reconstruction will be, consequently implying also more postprocessing. Supplementary equipment can even give more data, such as force plates, tiles in the floor measuring forces that act on them, or synchronized 2D videos.

Musical Feature Extraction

As Motion Capture technology provides very precise data for the body that moves to music, the reference points within it, have to be defined on a likewise higher level of detail than just the human ear. For this purpose, computational aid is in development within the area of Music Information Retrieval (MIR), an interdisciplinary field of research, drawing from musicology, information science, audio engineering, and many others³. With this help, many different aspects of music can be extracted from digital recordings, easily defining "pitch, temporal, harmonic, timbral, editorial, textual, and bibliographic facets" (Downie 2003:297) of musical data. Though, human-organized

³For a more detailed account of MIR see Downie (2003).



Figure 4.6: Visualisation of the calculated beats by Sonic Visualiser. The orange bars are determined by the software's own plugin, while the pink lines are timepoints defined by the script in MATLAB.

sound is subject to individualism and surely cannot be broken down to computer generated performances, the results of such analyses can vary in how far the person developing the tools understands it. It is, yet, a reliable method for accurate definition of musical parameters, which is necessary to define measuring points within the musical data of the current study.

For the musical analysis two programs have been tested and utilized: Sonic Visualiser, a free software, distributed under GNU General Public License, which has been developed in London for viewing and analyzing audio files (Cannam, Landone & Sandler 2010, 2013) and the commercial software package MATLAB 2013, a numerical computing environment and programming language, that also allows signal processing via toolboxes and predefined functions. For a first estimation of the tempo of the audio tracks chosen for the study, the Vamp Plug-In "Tempo & Beat Tracker" provided by Sonic Visualiser has been used, which detects beat positions with a two state model (Davies & Plumbley 2007). The beat here is localized right after the beginning of strong note onsets.

For further analysis, however, a code for beat tracking within MATLAB has been employed, as further work required the application of the software and hereby an easier workflow is guaranteed. The method first estimates a general tempo of the audio track, delivering a slower and faster one, from which, then, in relation to the "onset strength", the beat positions are tracked (Ellis 2007). Their localization is close to or on the maxima of the "onset strength waveform" (for a comparison see Figure 4.6). The output, then, is a time series with the position of the beats in seconds. What problem needs to be kept in mind when determining a temporal structure, however, is that with a construct as the beat, representing a subjectively perceived measure, the meaningfulness of defining it as a time point within such a small scope can be questioned. Whether the beat starts right at the beginning of the onset of a musical event, or maybe only on the first peak, needs to be discussed in further research. This also includes the delay that occurs from the original generation of sound, as the flow of data from a playback device to a reproducing unit as a speaker, until the actual perceiving of the sound in the body and the understanding of it as a beat. All these factors happen within such a small range (just as the above beat tracking methods), that for taking all of them into account, a whole team of different trained specialist would have work together on it. For the current study, the question is concerning macro structural movement in relation to a reference beat within macrotiming. It is an experiment that just tries to explore the possibilities within the used technologies. Therefore, the exactness of the measured and analyzed data is allowed to work within a bigger range of error than the scope of the original measurements. Case Study

Chapter 5

Case Study: Introduction

In the present study, movement of *capoeiristas* doing the *ginga*, shall be examined towards their relations with given musical stimuli, more precisely, the points in time of those audio material, to which a practitioner of capoeira would set the referencial beat. A surprisingly high number of studies already have been conducted in the investigation of the relationship between music and movement, by means of Motion Capture Technology. Some of them treat the influence of (computational extractable) musical parameters on movement style, such as Toiviainen, Luck & Thompson 2009; Wöllner & Deconinck Frederik J. A. 2012, while quite a few try to understand the general phenomenon of synchronization with different approaches, such as Eerola, Luck & Toiviainen 2006; Luck & Toiviainen 2006; Loehr & Palmer 2009; Palmer et al. 2009; Hove & Keller 2010; van Dyck et al. 2013. The most concrete works on dance and entrainment come from Belgium (for example Naveda & Leman 2010) and Finland (for example Burger et al. 2012, 2013). Still, a practical attempt of analyzing motional structure in reference to a beat has not been conducted yet in total¹.

Through the analyses of musical and motional structures in chapter 2 on page 21 and 3 on page 51, a few criteria have been established, indicating on what elements of each part has to be paid attention. The question in this work is primarily concerning the aspect of dance within capoeira. Though, of course, dance is not a universal phenomenon, I want to treat it as a generally accepted view of motional structure that relates to an individual perceived experience of what can be called rhythm. This operational definition serves this study as a heuristic method to investigate temporal dependences of bodily movement to musical work. It relates to the most likely general idea of those, who understand and describe capoeira in an easy way as a dance. Since even practitioners partly characterize it as such, some aspects of dance have to inherit the art. One possibility apart from the mere fact that movement patterns are accompanied by music, will be investigated here.

Even at this early stage, several hypotheses can be proposed on the subject. Some authors mention the complicated relationship of music and movement in capoeira, most of them coming to a similar notion of the movement fluctuating in synchrony with the music. Barbara Browning explains that " [...] unlike most of the highly sophisticated rhythmic patterns of African Brazil, capoeira music doesn't dictate stepping on a certain beat. Rather, the music dictates the emotional tenor of the game and its intent.

¹I am currently in touch with Birgitta Burger, a German musicologist and computer scientist from the Finnish Centre of Excellence in Interdisciplinary Music Research at the University of Jyväskylä. Many of the ideas in this work were inspired by her and she helped me with the mathematical approach to the study, especially on the subject of synchronization. A paper on it will soon be published and will probably be one of the first on the matter.

The moves themselves move in and out of synchrony with the berimbau." (Browning 2001:169). Rosa even explains this with two different rhythms a *capoeirista* follows in the *roda*, an "internal" and an "external" one:

"[...] capoeira players sense and synchronize their call-and-response interactions through auditory perception (hearing). In capoeira angola, all movements, gestures, and intentions are rhythmically coordinated in relation to a player's response to both external rhythms (e.g., instrumental music, songs, and/or clapping) and internal ones (e.g., breathing, heartbeat, perceived sounds, melodic memory). In addition to their field of vision, capoeira's tonal rhythm (toque) functions as a guiding score or matrix over which the two players at the center build both synchronized and multimeter interactions, often coming in and out of sync with the main riff. Since performers are not encouraged to communicate verbally, furthermore, this audible synchronization generates a sensorial contact between the pair at the center and ensures a constant connection between them and the musicians controlling the entire event (circle of capoeira) from the periphery." (Rosa 2012:160–161)

The moment of synchronization most likely lies within the basic 'step' of capoeira, the ginga (see chapter 3.1 on page 55). Assuming this, different possibilities of its embodiment open up. One idea is that of 'polymetric' intersection of the tempo provided by the music and the individual tempo of the *capoeirista*. Here, moving in and out of synchrony, can also be seen as a smaller part of a more complex synchrony. If the 'ins and outs' are cyclic, an overall pattern of correlation may appear. The following graph (Figure 5.1 on the next page) illustrates this model, essentially depicting a simple phase shift of the signals. The *qinqa*, represented by the red sinewave, can be called the inner structure at a personal tempo, cyclic with a steady period of repetition of the ginga's steps. The beat of the music, represented by the turquoise sinewave, can be called the outer structure and is cyclic as well, however, its period is much bigger than the one of the inner structure. In the example, which is just a hypothetic model, the ratio would be 10:3, that is, three cycles of the *qinga* within ten beats. At such odd proportions, the synchrony of both structures would only manifest itself within many consecutive repetitions of the *qinqa*, which in a normal game, usually is not the case, being always interrupted by movements as attacks or defenses. Furthermore may the ratio be in such high numbers, that, as a human, a periodicity could not be recognized anyhow.

Another theory serves more the idea of the ginga as a pole for recreation and reconnection to the music. It is here that the capoeirista again has an individual tempo of which the length of the cycle is just minimally smaller or bigger than that of the music's beat. This would cause us to perceive the ginga as actually 'in time' with the beat at the very beginning of its execution, but quickly gets 'out of sync' again as shown in Fig 5.2 on the facing page. This model then repeats each time the ginga gets interrupted by other movements and starts over again.

Both assumptions are products of one main theory to which they are subject to: the existence of an individual tempo of the *capoeirista*. No matter if one calls it inner/outer structure or polymetric intersections, it is expected that every practitioner of capoeira sets an own individual pace for each music. It is then possible that for each *toque*, an overall acceptable range of tempo in movement exists which every *capoeirista* incorporates depending on its education, teachers, and personal preference. This pace is also possible to have no direct referencing points within the music whatsoever, but is just derived from its musical structure.



Figure 5.1: Two sine waves representing the cyclic events of ginga and beat. Each wave has a different period, representing different tempi of movement and music. The intersections of the waves are timepoints where movement is synchronous to the music, that is, the pivot points of the ginga together with beats of the music.



Figure 5.2: In this representation, the cyclical structure of the ginga and the beat drift apart from a joint starting point, since one of the tempi is slightly slower/faster.

Another existing model, which is already quite precise, is the Labanotation given by Lewis (see chapter 3.1 on page 55, Lewis 1992:221). As a principle of Labanotation, the proportions of the lengths of movement signs indicate the length of the respective movement (Knust 1997:2). The notator, therefore, must have had a temporal structure in mind when writing down the *ginga*. What can be drawn from the notation, is that the focus definitely was on timing of steps. Other movements are to be executed in accordance or stay the way they are. A relation to music is not given, since it is only the kinetogram without additional musical information. What has to be verified is inner structure of the steps of the *ginga* itself. The proportions are given that each full *ginga* is divided into two same-length mirror-inverted movements in the median plane of the body. Furthermore, each of these movements are evenly divided by two. The last step back to the basic position takes half the time, while the step back with the shift of balance, each, again, take half of the first duration.

The different theories will be tested for their applicability on selection of *capoeiris*tas. What is important to consider, is that the current study seeks in no way statistical significance in terms of providing a representative sample of capoeira practitioners. This massive undertake needs to be treated in further studies. It is rather an explorative study, seeking to experience the possibilities, restrictions, and aspects of working with technologies comparatively new to disciplines such as ethnochoreology and others. What shall be found, is a way of implementing new methods and techniques to the basic methodology of such fields. An all too technical approach should therefore tried to be avoided. This is unfortunately not absolutely evadable, since the preparation, processing and interpretation of such data requires a basic understanding of their nature.

Chapter 6

Methods and Procedures

In the beginning preparations for the study, the question of the participants' selection was raised, concerning several factors: nationality, expertise, proficiency, cultural background, etc. It was the question if it would be necessary to try to only include Brazilians, or at least people who have been trained there. Although Brazilian capoeira may differ in its individual incorporation, due to the distinct role of the art in the society, national traits within movement patterns are doubtlessly excluded. Cultural and social education may play a role in the shaping of a character, however, "[o]ne's movement or habits do not automatically grow out of one's social positioning; all children tend to be ill mannered, uncultured, and in need of training, no matter the group to which they're born." (Downey 2005:170) Thus, including European *capoeiristas*, does not affect the results produced, since the distinct way of moving in capoeira only is learned within the training of it. To make sure this kinesthetic knowledge was already embedded within the participants, a minimum of 5 years of experience was mandatory. In this manner, the proficiency of each proband was ensured, which, apart from this criterion, only relies on personal experience.

Since this study only serves as a pilot, the number of participants was kept to a minimum, from which comparisons still could be made. A total of four persons took part, all of them recognized as experienced and *skillful* capoeiristas. One of them is not active anymore, due to an accident that impedes the functionality of the arms. The factual data can be seen in the table below.

	Participant 1	Participant 2	Participant 3	Participant 4
Nationality	Austria	Austria	Austria	Brazil
Sex	Male	Female	Female	Male
Style	Regional	Regional/Angola	Regional	Regional
Experience	> 7 years	> 7 years	> 7 years	> 7 years
Weekly Effort	4-5 times	4-5 times	2-3 times	4-5 times

Table 6.1: Overview of the factual data of participants

6.1 Apparatus

For the collection of motion data, an optical Motion Capture System with eight cameras by Vicon has been used, which was provided by the Department of Biomechanics, Kinesiology and Applied Computer Science at the Institute of Sport Science at the



Figure 6.1: Camera setup and workspace for the study.

University of Vienna¹. The cameras, six of them with 1.3 megapixel, two with 4.0 megapixel, were connected via the MX Net, which synchronizes the cameras and is responsible for the dataflow and transfer to the computer, where it can be viewed and edited with the software Vicon Nexus (citation). In the camera setup, the higher resolution was placed in front and back to the participant (parallel to the coronal plane), since the ginga was performed stationary and, therefore, the body was better captured. The remaining six cameras were put up, forming an observational area of about 4x3 meters. An additional 2D video camera (Panasonic HDC-SD80) recorded the trials in a frontal and central perspective for monitoring purposes. The design is illustrated in figure 6.1.

The cameras are equipped with stroboscopic infrared LEDs, lighting the observation area for markers, to reflect the light which is recorded by the cameras at a frame rate of 250 Hz. The markers are built of a wooden sphere of approximately 1 cm in diameter, covered in reflective tape and mounted onto a foot with a plastic thread. They are attached to the participants with double-faced adhesive tape to either the clothes they are wearing or directly to the skin.

The position of a marker was calculated and then visualized in Vicon Nexus, when at least two cameras can record it. In order to produce a three dimensional model of the body later on, a digital template, calculating it, is needed. These setups require the markers to be placed in predefined position upon the body. The model in use here is the Plug-in-Gait Full-Body model, which comes with Vicon Nexus as a standard. It allows modelling within the 6 DoF, and dividing the body into joints and segments, each with individal calculations for such physical parameters as velocity, speed, angular

¹I want to thank Dominik Hölbling for the excellent support and explanations with the system, as well as Emmanuel Preuschl for the technical support and Prof. Arnold Baca for providing the equipment and letting me use the biomechanical laboratory.



Figure 6.2: The size of a marker. (Picture by Dominik Hölbling)

momentum, etc. and, furthermore, an additional, calculated marker for the centre of mass. If more detailed models are needed in the future, they can be developed in any desirable way, but for the start, this standard model for the entire body is sufficient. It consist of 39 markers indentifying important joints and parts of the body. This is achieved by either being placed directly on or with multiple markers around these parts, in order to later define the centroid and, thereby, the desired point, such as with wrists or the head. The exact placement of the markers can be seen in Figure 6.3 on the following page, as a direct comparison of the instructional graph and the actual placement on a body.

Positioning includes following body parts, with respective marker numbers. If not indicated otherwise (L/R) or on median plane, the setting applies for both sides of the body (Wanderley): 1-4: head; 5-6: spine (C7, T10); 7: clavicle (jugular notch); 8: sternum (xiphoid process); 9: R back (middle of scapula); 10: L shoulder (acromioclavicular joint); 11: L upper arm (between marker 10 & 12); 12: L elbow (lateral epicondyle humerus); 13: L forearm (between 12 & 14/15); 14: L wrist (thumb side); 15: L wrist (pinkie side); 16: L hand (below head of 2nd metacarpal, dorsal); 17-23: markers 10-16 on R; 24-25: pelvis front (L&R anterior superior iliac spine); 26-27: pelvis back (L&R posterior superior iliac spine); 28: L thigh (lower lateral surface); 29: L knee (lateral epicondyle femur); 30: L tibia (lower lateral surface); 31: L ankle (lateral malleolus); 32: L heel (calcaneous); 33: L toe (2nd metatarsal head); 34-39: markers 28-33 on R; 40-41: pelvis (auxiliary markers between 24/26 and 25/27 for reconstruction). The participants were given a pair of black, tight-fitting and nonreflective training shorts to wear, women were asked to bring a dark, non-reflecting sports bra. Additionally, long hair was asked to be tied up, in order for them not to occlude any markers. By reducing the clothes to a minimum and attaching the markers as close to the body as possible, ideally affixed directly on the skin, more accurate results can be achieved. Markers placed on clothes, are numbers 28/34 on shorts and 6/8 on the bra. Already constructed are numbers 14/15 and 21/22 respectively, which are mounted on a small bar, which is fixed to a wrist band and the four head markers 1-4 to a headband. Since capoeira is played barefoot a lot of times, this part posed no problem with markers, or in the execution of the movement.

6.2 Musical Stimuli and Synchronization

For the musical accompaniment of the test persons, three different stimuli have been chosen. In the selection, importance has been attached to the differentiation within the musical tempo of the example, with regards to the research question. The three audio tracks are taken from commercial CDs, differing in tempo, due to the different *toques* played. To have a preferably big range between them and an obvious distinction, the patterns are Angola, Iúna and São Bento Grande (de Bimba)/Regional. Table 6.2 gives



Plug-in-Gait Marker Placement

(a) Plug-In-Gait Manual for marker placement. (Wanderley)



(b) Reflecting markers.(Picture by the author)

Figure 6.3: Direct comparison of the Plug-In-Gait marker placement as described (a) and on the actual body (b).

an overview of the samples

Another criterion in the selection was an easy recognizability of the musical structure and the *toque* for evoking the corresponding movement structure. Both, stimulus 2 and stimulus 3, start as an independent piece, while stimulus 1 is cut out of the long chain of consecutive songs. Since there is no singing at the beginning of the track, the basic pattern can easily be identified. The other parameters vary from no singing and clapping in stimulus 2 to both in stimulus 3. Instrumentation is written down by listening, with quantity given when sure. The influence of lyrics on movement is not subject of the study, but they can be viewed in the Appendix.

For synchronization and the reference to the beat later on^2 , additional click tracks for each stimulus have been created again with a MATLAB code by Ellis. It creates a signal of the same length as the source track, with blips at times t (in seconds), as previously defined in the beat tracking procedure³. For the synchronization with the motion data, both audio track and respective click track were played simultaneously via Audacity (free software under GNU General Public License source) on an external Lenovo laptop. All audio material has been converted to mono, this way, both tracks each corresponded to one channel of a stereo signal. The laptop's output was, first, sent to an audio interface, splitting the stereo output with one channel, going to the loudspeakers and, second, to an analogous card of the Motion Capture system. The music was played back by the speaker pair - subwoofer combination Logitech X-230 placed in front of the observation area of the cameras. The analogue data in Vicon Nexus, received by the generic analogue card, can be detected as time bar events, essentially the same time series as produced with beat tracking in MATLAB, now embedded in the software⁴. See figure 6.4 for a graphical description of the setup. In this manner, motional data at the corresponding time points can be looked up and compared as well as analyzed.

6.3 Procedures

Preparations for the study include the setup of the Motion Capture system, its calibration and connection to the audio apparatus as well as preparing the markers (placement of on double-sided tape). A schema of the test design is given in Figure 6.1 on page 84. The cameras are placed around the observation area in the middle, all mounted on different heights (which is necessary for their determination by the software). After starting all the devices, Vicon Nexus has to be switched to camera view, the perspective of each single camera. Here, pre-existing disturbing reflections or infrared light

in which are fblip=100, the frequency, and tt=(0:round(tdur*sr)), time points of the beat, with tdur=0.01, thus, 10 ms.

 4 A time bar event is detected by defining an individual threshold for the analogue data, which in this case was electric voltage with maxima of 3V per peak of the click tracks. The threshold was set to 0.05 to ignore the noise floor created by the card.

²The concept for this scheme was developed by Emanuel Preuschl.

 $^{^{3}}$ The predefined signal for the blip has been modified for the local system to be recognized. It was changed to a sinusoid with 100 Hz for a duration of 10 ms and amplitude 1. The original function of the code "mkblips.m" in line 19-22 was substituted by

¹⁹ tdur = 0.004; 20 fblip = 0.002; 21 tt = (0:round(tdur*sr))'; 22 x = sin(2*pi*tt/sr*fblip);

Source	Lyrics	Instruments	Clapping	Tempo in BPM	Toque	Artists	Title	
Nzinga, 2004, 'Camugerê', in Capoeira Angola. CD. Track #3	call and response (see Appendix C)	3 berimbau 1/2 pandeiros 1 atabaque 1 agogô	none	121	Angola	Grupo Nzinga, Mestre Cobra Mansa	Camugerê	Stimulus 1
Mestre Barrão, 'Toque de Iúna', in Axé Capoeira: Vol III. CD	none	2 berimbaus pandeiro 1 atabaque	none	164	Iúna	Axé Capoeira, Mestre Barrão	Toque de Iúna	Stimulus 2
Capoeira Nagô, 'Lembra de Bimba', in Capoeira Nagô: Vol. 2. CD. Track #12	call and response (see Appendix C)	3 berimbaus 1 atabaque	$\mathbf{X} \cdot \cdot \mathbf{X} \cdot \mathbf{X}$.	244	São Bento Grande (de Bimba) / Regional	Capoeira Nagô	Lembra de Bimba	Stimulus 3

Table 6.2: Overview of the different musical stimuli.

CHAPTER 6. METHODS AND PROCEDURES



Figure 6.4: Audio setup for playback of musical stimuli.

sources can be eliminated (for instance, greasy spots on the floor, or sunlight, coming through not-screened-off windows) to provide a clear picture in which single markers are put within the observation area separately and in groups, for positioning each camera to their best viewing angle. In the subsequent masking, any spots still appearing on the 'empty' screen, are occluded and will not be registered by the camera. For their calibration, that is, their position in relation to each other, a pre-constructed staff "120mmWand4" with markers mounted to it in defined positions, will be moved in the entire observation area until each camera gives the signal for it being ready. In a last step, the origin has to be set up, defining the axes of the three dimensional coordinate system, which can be placed at will within limits of the observation area, by using a triangle "9mmL-Frame" with markers added to it, similar to the wand before. In this design, the origin is such that x defines movement in left/right direction, y forwards/backwards and z up/down, in respect to the starting position of the participant facing straight towards the side of the workstation. After the routines with Vicon Nexus, the audio devices are connected as described above. Last, the 2D video camera is placed.

The whole event of capturing one *capoeirista* a session is divided into different trials, equivalent to one cohesive recording in Vicon Nexus, that is, from beginning to end without cuts. The participants were invited to the biomechanical laboratory at the USZ⁵ Vienna, where they were informed and instructed about the upcoming experiment. Each one was given the possibility of warming up, also within the camera area, to get used to the conditions (parquet floor, etc.), after they had been given clothes to wear. Then, the markers were placed and the capturing started. For the later and easier reconstruction of the model in Vicon Nexus, the captured had to be recorded a few seconds in the 'T-Pose' (as seen in Figure 6.3). After that, for each trial, the music is started whenever the participants were ready. They did not know what music was to be played and were asked to do the *ginga* to it. After about one minute, on a signal, they were allowed to move freely to the music. For additional comparison and reference,

⁵Universitäts Sportzentrum Wien.

two participants had additional trials, clapping to stimulus 1, and one participant was captured doing what the person considered a 'wrong' ginga. After the trials, the following anthropometric data was collected, in order for the program to calculate the model: mass (kg), height (mm), leg length (mm), knee width (mm), ankle width (mm), shoulder offset (mm, distance of markers 10/17 to center of glenohumeral joint), elbow width (mm), wrist width (mm), hand thickness (mm). After quickly re-checking the collected data, the markers were removed and the study for the participants was over.

In a post-processing phase, the raw data has to be edited, in order to do later work and analysis. Each editing includes several steps for one session. The first trial, the T-Pose, has to be labeled. Each marker is tagged with its description, as listed above, and thereby connected with others, according to the model; this gives a basic frame of the body. With the "static subject calibration", the model, including mass distribution and definition of joint axes, is then calibrated. Missing segments in the trajectories of each labeled marker have to be filled and edited if markers are occluded during a trial, are not captured by two cameras simultaneously, are mistaken for other markers, additional reflections appear, or the like. Two options are provided by Vicon Nexus for this: the spline fill and the pattern fill. The first method uses an $algorithm^{6}$ to calculate a suggestion mathematically, referring to last positions of the marker before the gap; the proposed trajectory is shown as a red dashed line. In the second method, a source marker has to be picked, from which the motion for the missing object is adapted; it is presented as a green dashed line. For reference, a blue dashed line shows the shortest connection in distance for the missing segment. The smaller the gap and smoother the trajectory before the missing part, the more accurate the spline fill will function. For bigger segments and erratic curves before, the pattern fill command is more appropriate. It is especially convenient for markers on the same bone, thus, where a rigid connection between both exists. When all markers within the desired section of a trial are labelled, that is, all captured points in space that belong to the model have a tag in each frame, the remaining trajectories can be deleted, leaving only those of the model markers. As those may be subject to statistical error in the capturing process, or also just loosened during the session, filtering routines can be applied to smoothen small outliers in the curves and noisy lines, which is necessary for exact analysis techniques (for example, velocity and acceleration curves). The software provides such filters as Butterworth or Woltring, the latter being used in this case, since it applies "more specifically to kinematic data which is prevalent in biomechanics research" (Vicon). The last steps include the application of the "static gait model", calculating the joint positioning and axes of the body, head and extremities, as well as the "dynamic gait model" for centre of mass and forces, momentum, angles, etc.

⁶Based on spline interpolation.

Chapter 7

Evaluation

7.1 Data Processing and Analysis

To handle the massive amount of data, the focus has to be set on only a few aspects relating directly to beat perception and embodiment. Therefore, the analysis aimed its attention, firstly, at the periodicity of movements in relation to the one of the beat, and, secondly, on the direct connection of selected parts of the body to the beat.

The periodicity of movement and music refers in this context to the cyclic repetition of a pattern over time. It can be presented as either the temporal frequency (in contrast to spatial or angular frequency), that is in the unit of Events/Time, or Hertz (Hz), or by giving the period of the event, that is, its duration. The frequency of the musical stimuli has already been calculated and presented earlier in Beats per Minute (BPM). The periodicity of movement has been calculated in MATLAB, using the MoCap Toolbox (Burger & Toiviainen 2013) and its functions to determine the period for all markers. The function mcperiod uses autocorrelation to estimate a period for each marker separatly, proposing a result for each coordinate of marker. By examining the graphs of distinct markers (feet, arms) a maximum period of 4 seconds was set¹. By taking the arithmetic mean of all markers, an overall period for the entire body was estimated. Since the movement of the ginga is mirrored (as described in chapter 3.1), the period is divided in half, thus representing the time of one single movement pattern. Furthermore, the beat period was divided in half, left the same, doubled, and multiplied by 4, representing the time of an elementary pulse, a gross pulse, a reference beat, and a cycle of a *toque*.

The second analysis examines, in contrast to the relative observations of the first one, total values of the relation between pivot points of body parts and beat locations. The closest connection between those two is usually found between the movement of the feet and the beat. The characteristic movement of the heels can easily be seen in Figure 7.1.

It shows the time series of the z-coordinate of the marker positioned on the left heel for each participant. The distinctive 'bouncing' of the entire body, resulting from a quick shift of balance back- and forwards, is easily recognized as an accent with the entire body. This suggests that these pivot points of the heel are closely connected to a perceived rhythm of the *capoeirista*. Therefore, the timepoints of these events were filtered out for comparison with the timepoints of the beat. In a MATLAB script, written by Hannah Huber (see Appendix C) especially for this research, all of the timepoints of the desired heel marker minima are compared to the timeline of the

¹Exact parameters were: mcperiod(*d*, *4*, 'highest').



Figure 7.1: The timeseries for the z-coordinate of each participant's left heel marker in stimulus 2.

beat. For each pivot point, a corresponding beat was detected by choosing the one closest, that is, the one with the smallest temporal difference to it. Figure 7.2 shows an example of the detected pivot points next to a graphical presentation of those points with their corresponding beatpoints. The histogram in Figure 7.3 represents the temporal distribution of the pivot points in relation to the timepoints of their corresponding beats². By calculating the mean of both left and right heel marker, an average temporal deviation for the accents of the body of the beatpoints can be displayed. Due to technical problems (missing of beat timepoints), subject 1 had to be left out of this analysis.

7.2 Results

In table 7.1, an overview of the calculated periods is presented. For each stimulus, the duration for each subdivison of the rhythmical pattern is given, along with the length of a single movement pattern of the body. This refers to the *ginga* movement for one side of the body, be it either left or right, including the step back from the original parallel stance, the shift of balance on the rear foot and the step back forwards in the parallel stance again (as described in chapter 3.1). It can be easily seen that the closest connection to the periods within the music is on the level of an entire cycle of a pattern, that is, eight elementary pulses. The corresponding time in the table is written in bold. Table 7.2 shows the deviation of the musical cycle period for each test subject. Positive values indicate faster movement, while negative values show slower movement than the music. It is easily seen that all participants moved considerably faster in the first stimulus, very close together with the music in the second stimulus, and slower in the third stimulus.

A maximum of about 19 % faster movement was found in stimulus 1, 14 % in stimulus 2 and 34 % slower in stimulus 3. Although the movement was clearly either faster or slower than the music's speed, a steady period for each participant has been observed, showing no irregularities in any of the graphs.

²See Appendix C for all figures.



Figure 7.2: Example of a graph of the heel marker's movement in the z-axis (up and down) with vertical lines representing the moments of pivot points of the heel and their adjacent beat timepoints.

Period (in seconds)					
	$\mathbf{Stimulus} \ 1$	Stimulus 2	Stimulus 3		
Music	121 BPM	164 BPM	244 BPM		
elementary pulse	0.248	0.183	0.123		
gross pules	0.496	0.366	0.246		
reference beat	0.992	0.732	0.492		
cycle	1.983	1.463	0.984		
Subject 1	1.705	1.446	1.114		
Subject 2	1.798	1.677	1.278		
Subject 3	1.604	1.462	1.325		
Subject 4	1.729	1.533	1.299		

Table 7.1: Overview of the calculated periods for music and one ginga cycle.



Figure 7.3: Histogram of the distribution of the beats around local minima of the heel marker.

account from macroar egete periode (in ecconde)				
	$\mathbf{Stimulus} \ 1$	Stimulus 2	Stimulus 3	
Music	1.983	1.463	0.984	
Subject 1	0.279	0.017	-0.131	
Subject 2	0.186	-0.214	-0.295	
Subject 3	0.379	0.001	-0.342	
Subject 4	0.255	-0.069	-0.315	

deviation from musical cycle periods (in seconds)

Table 7.2: Temporal deviation of the mean body periods from the calculated musical cycle period for each stimulus. Positive values indicate slower, negative values faster movement.

	Stimulus 1	Stimulus 2	Stimulus 3
beat duration	0.49	0.36	0.25
Subject 2	0.12525	0.10705	0.11635
Subject 3	0.11955	0.09695	0.13175
Subject 4	0.12325	0.0947	0.11495

mean temporal deviation of pivot points from beat (in seconds)

Table 7.3: Temporal deviation of the mean body periods over all stimuli from the calculated musical cycle period. Positive values indicate slower, negative values faster movement.

The second analysis examined the movement of particular body parts in relation to the beat. Table 7.3 gives an overview of their results. Given is the mean time in seconds that lies between the timepoint of a beat (gross pulse) and the pivot points of the heels.

An example of the distribution of those points, in regard to the beat, can be seen in Figure 7.3. These times of deviation are more or less steady, regardless of the duration of the gross pulses. This leads to a range of up to 25 % lag of the movement towards the beat.

7.3 Discussion

The results of this study give some clues about the interaction of music and movement within capoeira's ginga. Both approaches of, firstly, examining periodic relation within the moving body and the musical events, and, secondly, the specific examination of body parts, representative for the embodiment of musical pulse, lead to a central idea. The original theories (see chapter 5) all covered this idea. The first theory proposed polymetric intersections, that is, the coinciding of reference points in the *capoeirista's* movement and those within the music, suggesting two rhythms for each part. The second one based on the first, but assumes that the first movement of the ginga always is such an intersection. This would mean that one of the two rhythms is just slightly slower or faster than the other, resulting in a kind of phase shifting of the music's and movement's periodic patterns. The last bigger theory suggests an individual rhythm of the *capoeirista* that does not stand in any immediate connection towards the beat, or any other reference pulse.

Considering the theories, the results are suggestive of a generalized idea of all of them. It is unlikely that any periodic event in music whose duration lies far below one second, serves as a reference point for the movement of the *ginga*. The presented stimuli in the study covered a range of musical tempi as wide as possible, with the result that the musical cycle of a pattern is the most probable aspect of orientation for the *capoeirista*. This implies the general idea of a relative tempo, individual for each player. The results of the the second analysis confirm this: The uneven distribution of the feet's pivot points, representing the most significant movement quality of the *ginga*, the swaying and bouncing, show no direct link between these points and a musical pulse. Yet, a steady period of these and other movements, such as the arms, upper body and even the centre of mass, show that the movement does not flow arbitrarily.

The basis for the interrelation of music's and movement's tempo, then, lies in the existence of various individual and possibly absolute tempi for each *capoeirista*, which



Figure 7.4: A sketch of the idea of the tempo correspondence between music and movement in the *ginga*. The colored bars depict the movement tempo of the *capoeirista* from slow to fast, with the inner white bars defining the tempi of the music. The movement tempo mainly ranges in that area, close to the one of the music, the borders, however, are diffuse, indicated by the fading ends of the bars. If one is moving significantly slower or faster than indicated by the bars, this is what is often understood as 'not playing to the music'.

are in no direct relation to the heard sound. Such an absolute tempo may have been incorporated by first 'adopting' it from teachers and surrounding students, and then by relating to individual tempi of different music/playing styles. The relationship of these individual tempi T_i of a capoeirista (c) and a beat (b) to the absolute tempo T_a , that is, during an interval of time playing (the actually measurable time of the period), can then be described as follows:

Each type of play (jogo) and music (toque) has its own range of tempo $T_i(b)$, reaching from x to y BPM, just as every person has his or her individual range of movement tempo. This means lower and upper boundaries for these tempi can bet set. The assumption is that the individual tempo of the *capoeirista* $T_i(c)$ is in accordance with the one of the beat $T_i(b)$, therefore, never exceeding the range of the latter significantly. Hence, every movement period lies within an accepted range of movement speed for each jogo or toque. Moving outside this range would be regarded as 'not playing to the music', which is often seen with novices in the art. The absolute tempo of $T_a(c)$ of the *capoeirista's ginga* is derived from the absolute tempo $T_a(b)$ of the music, which alignes with the period of the cycle of a musical pattern. This comprises eight elementary pulses, since most toques are of the given length or are built from several cycles. Figure 7.4 displays this idea of overlapping tempi for both movement and music.

As for the results of the study, there is an apparent consent on the relative tempi of the participants. Since all of them come from a background which is more influenced by the Regional style, all of them move significantly faster in to the stimulus of the slow and calm *toque* Angola. Stimulus 2, Iúna, is most familiar to them, and since it is often used for shows with solo performance, it seems resonable that this is the trial where movement and music are closest. The last, stimulus 3, Regional, however, is even for this *toque*, at such a fast pace that all participants moved in a slower manner.

Since the movements of the *ginga* rarely are in perfect concordance with temporal referrce points in the music, a type of polymetric relation is plausible. Whether or not the music provides a starting point for the movement, two steady periods overlap. Their ratio will always be in an odd manner, since already doubling or only half of the tempo would result in too fast or slow movement. Figure 7.5 illustrates the intersections of both cyclic events. Due to their periodicity a steady pulse of these intersections occurs, which is one explanation for the perception of the ginga as 'in time, but somehow not'.

What has to be kept in mind is the fact that, apart from formalized training where all *capoeiristas* try to move in unison, the *ginga* is part of the bodily play in capoeira,



Figure 7.5: An enhanced interpretation of Figure 5.1 with the green bars designing the polymetric intersections, constituting a new, polyrhythmically calculated beat.

which always happens in pairs. If one moves out of synchrony with the opponent in such a manner that it upsets the flow of the game, it is considered bad style. So, apart from musical references for the movement determined in this study, several other aspects for synchronizing one's movements exist. The presence of an opposite individual on which all focus is laid on and which demands an adaptation of ones own movement patterns, greatly influences the choice of an absolute tempo reciprocally. Additionally, it has to be regarded that the *ginga* is not an isolated movement that is performed on its own, but rather a retreat from quick and intensive sequences of the fighting and dancing interactions of two bodies. It is what connects every action in *roda* and the foundation of physical play. No matter how the *ginga* is defined, it is one important part in playing capoeira, which contributes to the understanding of the art as also a dance. Last but not least, the consonance of movement and music is found here in the way described above.

Chapter 8

Conclusion and Perspectives

The idea for this work started growing, with the first time I saw capoeira. It was my first lesson and the sensation of watching the intricate interrelation of movement and music in the art and it astounded me. Everyone who asked for this relation, did not give a precise answer about possible dependencies between the two parts, but rather described the general 'feeling' of playing to, or with the music. It quickly became clear that the *ginga*, unlike in most dances, does not follow a predefined scheme for the movement to lock onto the beat. Yet, it was also evident that a relationship between music and movement exists. Finding a way for understanding this relation and exploring the possibilities that might open up in regard to such investigations were the main objective in this work.

First off, a general introduction to capoeira was given, including a brief historical summary of its development, leading to its current level of reputation and a detailed examination of musical aspects and the motional structure of the *qinqa*. Following the evolution of the art helps to understand its contemporary status. The long time of persuing capoeira for being illegal, formed character treats which are presented today as characteristics for it. Not only songs tell of those times, also the vocabulary still reminds of it, with synonyms such as $vadiagem^1$ or $malandragem^2$. The entrance in higher social levels came alongside the advent of the *academias*, which put the indecorous street fights within limited boundaries. From Mestre Bimba's efforts of establishing rules for the formerly untamed confrontations, emerged an entire new style of capoeira, Regional, which was rapidly contrasted with Mestre Pastinha's 'traditional'style of Angola. The many hybrid forms today lead to a more regular movement style within the *roda* on the one hand, coming from the influence of other martial arts, and a loss of rituals and aspects of the *roda* itself, on the other hand. There are, however, schools following one path or the other radically, sometimes not even acknowledging any other forms of the art.

The analysis of musical features in capoeira has not been subject to many analyses yet. Mainly Oliveira Pinto (1991) conducted research on the topic. His results resemble mine closely, though its transcription differs slightly. What is missing, is especially the very important buzz sound of the *berimbau* which cannot be let out, since it serves as a reference point within the patterns of the musical bow, the *toques*. Each of these is built from one or more 8-pulse cycles where at least one contains the two distinct sequent buzz tones on two consecutive pulses, which are indicating towards the beginning of the pattern. Though most players start on this point, and probably most listeners set the

¹pt.: "loitering"

²pt.: "straying"

beginning of a *toque* here as well, transcribing it, shows that the beginning falls on the beat just before that. Two different clapping patterns, one of them the most famous formula in the 3-3-2 division, imply that a *toque* always is built towards what can be called beat one. Not only in the distribution of the three main sounds of the *berimbau*, low, high and buzz, but it can also be observed that dynamics build up towards that beat, which almost always gets accentuated. The subdivision of the patterns into cycles and pulses then helps to determine more fixed points within the rhythmical structure, such as the gross pulse and the referencial beat. The cyclic structure, however, is further supported by other parts of the musical ensemble, the *bateria*, and clapping persons in the *roda*. Their pattern essentially is the same, aiming towards beat one of the cycle with preparing claps on the gross pulses three and four. Thus, the musical cycles revolve around one main referencial point within the patterns, which later on can explain the synchrony of the *ginga* to the music.

The movement system of capoeira comprises motional structures of various influences. It embodies the repertoire of both dance and fight moves, which all have to be connected fluidly, expecting the *capoeirista* to be in constant motion. Actions can generally be differentiated by their intention: attacks, defenses, dodges, embellishments and the connecting basis, the ginga. The core of capoeira though, the malícia, a sense of cunning and tricking, does not allow clear boundaries between all of these movements and demonstrates the fuzziness of the "blurred genre" of capoeira (Lewis 1992:1f.). Where in one moment a *bananeira*, the handstand, serves as a graceful dodge of an incoming attack, in another, it may be to lure an opponent for quickly attacking with the feet in the air. A close relation or adaption to musical parameters with movements, which depend heavily on the current situation, seems very unlikely. Especially in very fast games (the agonistic ones as opposed to the ludic ones, as denominated by Lewis 1992) it is fairly difficult to focus one's attention to much more than the momentary movement. Here, the music serves more as an emotional backup, pushing the players to their limits. The ginga behaves differently in this concern. It is a crucial part of capoeira's motional structure, and the movement that follows a schematic pattern the most. This pattern can be described and analyzed, so that the kinetics themselves can be divided into smaller parts, which form the ginga. Kaeppler's research on analyzing dance structures (2007) offers the theoretical basis for this analysis. The idea of kinemes of a dance or motion, the smallest isolated unit of a movement recognized as such, also is prevalent in the Labanotation (Laban & Perrottet 1995; Knust 1997). An existing notation of the *qinqa* helped to define these units. An important aspect of the pattern is its symmetrical structure. From a basic stance, low and with knees bent, a step is taken back, alternating with the inner foot, that is, the foot that is closer to the middle line of the parallel stance. It is, therefore, a mirrored motion. The stepping back is fluently connected to the characteristic shift of weight from the front foot to the rear and back, which results in an accentuation of basic points of an embodied rhythm. This clearly defined framework suggests the ginga as the ideal point in the roda to connect to the music. Both are cyclic structures and most of the *capoeiristas* agree that there is a close connection between the two of them.

Several methods have established, until today, for analyzing dance and movement structures. Apart from manual work by observation, such as mere description or notational systems, computer-based analysis is on the rise. The technical developments in the last decades allow for already meticulous examinations of recorded material. Where in the beginning the possibility of reproducing an event at all was a huge step forwards, the digital processing of these images nowadays, gives the possibility of observations within a hundredth of a second. Yet, new technologies are going to be established which allow for even more detailed and accurate analyses. By using a state-of-the-art optical Motion Capture system, the possibilities of this technology, which is not yet far spread in dance and music analysis, could be exploited and applied in a specific case study. Where in a standard video analysis, such as frame-by-frame, many aspects of a movement can get lost, not least because of its reduction of the movement into two dimensions, whereas with Motion Capture, the trajectory of every important part of the body, and the body itself as a whole, can be recorded and reproduced in a threedimensional environment within the range of milliseconds. This may not have been a reason for this study first and foremost, but it opens up a scope of possibilities. In this case study, it was about a general approach towards a new apparatus that could simplify movement analysis greatly.

The study itself covered the recording of four different *capoeiristas*, which were all trained, mainly, in a contemporary style of capoeira, primarly influenced by Regional. The participants were prepared for the recording by putting retro-reflective markers on certain points on their body, which are captured by the infrared cameras of the Motion Capture system. They were presented with three musical stimuli to which they were asked to gingar (do the ginga), and on cue, to move freely as *capoeiristas* to the music. The three different *toques* of the music were Angola, Iúna, and Regional, ranging in speed from calm and slow, over a steady pace, to decidedly fast. Having extracted timepoints of a beat, that is, the gross pulse as transcribed, it was possible to compare several factors of the recorded movements to temporal events in the music. The two selected methods of comparing periods of the body and the music, and an immediate comparison of the feet's pivot points with the beat, lead to the conclusion that the *qinqa* is not locked at any point in music in a direct manner. It rather suggested the idea of individual tempi for each *capoeirista*, depending on the *toque*. The individualities of these tempi may derive from the training one received, or the style one is playing in. A variety of influences are worth consideration, since capoeira is learned in a most imitative process (Downey 2005). These tempi are most likely to orient themselves towards the tempo of a musical cycle. As observed, the cycle is the prevalent structure in the music, dynamically leading to the first beat. Even though it could not been proved in this study, due to its technical design, it is safe to assume that the physical accents of the body coincide with these beats in the music most. These two prominent points provide a stable basis, both for the music as a reference point within the pattern, as well as for the movement, literally, as a firm stance to start movement from. The results should not be generalized for all styles of capoeira. In Angola, for example, a far more interrupted and unsteady ginga is prevalent. Furthermore, the dimensions of this study have to be considered. The qualitative analysis of a few parameters can only raise ideas of the understanding of the *qinqa*.

A main objective in carrying out this research was, in particular, an interest in new methods and the opportunity of working with an advanced form of analysis tools. The practicability, required knowledge, possibilities and limits of analysis, or userfriendliness, are a few questions of interest, in regard to using such technologies within the study of dance and movement. It is important to know at this point that Motion Capture systems are made for these kind of studies. The capturing of (not only human) motion and its later accurate reproduction, are the essentials of this technology. It is what all of these systems were developed for. The subject of biomechanics within medicine is one of the most popular fields of application for Motion Capture today, apart from its role in the entertainment industry. Detailed gait analyses can help physicians find causes for pain or diseases of orthopedic character. Through the recordings of a motion capture system, not only a reduced plan of the seen movement, as in 2D-videos, is recorded, but rather a fully reconstructable model of the captured body. Especially, optical capturing devices allow precise remodelling, defined by the number and type of markers used in the recording process. The output from this is not only the trajectory of each single marker with millimeter precision, but by already existing algorithms, all important kinetic and kinematic basic parameters are easily calculated. Predefined schemes for body model calculation exist in various forms, depending on the application it should be used for. If the entire body is not necessary for an analysis, only selected parts of the body can be captured and easily reconstructed. More than consumer knowledge of a provided software and of the examined subject are not necessary. All this may not only help dance studies, but any research dealing with motional structures. In musicology, there are first attempts for observations on the interpretation of music. Rhythmical analysis, such as questions of timing, can be reduced to motional structures and much more.

The present explorative study tried to find advantages and problems with the application of a Motion Capture System in a part of the field of ethnochoreology. An obvious difficulty is the virtual immobility of the optical system. Eight cameras need massive tripods for absolute stability, since they may not move during a recording, plus additional equipment for converting and transfering data is necessary. This implies a laboratory environment, while capturing. Since optical systems are based on infrared cameras, the room should always be darkened, not letting infrared parts of the sunlight's spectrum interfere with a recording. Such big systems, therefore, are not ready for ethnographic field studies, yet. The possibilities, however, are quickly evolving and first researchers' endeavors explored the use of different forms of motion capture in the field. Still, for exact analyses, a type of laboratory space is required. Whether these circumstances will influence the results of recordings or not, cannot be stated yet. The situation for participants in such experiments differs undeniably from what context they normally participate in. How much this differs, depends on what genre is examined. For professional athletes, such as kickboxers, I was told, they did not care much about the environment; especially considering that they wear the same outfit in their sport. Interviews with participants of this study gave the expected answers. All of them needed time to adapt to the situation: standing in front of eight cameras, with nothing to wear except short pants and a bra respectively, being observed by other people from the outside. They were sure that this situation did not significantly influence their way of moving, but it still is an aspect that has to be kept in mind when working with other persons, children or more insecure persons for example. An additional restricting fact is a limited space of mobility for a moving person. The system delivers more accurate results with a smaller observation area of the cameras, but it can be expanded to such an extend that most movements can take place within these boundaries. The only premise is that at least two cameras can recognize a marker, in order for it to be captured. All of the mentioned issues are just, as the applied calculations, models, and the outcoming results, dependent on the object of the research. While a simple tapping experiment with only recording one marker on a hand would not require much space and, presumably, a maximum of three cameras, exploring the corporal synchronization of a group of fifteen dancers, a much higher effort was to be applied. Though both of it is possible, the design of the experiment had to be adapted, for example, using only a few markers for one body in the latter. The possibilities are present, they just have to be used in a creative and reasonable way.

I presented a first approach of using a newly established technology for motional analysis in regard to its connection to music. In the *ginga* of capoeira, an individual model of synchronizing to musical events has been investigated. It is a first step towards a better comprehension of the intricate relationship of motional and musical structure that prevails in the art. In further research, a general approach of synchronization to a musical beat can be advanced. It is necessary to develop software that will help to easily analyze the massive amount of data that accumulates by using new technologies. It has to be created specifically for the dance scholar, so that one can use it, without having to know the underlying technical aspects or mathematical procedures as long as it provides coherent results. For this, a close cooperation between technicians and the researcher is crucial. Future research will hopefully tackle this issue, in order to develop an interdisciplinary approach towards the study of music and movement.

In general, the understanding of the human body is the first step to a deeper understanding of dance or the interrelation of music and movement. Knowing what and in what fashion the body executes its motions, can explain phenomenona that happen on another level than the physical event of motion. Abstract concepts, such as the beat, may be explicated. The idea of style in movement may be traced back to specific ways of interacting with music, depending on smallest amounts of change in a movement. The understanding of rhythm and time perception, emodiment of music, or the humans' idiosyncratic ability of synchronizing to an external clock (entrainment), can be further understood when analyzing the moving body. All of these concepts, and much more, can be part of the above mentioned interdisciplinary research. With the technologies evolving at the current speed, they become increasingly available, especially concerning the financial aspect. Where and how far this kind of research takes us within the near future, cannot be determined yet, as it is still in its very beginnings. What is sure, is that it can help to push movement analysis to new limits, by facilitating the process of analysis and, therefore, making room for the interpretation of the results.

With this in mind, I hope I have contributed a part to the understanding of the complex interrelation of music and movement in the fascinating art of capoeira, and have taken a first step towards a new way of methodical approaches within the study of dance. After all, the incredible performance that a dancing body is able to achieve, while dancing, must not be forgotten.

Appendix

Appendix A

References

Audio:

Capoeira Nagô, 'Lembra de Bimba', in Capoeira Nagô: Vol. 2. CD. Track #12.

Mestre Barrão, 'Toque de Iúna', in Axé Capoeira: Vol III. CD.

Nzinga, 2004, 'Camugerê', in Capoeira Angola. CD. Track #3.

Software:

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C.1 Lyrics

The following lyrics are transcribed from the audio files used as the stimuli in the present study. Lyrics in **bold** indicate answering parts of the chorus whereas text in standard font style show the part of the soloist.

Stimulus 1: "Camugerê" by Capoeira Nzinga

Camugerê^a Como tá, como tá **Camugerê** Como vai vos mise **Camugerê** Eu vou bem de saúde **Camugerê** Para mim é prazer **Camugerê** Como vai como tá etc.

Camugerê How are you, how are you **Camugerê** How is it going **Camugerê** I am of good health **Camugerê** It is a pleasure for me **Camugerê** How is everything etc.

^{*a*}Word of unknown origin.

Stimulus 3: "Lembra de Bimba" by Capoeira Nagô

Êe, lembra de Bimba Eu quero escutar de você O criador, criador da Capoeira Você ensinou a bater, oi lelelelele

Êe, lembra de Bimba Eu quero escutar de você 0 criador, da criador Capoeira Você ensinou a bater Foi na escola, onde você praticava Que eu vi a luta de pé Onde a Capoeira agora é brincadeira Por sempre eu quero aprender, oi lelelelele Êe, lembra de Bimba Eu quero escutar de você criador. da 0 criador Capoeira Você ensinou a bater Lembra, lembra de Bimba Mandingueiro Saudoso Mestre igual não tem La no céu a todos fica olhándo Ele quer ver, que pratique como ele oi lelelelele Êe, lembra de Bimba Eu quero escutar de você 0 criador. criador da Capoeira Você ensinou a bater oi lelelelele

Ê, remember Bimba I want to listen to you, How the creator of capoeira Taught you how to fight, oi lelelelelele Ê, remember Bimba

I want to listen to you, How the creator of capoeira Taught you how to fight/clap It was in the school, where you practiced That I saw the fight of the feet Where capoeira today is a game I want to learn it forever, oi lelelelelele

Ê, remember Bimba I want to listen to you, How the creator of capoeira Taught you how to fight/clap Remember, remember Bimba Reminiscent master of trickery who has not seen the same Up there in the sky is he watching all of us He wants to see, that you practice like him, oi lelelelele Ê, remember Bimba I want to listen to you, How the creator of capoeira Taught you how to fight/clap oi lelelelele

C.2 MATLAB-Code

The programm displayed was used to find the local minima, that is, the pivot points, of the heel markers movement in the z-axis (up and down). They were detected by using the first and second derivative functions of the MoCap-Toolbox (Burger, Toiviainen 2013) under the use of a low boundary for the original movement data in order that only the desired points are detected, ignoring noisy data when stepping on the ground. The extracted timepoints are compared to the recorded beat events and assigned to the temporarily closest beatpoint. Their distance is saved as negative coming befor the beat, and as positive coming after the associated beat (in seconds). A graphical output is provided for these distances as a histogram and a graph of the original marker movement with highlighting of the minima and their allocated beats. The entire script was written by Hanna Huber for this study.

Contents			
Prepare data			
Find local minima of z coord for each marker			
 Eliminate multiple minima 			
Find closest beatpoint			
 Store results 			
Plot results for marker m			
<pre>function [heel_min] = findMinima(mat_file, markers)</pre>)		
<pre>% Finds local minima of r coordinate for specified markers and relates them % to heat time points % Input: mat.filestilug containing path to .mat file (toolbox output) % markersnd cell array or strings marker appendix to marker % where H is the number of minima for a specific nexture, % where H is the number of minima for a specific nexture, % t_minlwN vector of corresp. times to a specific nexture, % t_minlwN vector of corresp. times to a specific nexture, % cluster theory. In vector of corresp. times to a specific nexture, % cluster theory. In vector of corresp. times to a specific nexture, % cluster theory. In vector of corresp. times to a specific nexture, % cluster_beat i.NN vector of corresp. times to a specific nexture, % cluster_beat i.NN vector of (signes) distances % cluster_beat [s] %</pre>			
Prepare data			
<pre>% Define thresholds threshold = 6; % first order derivative close upper = 200; % heel range upper boundary lower = 100; % heel range lower boundary % Number of markers m = length(markers); % Cell array containing results heel_min = cell(n,4); % load data iumaGinge = load(mat_file);</pre>	to zero		
originalMarkers = iumaGinga.originalMarkers; beatTimepoints = iunaGinga.beatTimepoints; tSeconds = iumaGinga.tSeconds;	<pre>% marker data struct % sample points corresp. to % sa</pre>		
<pre>% Process data fdata = iumaGinga.originalMarkers.data; fldata = wctimeder(iumaGinga.originalMarkers); f2data = mctimeder(iumaGinga.originalMarkers, 2);</pre>	<pre>% function values (coords) % first order derivative % second order derivative</pre>		
<pre>% Beat point correction for t>>60s bmax = max(beatTimepoints); tmax = find(beatTimepoints==bmax, 1, 'last'); beatTimepoints((tmax+1):end) = beatTimepoints((tmax));</pre>	x+1):end) + 60;		
<pre>i Avoid out of bounds error during histogram check: > First bin: [first time sample point, first beat] 4 Last bin: [last beat, last time sample point] bestTimepoints = [tSeconds(l) bestTimepoints tSeconds(end)];</pre>			
<pre>% Iterate over all markers for mi = 1:n</pre>			
Find local minima of z coord for each marker			
<pre>% Find marker index m = markers(mi); index = find(strcmp(originalMarkers.markerName</pre>	ر ((هر		
% Find column containg z coords k = index*3;			
<pre>% Extract kth column z_coords = fdata(:,k); z_coords1 = fidata(.k); z_coords2 = f2data.data(:,k);</pre>			
<pre>% Find frames of local minima within range f_min = find(abs(c_coords)(threshold «</pre>	<pre>% z'(t) = 0 (extrems) % z'(t) > 0 (minims) % lower < f(t) < upper (within range) % vector of sample points [s] % number of heel minima</pre>		

C.2. MATLAB-CODE

Eliminate multiple minima

% Histogram:	
% N number of minima per heat interval	
% bin corresp. beat interval index	
<pre>[N, bin] = histc(t_min, beatTimepoints);</pre>	
<pre>bin_index = find(N>1);</pre>	% intervals containing more than one minimum
unique_min = true(1,n_min);	% store unique minima
<pre>for i=1:length(bin_index)</pre>	
<pre>mult_min = find(bin==bin_index(i));</pre>	% indices corresp. to same local minimum
<pre>zprime = z_coordsl(f_min(mult_min));</pre>	% corresp. first order derivative
minimal_min = (zprime==min(zprime));	% index with minimal derivative
unique_min(mult_min(~minimal_min)) = false;	% eliminate all others
end	
f_min = f_min(unique_min);	
t_min = t_min(unique_min);	

Find closest beatpoint

[closest_beat, dist_to_beat] = findClosestBeatpoint(t_min, beatTimepoints);

Store results

heel_min(mi,l) = {f_min};	% frame indices
heel_min(mi,2) = {t_min};	% time points [s]
heel_min(mi,3) = {closest_beat};	% corresp. beat time points [s]
heel_min(mi,4) = {dist_to_beat};	% corresp. distances [s]

Plot results for marker m

% Detected minima figure("Mase',stroat('local minima for marker ',mmx2str(index))); plot((steorads,coords); xlabel('t("[s]'); ylabel('s[ms']); hold off % Minima and bestpoints figure('Mase',stroat('filmina and bestpoints for marker ',mm2str(index))); plot(tesconds,coords); xlabel('t("[s]'); ylabel('s[ms']); hold off Mx = graph2d.constantline('locas','Color',[.0.9.0]); chamsedgendwar(Mx,'%'); bx = graph2d.constantline(closest_best, 'Color',[.5.0.0]); chamsedgendwar(Mx,'%'); bald off % Distance to closest best point off strong ('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); plot('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); bald off % Distance to closest best point % bistance to closest best point % bistance to closest best point for marker ',mm2str(index))); par(t_min, strong'); plot('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); par('main',strong'); plot('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); par('main',strong'); plot('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); par('main',strong'); plot('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); par('main',strong'); plot('s(t)', 'local minima', 'closest bestpoint for marker ',mm2str(index))); par('label('distance t_(mini)-t_(pt) (s)');

end

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<pre>cumction [closest_byt, dist_ta_byt] = find(closestBeapoint(t_win, beat_pts)</pre>
hin correspondent internal index
· bin collesp. beac interval intex
<pre>[~, bin] = histc(t_min, beat_pts);</pre>
<pre>% Compare distances abs_left = abs(t_min-heat_pts(bin)); abs_tingt = abs(t_min-heat_pts(bin+1)); left_closer = find(abs_left<-abs_tingt); right_closer = find(abs_left<-abs_tingt); closest_bpt(left_closer) = beat_pts(bin(tight_closer)); closest_bpt(right_closer) = beat_pts(bin(tight_closer)+1);</pre>
% Minimum before first beat: first beat is clostest
% Minimum after last beat: last beat is closest
closest_bpt(bin==1) = beat_pts(2);
closest bpt(bin==length(beat pts)-1) = beat pts(end-1);
<pre>const_program=rengations_prof x = boos_profement;; % Store distance dist_to_bpt = t_min - closest_bpt; end</pre>

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C.3 Graphs

All Graphs were derived from MATLAB data processing. Participant 1 has missing data in the second (Iúna) and third (Regional) stimulus, due to technical problems. The graphs are sorted for each subject by left and right heel. For each participant, all trials are displayed top to bottom: Stimulus 1, 2, 3 (Angola, Iúna, Regional).

Local minima

Graphs representing the movement of the heel markers (left and right) in the z-axis (up and down) with pivot points detected as local minima (green circles).



Figure C.1: Local minima: Subject 1



Figure C.2: Local minima: Subject 2



Figure C.3: Local minima: Subject 3



Figure C.4: Local minima: Subject 4

Minima-Beat allocation

Graphs representing the timepoints for each of the pivot points of the heel, together with their closest beat.



Figure C.5: Minima-Beat allocation: Subject 1



Figure C.6: Minima-Beat allocation: Subject 2



Figure C.7: Minima-Beat allocation: Subject 3



Figure C.8: Minima-Beat allocation: Subject 4

Time deviation of pivot points from beat

Histograms representing the temporal deviation in seconds of each pivot point in relation to their closest beat. Value is negative for beats coming after, and positive for beats coming before the timepoint of the heel minima.



Figure C.9: Time deviation of pivot points from beat: Subject 1



Figure C.10: Time deviation of pivot points from beat: Subject 2



Figure C.11: Time deviation of pivot points from beat: Subject 3



Figure C.12: Time deviation of pivot points from beat: Subject 4

Appendix D Curriculum Vitae

CURRICULUM VITAE

Degrees and education

10/2014 – ongoing	Vienna University of Technology Bachelor Media Informatics and Visual Computing (Computer Science)
04/2012 - 2015	University of Vienna Master Musicology
	 Focus: Ethnomusicology, Ethnochoreology Masterarbeit: "Movement and Music. It is not a dance, but Capoeira", Supervisor: Univ Prof. Mag. Dr. Regine Allgayer-Kaufmann
10/2009 - 04/2012	University of Vienna Bachelor Musicology
	 Bachelor of Arts: passed with distinction (5 Semester) Bachelor thesis 1: "<i>Caido no Santo</i>. Der Fall in den Heiligen. Geistbessesenheit und Musiktherapie im <i>Candomblé</i> von Brasilien", Note: 1,0 Bachelor thesis 2: "<i>Hira sy Tsinjaky vaovao: Kilalaky</i>. Zur Konstitution einer neuen madagassischen Tanz- und Popularmusikform.", Note: 1,0 Elective curriculum: Medienästhetik im Alltagseinsatz (Media studies)
10/2010 - 05/2011	University of Vienna Bachelor Transcultural Communciation Languages:Italian, English, German

Professional Experience		
03/2014 - 08/2014	University of Vienna Studienassistent	
01/2014	University of Vienna Contract for work (Administration)	
12/2013 - 02/2014	University of Vienna Contract for work (Administration	
10/2013 - 02/2014	University of Vienna Tutor (Introduction to Ethnomusicology)	
03/2013 - 07/2013	University of Vienna Tutor (Transcription)	
10/2012 - 10/2013	University of Vienna Studienassistent	
10/2012 - 02/2013	University of Vienna Tutor (Transcription)	
11/2011 - 12/2011	University of Vienna Contract for work (Database of musical instruments)	

Field work and (scientific) activities

07/2014	Symposium: Ethnochoreology, Croatia: Paper (Is capoeira a dance?)
08/2013 - 09/2013	Fieldwork: Recife, Brasilien
03/2013 - 04/2013	Fieldwork: Music and dance in Malawi
10/2011 - 09/2013	ÖH Universität Wien, Student representation (Musicology)
10/2011 - 09/2013	ÖH Universität Wien, Student representation (Faculty for humanities)
07/2011 - 09/2011	Fieldwork: Music and dance in Madagascar
02/2011 - 03/2011	Fieldwork: Carnival costums in the region of "Auseer Land", Austria

Miscellaneous

Languages	German: native English: fluent Italienisch: good Portugiesisch: basics Latein: Latin proficiency certificate
IT	Good knowledge in MS Excel, MS Word, MS PowerPoint , i3v. Basic knowledge in Logic, WaveLab, FinalCut, Adobe Photoshop, Adobe Premiere, Adobe Soundbooth, typo3, Java, MATLAB.
Memberships	ICTM – Internation Council for Traditional Music (http://www.ictmusic.org/) EMuK – Ethnomusikologischer Kulturverein (http://www.emuk.at/)

Appendix E

Abstracts

Abstract

The cultural phenomenon of capoeira is an art that blurs the borders of such genres as dance, fight, and musical performance. By its practitioners described as a dance-fight or fight-dance, the art incorporates various modes of embodiment of temporal structures. Although the dialogue between two bodies seems to be based on the action/reaction flow of martial arts, the dance-like attitude of the movements is prevalent, not least since movement in capoeira is always supposed to be accompanied by music. The interaction of music and movement is considerably noticeable in the form of a basic step: the *ginga*. It is the swaying movement where the practitioners get in concordance with the music after rapid sequences of kicks and evasive maneuvers. How the synchronization of these movements to the external sound stimulus take effect, however, is quite uncertain. Learning capoeira does not comprise instructions of how to move music in a certain manner, but leaves you open for adapting it from other people around you.

The phenomenon of synchronization, or a consequent style of locking onto a beat, starts to be investigated nowadays with new technologies, allowing to analyze motion even in the range of a millimeter. For this study, a Motion Capture system is used, recording *capoeiristas* (capoeira practitioners) doing the *ginga*. By capturing retro-reflective markers applied directly onto the body of the participants, the trajectories for the main body parts are reconstructed in such that any movement quality, for example, distance, acceleration, angles or else can be analyzed in relation to a beat that was previously extracted from three different musical stimuli.

The findings of these study provide a theory about the intricate way of the embodiment of a beat in capoeira suggesting the idea of polymetrical overlapping of both, the tempo of the music, and the individual movement speed of the *capoeirista*. The work strives to explore the possibilities of new technologies for the analysis of human motion and dance. It shows that even with a small amount of technical knowledge, a notable number of different approaches allow the indepth study of music and movement relationship.

Zusammenfassung

Das Phänomen Capoeira ist eine Kunst, die die Grenzen zwischen solchen Genres wie Tanz, Kampf und musikalischer Performanz verschwimmen lässt. Von den Ausübenden oft als Tanzkampf oder Kampftanz bezeichnet, beinhaltet die Kunst eine Vielzahl verschiedener Arten zeitliche Strukturen zu verkörpern. Obwohl der Dialog zwischen zwei Körpern vordergründig auf dem ständigen Wechsel von actio und reactio der klassischen Kampfkünste basiert, ist die tänzerische Komponente doch vorherrschend; dies nicht zuletzt, da Bewegung in Capoeira immer von Musik begleitet sein sollte. Das Zusammenspiel von Musik und Bewegung ist besonders in einer Art von Grundschritt zu erkennen: der *qinqa*. Es ist die wiegende und schwankende Bewegungsstruktur in der sich die Ausübenden nach schnellen Folgen von Schlägen und Ausweichmanövern wieder in Ubereinstimmung mit der Musik finden. Wie die Synchronisierung dieser Bewegungen zu einem externen Klangstimulus ablaufen, ist jedoch nocht nicht vollständig geklärt. Capoeira zu lernen beinhalten nämlich nicht konkrete Anweisungen dazu, sich auf bestimmte Art und Weise zur Musik zu bewegen, sondern überlasst es den Personen selbst, sich diesbezüglich deren Umwelt anzupassen und es von anderen zu übernehmen.

Synchronisation, oder das folgerichtige Einstellen auf einen gegeben beat, wird heutzutage mehr und mehr untersucht; durch neue Technologien ist es zudem nun möglich Bewegung bis in den Millimeterbereich zu analysieren. Diese Studie bedient sich eines Motion Capture-Systems mit dem *capoeiristas* (die Ausübenden von Capoeira) bei der *ginga* aufgenommen werden. Es erfasst retroreflektive Marker die direkt am Körper der Teilnehmenden angebracht sind und damit die Bahnkurven einzelner Körperteile repräsentieren. Dies ermöglicht die Analyse einzelner Aspekte der Bewegung, wie etwa Geschwindigkeit, Entfernungen, Winkel und dergleichen, was im Bezug zu einem Beat analysiert werden kann, der im Vorhinein aus drei verschiedenen musikalischen Stimuli entnommen wurde.

Durch die Erkenntnisse dieser Arbeit kann eine Theorie bezüglich der Verkörperung eines beats in capoeira aufgestellt werden, die die Idee von polymetrischer Überschneidung der verschiedenen Tempi von Musik und Bewegung der *capoeiristas* miteinbezieht. Es werden die Möglichkeiten untersucht die neue Technologien im Bezug auf die Analyse von menschlicher Bewegung und Tanz leisten können. Man kann sehen, dass man selbst mit wenig technischem Wissen eine Vielzahl von Methoden zur Verfügung stehen hat, die zum fundierten Studium der Beziehung von Musik und Bewegung beitragen können.