

## Part V - Workshop

# Learning tonal harmony through bodily interactions and gamification

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## **Abstract**

In this document, we describe a new approach to learning and practicing tonal harmony, a topic that is often overlooked in music education curricula due to the abstraction and complexity of the musical concepts involved. Building on harmonic perception, embodied cognition and gamification, we propose a practice on two fronts: one in the physical space, with perceptual and full-body activities, and the other on a customized web interface, which acts as a benchmark and assessment tool. Preparation games are proposed for each of the 3 experiences implemented on the web platform and further improvements for its development are outlined.

## **Keywords**

Tonal harmony, chord perception, embodied cognition, gamification.

## Introduction

Harmony is a fundamental domain for understanding the inner structure of tonal music. The hierarchical relationships of the dominant and subdominant chords with respect to the tonic govern harmonic progressions and rule pitch organization and the progress of tonal melodies (Butler & Brown, 1994, p.194). This makes it possible to construct a two-way relationship between melody and harmony, in the sense that both are mutually dependent. Harmony provides a set of pitches (the notes of the chord) upon which the melody rests, while melody alone elicits its accompaniment, even when not all notes of a chord appear or when other passing notes are present.

Despite its importance for music cognition, tonal harmony is an overlooked subject in music education curricula, mainly for primary school children.

Moreover, the methods for teaching harmony in professional training elicit great criticism because of the frequent contradictions between theory and practice, for their indifference towards the various musical styles, and for their abstraction from perception (Eberlein, 1997). Software tools such as Harmonia<sup>1</sup> and Harmony<sup>2</sup> address university and conservatory students and show melody harmonization strategies and errors through interactive scores. Mapping Tonal Harmony<sup>3</sup> also employs a visualization system, which interactively tracks the harmonic movements based on the tonic, dominant and subdominant area of the composition.

Although these are important tools for helping students at a professional level, they completely ignore the musical qualities of tonal music chords (e.g. the differences of the chord functions such as tonic, dominant and subdominant). This excess of technicality and abstraction in the approach to tonal harmony is perhaps the reason why studies on harmony are not very popular and teachers are so reluctant to deal with harmony in primary school classes. Yet it has been proven that children have a strong harmonic sensitivity and, since early age, they are able to recognize tonal functions and chord qualities (Schellenberg et al., 2005).

## A new approach for teaching tonal harmony

The aim of our workshop is to propose a playful approach to tonal harmony based on harmony perception, embodied cognition, gamification techniques and gestural interaction. The musical games address western tonal harmony features such as harmonic changes, different chord functions and melody harmonization.

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1 <https://harmonia.illiacsoftware.com/frontpage>

2 <http://www.harmony.org.uk>

3 <http://mdecks.com/mapharmony.phtml>

The proposed games can be played in two ways: one in the physical space through perceptual activities and full-body movements, and the other employing a customized web platform, which can be freely used in the classroom from any device (computer, tablet, etc.) with a browser and a network connection. The full-body activities aim at connecting the musical perception to body movements and, therefore, to activate the proprioceptive and synesthetic qualities of bodily interaction. In this way, children can build an embodied cognition of musical features, which can be transferred to the experiences on the computer screen.

### Representation of the harmonic space

The German music theorist Hugo Riemann in 1896 defined his ideas about harmonic functions, subdividing the tonal space in primary chords – namely tonic (T), dominant (D) and subdominant (SD) – and parallel chords – namely parallel tonic (Tp), parallel dominant (Dp) and parallel subdominant (SDp) (Riemann, 1896). As in a major tonality the primary chords are all major triads and the parallel chords are all minor, we decided to organize the harmonic space in a circle: primary chords are in the lower part, with the tonic in the middle, the dominant at the right and the subdominant at the left (see Figure 1); parallel chords are above the corresponding primary chords in the upper part of the circle.

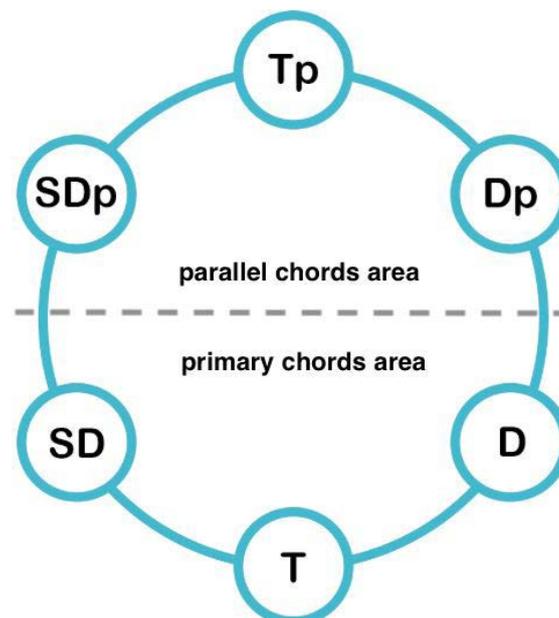


Figure 1. Organization of the harmonic space with the primary chords (major triads) in the lower part of the circle and the parallel chords (minor triads) in the upper part.

This spatial organization fits two important needs:

1. it ensures that every chord position can be reached without touching the others, if used in a physical space;
2. it subdivides the location of the major and minor chords of a major tonality harmonic space in two opposite areas, thus facilitating the perception of chord functions and musical qualities.

We employ this schema as a motion grid for musical games based on tonal harmony, imagining the chord positions projected on the floor and letting users move over them.

### **Description of the web interface**

Our web interface is developed as a wizard containing self-explanatory descriptions. The prototype focuses on three types of experience, conceived as a step-by-step process toward harmony awareness<sup>4</sup>. The topics of the experiences are:

1. Recognition of the implicit harmony;
2. Timed recognition of harmonic changes;
3. Melody harmonization.

Each activity is preceded by a trial session where a short explanation of the goals and some instructions are provided. Then three tests follow, employing different musical materials. Data of user's behavior are automatically logged by the system in a database for subsequent analysis.

#### Experience 1: Recognition of the implicit harmony

Implicit harmony is the chord that better fits a melodic excerpt (Bigand, 1993). In this activity, we ask the user to listen to a short melodic excerpt based on a single underlying chord. By selecting the various circles, the user can listen to the chords of the harmonic space and choose the one that better fits the melody. The chords are presented in the same sequence as in Figure 1, but the names of the harmonic functions are hidden and the tonic chord is randomly assigned to one of the six positions, thus introducing an arbitrary rotation of the original layout.

#### Experience 2: Timed recognition of harmonic changes

In this experience users must reconstruct a melody proving to have understood its harmonic structure, in particular recognizing the points where the implicit harmony changes. When this happens the melody moves towards a new chord leading to a melodic segmentation based on the points where the harmonic change occurs. This process is depicted in Figure 2 where the eight-bar melody of a very popular nursery rhyme is reproduced with its harmonization. The black triangles mark the harmonic changes. Beyond the initial tonic chord (lasting two bars) there are changes at bars 3, 4, 5, 6, 7, and 8.

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<sup>4</sup> The address of the web interface is <http://didacta18.lim.di.unimi.it/eng/>

1	2	3	4	5	6	7	8	
								<b>melody</b>  <b>harmonization</b>
								<b>harmonic changes</b> <b>chord positions</b>

Figure 2. Harmonization of a popular nursery rhyme with the expected harmonic changes and the chord positions in the harmonic space.

We represent the harmonic changes described above as stages of an adventurous journey (Figure 3).

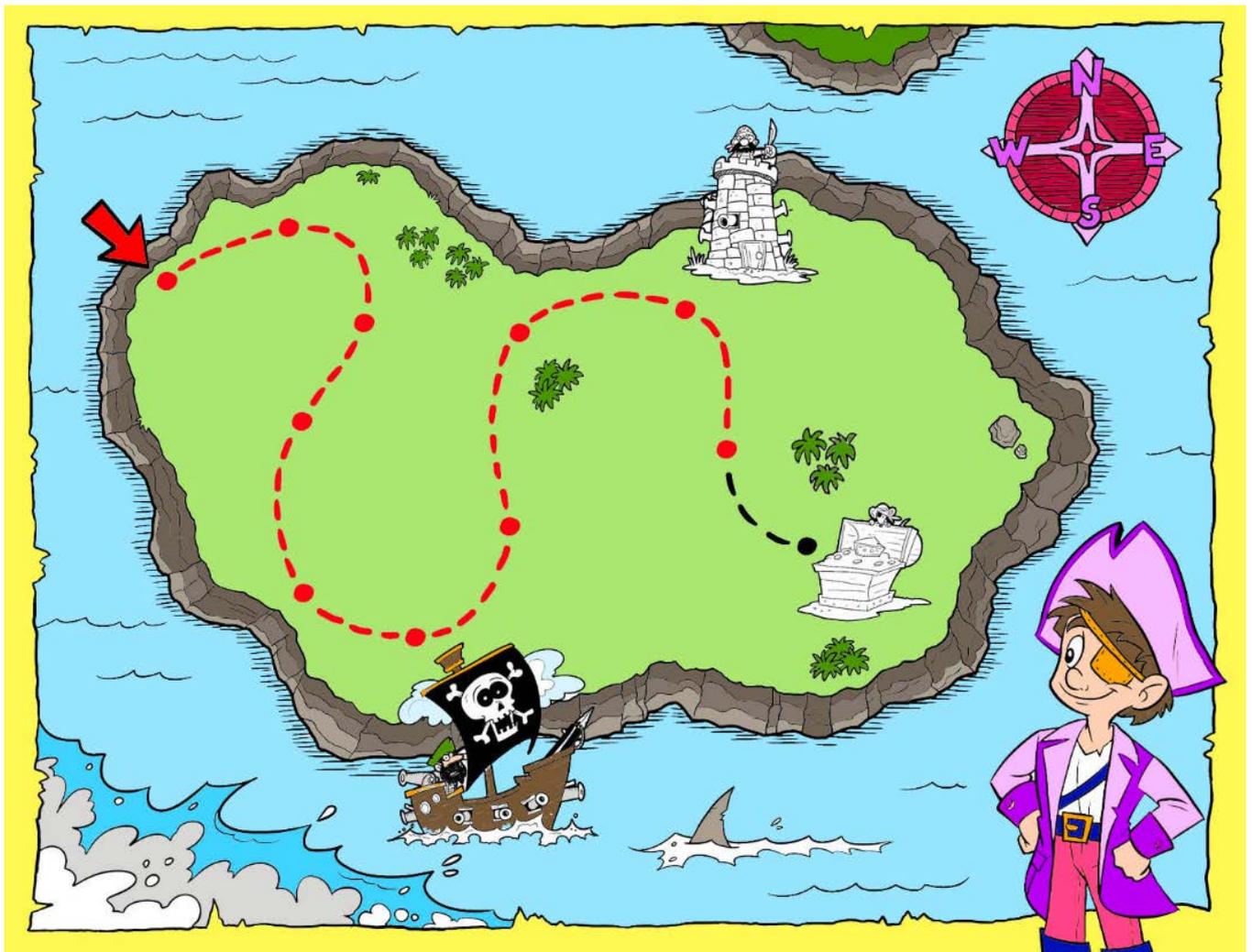


Figure 3. Representation of harmonic changes as subsequent stages of a journey (red points).

We cut the song audio file in correspondence of the harmonic changes and linked the resulting song excerpts to each subsequent stage. The user's task is to rebuild the whole song by clicking the corresponding points exactly when the harmonic change is expected, without leaving rests or overlapping the excerpts.

### Experience 3: Melody harmonization

After understanding and experiencing the concept of harmonic change, users are invited to discover what chords are involved in the melody harmonization. To do so, they can explore the harmonic space in the web interface of experience 3 where they can find two modes of use: the exploration mode (default), and the harmonization mode. In the exploration mode, they are free to listen to the melody and play each of the six chords of the harmonic space separately and without time constraints. When ready, they can switch to the harmonization mode where they have to follow the melody proceeding and select the right chord as soon as a harmonic change occurs. The whole process is depicted in the last row of Figure 2, where all chord positions are reported.

### **Linking the physical with the virtual**

Building on previous research about the use of a large-scale responsive environment for practicing melody harmonization [3], we leverage on physical activities to reinforce the learning of concepts to be transferred in the web interface. This can happen through the construction of a mental map of the harmonic space, which can be used to move in the physical space as well as on the virtual interface.

The possibility of connecting virtual and physical spaces through cognitive maps has been studied for helping blind people to navigate unknown space using spatial audio or haptic feedback in virtual environments (Lahav & Mioduser, 2008 and Sánchez, Sáenz, & Garrido, 2010). Here we employ a reverse process, as we transfer the training from the physical to the virtual space through a series of preparatory activities. Some of them are listening games that can be performed with the use of a musical keyboard, others are movement games that imply full-body interaction and embodied knowledge. In this context, the web interface acts as a benchmark of these perceptual and physical activities. This approach may refer on one hand to the concept of blended learning, which combines traditional classroom lessons with online activities (Graham, 2006); on the other hand it may also refer to the concept of algomotricity (Begel et al. 2004), which exploits kinesthetic learning experiences to grasp abstract concepts to be assessed with the use of the computer.

### **Preparation to experience n. 1: Harmony perception**

The chord functions of the harmonic space have perceptual qualities that children can be trained to recognize. The most popular is the tension of the dominant-tonic progression, but other progressions may be presented and perceptually described by children. Teachers who are particularly inclined to creative activities can organize games and quizzes about the perceptual character of the various harmonies and chord progressions. These activities aim at driving children's attention on what "harmony" means from a perceptual point of view.

#### Games

1. The teacher asks children to describe how they perceive some musical cadences (e.g., the perfect, the plagal, or the deceptive cadence) through adjectives (e.g., strong, melancholic, weak, etc.).
2. Children sing a melody and the teacher accompanies them with mismatching chords (e.g., concluding on subdominant instead on tonic). Children are asked to guess where the mismatching chord is and discuss the solution.
3. The teacher stops the accompaniment on a point where harmony changes and proposes two or more solutions for the changing chord. Children are asked to guess the right chord in order to continue the song.  
Children are now ready to start experience 1 on the web interface.

### **Preparation to experience n. 2: Perception of the harmonic changes**

The perception of the points where harmonic changes occur is very important for melody harmonization.

#### Games

1. Children sing a song and the teacher never changes the tonic chord at the keyboard. Find where the song needs a change in the accompaniment.
2. Children can mark the newfound points of harmonic changes with a gesture (clapping hands or stomping feet) or outlining the song syllables where the harmonic changes occur (syllables of change).
3. A two-groups game: group 1 knows the syllables of change of the song, while group 2 does not. Group 1 sings the song excerpt till the point of the harmonic change. Group 2 claps hands or stomps feet to make group 1 proceed to the next harmonic change.

Notice: the harmonic changes are not the same as the rhythmic pulse of the song. Sometimes they may overlap, some other times not (see the first two bars of the song in Figure 2: they have the same harmony, thus there is no harmonic change between bar 1 and 2).

Now children can transfer the embodied knowledge acquired through game n. 3 to the web interface.

### Preparation to experience n. 3: Melody harmonization

Melody harmonization is realized by playing the right chord at the right point of the melody. In the previous activity, children found the points of the melody where harmony needs to change. Now they have to discover what chord sequence better fits the melody, linking up their chord perception with the timed harmonic changes. Exploration of the harmonic space is very important to reinforce their feelings about the various chord progressions. Children who have already made the perceptual exercise about the main harmonic progressions in preparation to experience n. 1 can now search in the virtual harmonic space for the chords of the progressions previously defined and discussed.

#### Games

1. The web interface with the circle representing the harmonic space is made visible to the whole class (with a wall projection or a large screen). The teacher (or a child) performs basic harmonic progressions, such as those depicted in Figures 4a and 4b. The class, imagining the same harmonic space reported on the floor, moves accordingly.

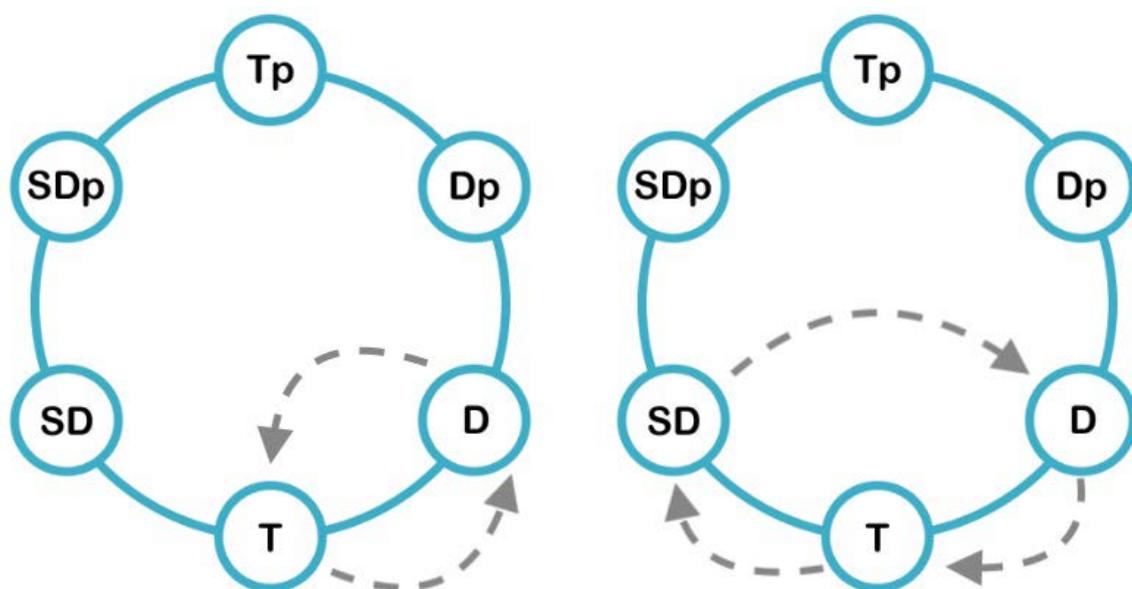


Figure 4a. Movements that realize the progression tonic-dominant-tonic.

Figure 4b. Movements that realize the progression tonic-subdominant-dominant-tonic.

In the case of the harmonic progression in Figure 4a, children, assuming their initial standing point as the tonic position, move a step to their front-right direction and a step back to the tonic. In the case of Figure 4b, children move a step to their front-left, then front-right, then back again to their starting position.

2. The teacher (or a child) improvises melodies on the progressions practiced in the first game. Another child (or the teacher) performs the progressions on the web interface while the rest of the class moves accordingly. The role of the melody improviser may be assigned in turn to all the other children.
3. The teacher proposes to sing a song to the class. A child finds the chord sequence that better fits the melody on the web interface. All the class sings the song and moves accordingly.

Once the motion patterns for accompanying the melodies have been practiced with a number of songs, involving additional chords and longer sequences, children are ready to access experience n. 3 of the web interface and to harmonize the proposed melodies.

## **Conclusion and further work**

In this workshop we presented a new approach to the study and practice of tonal harmony combining perceptual and full-body activities with the use of a web interface. The activities focus on abstract concepts of tonal music, such as implicit harmony, harmonic rhythm and melody harmonization, subjects usually considered too difficult for children.

Thanks to an intuitive representation of the harmonic space and to the practice of perceptual and full-body activities, we propose a set of games which lead children to the use of the web interface, intended here as a benchmark of the new acquired harmonic abilities.

An assessment of the validity of this approach needs to be conducted in different educational contexts and across various musical cultures. The implementation of the musical database and the possibility of providing teachers with tools to customize their teaching activities at the best are among the next objectives for the development of our platform.

Finally, the development of a system for the automatic assessment of children performances would be both a valid didactic tool and a further element to implement gamification.

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