

Using musical themes in mobile phone messages

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This thesis describes the concept and design of using the meanings of composed music works to convey information about sender IDs, contents and emotions in mobile phone short messages. I examine the use of selected musical samples to communicate the personalities of senders, categories of contents and emotional contents of messages. A set of experiments is reported which indicate that music conveys this information properly if the music themes are well selected and designed. Cultural differences affect how users interpret the same music work. The improvements and related important elements of using music in musical short message system interface design are also discussed.

Key words and terms: Music, Mobile Phone Short Message System (SMS), Interface Design, Music Interpretation, Evaluation.

Contents

1.	Introduction	1
2.	Using music to represent short messages	2
	2.1.Supporting contextual awareness of messages.....	3
	2.2.Keeping the privacy of the user.....	4
	2.3.Music is a language to convey meanings and emotions.....	4
	2.4.Music is natural interaction for users	5
	2.5.Using music to call user’s attention	6
	2.6.Using music is design for users’ desire	7
3.	Music, human perception and meanings	8
	3.1.How does music convey meanings and emotions	8
	3.1.1. Melody	9
	3.1.2. Harmony.....	10
	3.1.3. Rhythm.....	12
	3.1.4. Sound and colour.....	13
	3.2.Music and human perception	14
	3.2.1. Associations between music and human emotions and perceptions ..	14
	3.2.2. Previous studies in human perception and music	16
	3.3.The factors affecting human perception of music	17
	3.3.1. Quality of music (timbre).....	17
	3.3.2. Characteristics of listeners	18
	3.3.3. Cultural elements	18
	3.4.Designing music-tags for mobile short messages	19
4.	Music in user interface design.....	20
	4.1.Using music in user interface design.....	20
	4.1.1. Using music to provide graphical information for blind users	20
	4.1.2..Combining sounds and graphical menus to overcome usability problems	21
	4.1.3. Using musical grammars to design earcons	22
	4.1.4. An evaluation of earcons in auditory human-computer interfaces	23
	4.2.Using sounds or music to support awareness of messages	26
	4.2.1. Audio Aura – background awareness	26
	4.2.2. Using earcons to support awareness and opportunistic interactions..	29
	4.2.3. Using non-speech sound to summarize the important properties of messages	30
	4.2.4. Using auditory cues to provide peripheral awareness of messages ...	31
	4.3.Summary.....	32
5.	Design principles for musical short messages – Musical Theme.....	33

5.1.	Diagram of system work flow	33
5.2.	The quality of sound	35
5.3.	How to use music to present sender IDs	35
5.4.	Message categorization	36
5.4.1.	Message categorization for content.....	36
5.4.2.	Special cases for content	38
5.4.3.	Categorization of emotional contents.....	38
5.4.4.	Unknown messages	40
5.5.	Music selections for different contents and emotional contents	40
5.5.1.	Music selections for contents	40
5.5.2.	Music selections for emotional contents	42
5.6.	Privacy issue and customization.....	42
6.	Pre-evaluation of the design of the Musical Theme	43
6.1.	Research procedure	43
6.2.	Research design and methods.....	43
6.3.	The design of questionnaire	43
6.4.	The design of music-matching tasks	44
6.4.1.	The first music-matching task.....	45
6.4.2.	The second music-matching task	45
6.4.3.	The third music-matching task.....	46
6.5.	Subjects	46
6.6.	Testing environment and time	47
7.	Analyzing test results	48
7.1.	The results of short message system usage	48
7.2.	Analyzing the results of music-matching tasks	49
7.2.1.	The total results of music-matching tasks of all participants.....	49
7.2.2.	Comparison of cultural differences in music interpretation.....	52
7.2.3.	The results of post-interview for Musical Theme system.....	55
7.3.	Summary.....	56
8.	Conclusion.....	57
	References	59

Appendices

1. Introduction

Mobile phone short message is a very useful and widely used function. Short messages currently use only text or some simple graphics to present information to the user. The “beep” sound is used to tell the user that they have received a message. However, this sound does not give the user any information for example on the sender or the contents of the message. Moreover, the beep sound can be very easily ignored by the user, because it is used in almost all mobile phone products. It is hard for users to distinguish their own sound from everyone else’s, and as a consequence, some important messages might not be read in time.

Aaron Marcus [2001] has pointed out what desirable advanced user interface design is for mobile phones: it should support context awareness and recognize user’s emotions or convey emotions to the user. It also needs to be deeply personalized. Based on these above-mentioned observations and studies, I got an idea of using music to represent the contents of mobile phone short messages. User can become aware of important information about the message before reading it: For example, who sent the message; the content or emotional content of the message; and the urgency of the message. Furthermore, users are able to customize music in the messages according to their preference.

Music is a language that conveys different meanings through different works: The melody, tempo, lyrical contents, and rhythm all can evoke different emotional responses that are concomitant with the emotional content of the music. Research has shown that different music can affect people’s interpretation of an ambiguous piece of art [Johnson, 2001]: people evaluated a picture more negatively while listening to depressing music than those people who listened to upbeat music [Johnson, 2001]. This research illustrates that music is a powerful means of expressing meanings and convey emotional information.

Music has been used in user interface design as earcons designing in Hankinson and Edward’s report [1999]. In their report, they presented the idea of using a musical grammar to design earcons by using minor seventh chord in the earcons. Users can choose different types of objects and actions to do the task, and the system will provide the sound feedback (earcons) for users to see if they selected correct objects with correct actions. A correct combination would sound harmonious (in their theory, the minor seventh chord sounds harmonious) whilst a wrong combination of objects and actions would sound discordant. In this case, other discordant chords will be played.

In the AUDIOGRAPH system [Alty and Rigas, 1998], music was used to guide blind users to discover all information about the interface and control the commands. For example, they used the up sequential notes to represent the EXPAND command, and CONTRACT was represented by the inverse of this pattern.

Moreover, music is also used with graphical feedback to present information to the user. Brewster and Crease [1997] added musical feedback to a menu system, which helps users to become aware of action slip and accidental mouse movement problems.

Some researchers have focused on using music or sounds to support awareness of messages. Isaacs et al. [2002] have designed mobile Instant Messenger called Hubbub that uses musical sounds to present each user's sound ID and sound messages. In Nomadic Radio [Sawhney and Schmant, 2000] different sounds of water indicate the status of the system, for example, the sound of flowing water indicates that the system is active. In addition, in the "email glance design" [Hudon and Smith, 1996], a stream of short sounds is used to indicate important properties of a message, such as message sender, category and content flag.

This thesis explores how to use composed music to represent different message contents to the user in mobile phone devices. The following questions are looked at in my research:

1. What kind of messages can be represented by music? The contents of mobile phone short messages are various, thus it is very important to decide what message contents can be represented by music, and which not. Also for those messages which cannot use music to represent content, can I use music to describe other features of them, such as the emotional content of message or sender's identification?
2. How to categorize messages? The categorization of messages is essential for the system to determine what kind of music should be played.
3. Which music can be used to indicate important information in messages? Can a user with average musical knowledge interpret the meanings and emotions of certain music in a certain way?
4. How do cultural elements affect the interpretation of music?

In Chapter 2, I explain the reasons for using music to represent mobile short messages. In Chapter 3, I discuss some studies that have shown that music could convey meanings and emotions. Next, some previous works of using music and sounds in user interface design will be described in Chapter 4. In Chapter 5, I introduce my design principles of this musical short message system. In Chapter 6, the design of my pre-evaluation test for the system is portrayed. Furthermore, I analyse the result of the evaluation in Chapter 7. Finally, conclusion will be made in Chapter 8.

2. Using music to represent short messages

The chapter discusses the reasons for using composed music to indicate important properties of mobile short messages (SMS). The most important reason for using music is to support content awareness of messages. Meanwhile, music can represent

messages that provide differentiation of notification cues, and it also keeps the privacy of the user. For example, the user can choose his or her favorite music to indicate specific contents of messages, but other people cannot interpret the meaning of this music. Therefore, this is a design of the personality.

Another reason for using composed music to represent messages is that music is a language to convey meanings and emotions, thus using music to indicate emotion and meanings is natural interaction for users. Moreover, music is effective at calling user's attention.

2.1. Supporting contextual awareness of messages

Communication is critical for people in society, especially in the work environment. People use a variety of devices such as desktop computer and mobile phone to access information and make timely communication. In the workplace, people have to always be away from their desk to do other activities such as attend meetings and talk with other people, so they wish to be aware of important or urgent events [Sawhney and Schmandt, 2000].

In the workplace, people are usually engaged in some tasks that require their primary attention. Therefore they wish to be aware of important events and be notified of urgent communication, but these should not require them to shift their focus of attention or interrupt their work. [Sawhney and Schmandt, 2000]

Consequently, a music approach to interaction on a mobile device is a powerful mechanism for providing contextual awareness, which can be an alternative to visual text displays or as a secondary modality to enhance its usability.

Text-based messaging on mobile phones is very popular in Asia, Europe and America especially among young people [Isaacs et al., 2002]. It is easy to use and effective in delivering information. However, SMS does not support any contextual awareness of users. There is a 'beep' sound used for the notification of receiving a text message, but this sound cannot provide any information about its urgency or dynamic state [Sawhney and Schmandt, 2000]. Therefore, when the message is received, the receiver has no idea about the message sender, or the content of the message without reading it. As a consequence, users may be agonising about not being able to read the message immediately but they want to know who sent the message and what the content is. Or users may be agonising over wasting time in reading many irrelevant messages when they are busy.

Using music to present information of a text message allows users to acquire information in a hands- and eyes-free manner. It may not require one's full attention to distinguish the music. This allows users to easily 'read' SMS intermixed with other activities [Hudson and Smith, 1996]. Thus users can become aware of the message sender and get a rough idea about the content or emotional content of the message even

when they cannot read it at that moment, for example when they are moving from one place to another or doing other things which require their attention.

Moreover, using music provides awareness of the message sender or content of the message that enables users to make timely decisions about next actions depending on their current situation. Therefore, based on the information indicated by the music, the user could decide to ignore the message at this moment or read it immediately without having to shift focus of attention from the current task to interact with the device to access the information [Sawhney and Schmandt, 2000].

2.2. Keeping the privacy of the user

Mobile phone device is always used in a social environment, such as workplace, bus or railway station, shopping centre or in a street. Users do not feel comfortable hearing personal information aloud while being near colleagues or strangers. Presenting message information by music will offer more privacy to users, since music cannot be immediately interpreted by other people [Isaacs et al., 2002].

Meanwhile, users can customize the music to portray specific or special properties of the message, such as a specific message sender and some predictable contents of messages. Therefore, only the user can interpret the meaning of certain music.

2.3. Music is a language to convey meanings and emotions

Music is a language that conveys different meanings through different works. Landry [2004] states that “Humanity is inherently musical.” Regardless of age, sex, race, religion, or nationality, music speaks to us all. Music is the ultimate expression of universal feelings and that great composers transform these emotions into art. Music consists of melody, tempo and rhythm, and some music works also have lyrical contents. All of these elements of music could evoke different emotional responses that are concomitant with the emotional content of the music. Researchers have also shown that even when music becomes background entertainment, it still could induce people’s emotions in a direct and often unconscious way [Landry, 2004].

Landry [2004] has also suggested three musical principles that provoke emotions: “modulation, suspensions, and syncopation”. When these three principles change in music, listeners feel an emotion, “a visceral response to an unexpected situation” [Landry, 2004]. Marvin Minsky [1981] has argued that hearing music is like viewing scenery, and “when we hear good music our minds react in very much the same way they do when we see things”. Moreover, some researchers have indicated that different types of music will affect people’s interpretation of an ambiguous piece of art work [Johnson, 2001]: people evaluated a picture gloomier while listening to depressing music than people listening to happy music did [Johnson, 2001]. These studies illustrate that people are in synesthesia with music and music can arouse, shape and control people’s emotions.

Nowadays, many kinds of media make music accessible everywhere in the world. People can listen to any music without temporal, cultural, national and spatial restrictions. Therefore, some classical music and some attractive popular music not only command attention and approval in their cultural times and places, but also arouse the same feelings among all people in the world through times. For example, regardless of listener's nationality, people may feel excited and invigorated while listening to Beethoven's "Ode to Joy". All children or infants should feel peaceful and touched when they listen to lullabies, even if they cannot understand the lyrical contents of the songs. Consequently, music can form a universal language that can be understood by every person around the world.

2.4. Music is natural interaction for users

Music as an output combined with text based display can significantly improve usability by sharing information across sensory modalities, and this multimodal interface allows a more natural communication between mobile phone devices and their users. [Brewster and Crease, 1997]

The use of auditory icons in user interfaces is becoming more popular since it provides several benefits to users. Using composed music to present information of a SMS may offer the following benefits to interaction:

- Using music to indicate information of messages that provide greater flexibility to users than text display, since users can hear it from any orientation without the need to concentrate on mobile phone devices. [Brewster et al., 1993]
- Music can be understood when vision is unavailable, such as for blind users, or when user is away from mobile phone device. [Buxton et al., 1985]
- Music may transfer meaningful units of information faster than speech. [Buxton et al., 1985]

Previous research shows that sound could convey meaningful information to users. Some researchers have described advantages and features of using sound as a significant means of output. They have also made suggestions about future research and applications by using sound in user interface design. Sara Bly [1985] has claimed that future work in using sound in the computer/human interface "should experiment with the aspects of sound which convey the most information in a computer/human environment." Douglass L. Mansur [1985] has also suggested that certain aspects of sound are worth exploring as a means of information transfer, and sound is perhaps the greatest means of communication and conveying information. Furthermore, Mansur [1985] has pointed out that "well-designed audio cues may be easier to learn than certain other forms of communication such as visual icons."

Consequently, considered with these suggestions and studies, I intend to use composed music works to indicate properties of SMS, which will be a natural

interaction between users and mobile devices, and it may be more effective for communicating information than other auditory cues, such as earcons under these circumstances.

The most significant reason for choosing composed music to present information instead of using earcons is that users need not be trained to recognize different timbres, rhythms and pitches or harmonics to acquire information. The famous pieces of music will be chosen to represent information of messages and each music work has a specific meaning and emotional content. Therefore, it is natural for users already familiar with these music pieces to interpret the meanings of these works.

Earcons could be good for presenting simple information of icons, menus and some simple actions, such as copy, save, delete, open and close [Brewster et al., 1993]. However, they are hard to use in presenting some complex information, since users must be trained to distinguish pitch, rhythm, timbre or harmonic to identify different information. Changes in these dimensions of sound will be much more complicated for the complex information, thus it should be a burden for users to learn these earcons. Brewster et al. [1993] have experimented that combined earcons are difficult for users to recognize.

Thus, using composed music to present information of messages reduces user's burden of learning how to distinguish different earcons, and music can also be used to present complex and emotional information.

2.5. Using music to call user's attention

Researchers [Isaacs et al., 2002] have explored that music is effective in calling one's attention to an event or a change in state by using sound to attract attention. The use of motifs – short themes of composed music works - should be more effective than other simple tones for capturing user's attention, since motifs are much more meaningful than other simple tones.

Treisman's shadowing study [Matlin, 2002] presented two messages to participants wearing headphones, and different messages were being played to each ear. The subjects were instructed to shadow the messages, which meant repeating the message being played to one ear, and ignoring what was being heard in another ear. Results showed that people could respond to messages, which are performed according to a criterion. The criterion could be either message content (semantic characteristic) or message source (physical characteristic). Figure 1 illustrates Treisman's shadowing study.

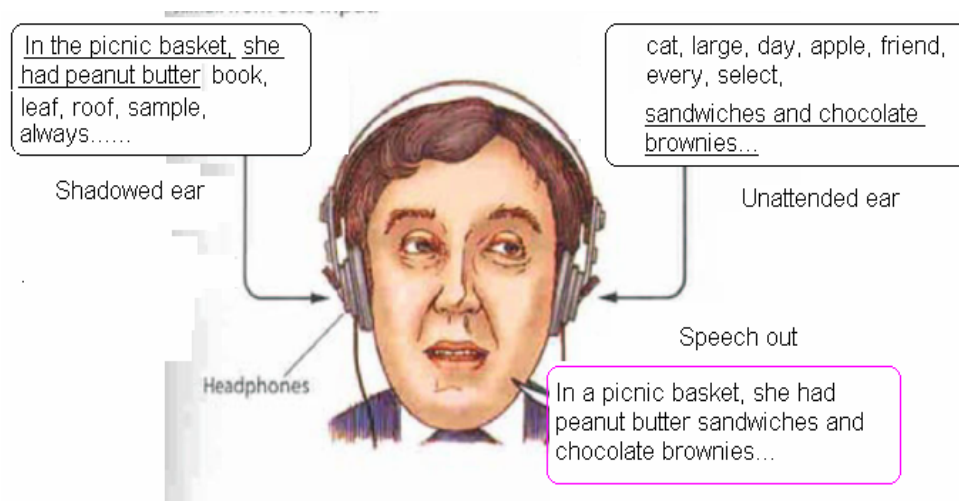


Figure 1. An illustration of Treisman's shadowing study [Matlin, 2002].

According to the theory of shadowing study, music can be effective at calling users' attention, since the melody of favourite music is meaningful and distinctive for users even in a noisy environment.

2.6. Using music is design for users' desire

Aaron Marcus [2001] has pointed out what desirable advanced user interface design is for mobile phones: it should support context awareness and recognize user's emotions or convey emotions to the user. It also needs to be deeply personalized. For example, users can customize their faceplates and ringing tones to distinguish their own device from everyone else's. Meanwhile, some emotional communication should be considered in vehicle UI design, such as arousal, fear/anger, love/bonding, pride, interest and boredom. [Marcus, 2001]

Based on this theory of mobile user interface design, the use of composed music to indicate important properties of SMS conforms to users' desire in the following aspects:

- The user can customize music of different contents or different senders depending on his or her preference, so it is designed for the personality.
- Music can represent contents and emotional contents of SMS to the user.
- The use of music to present information of SMS that provides context awareness to users as discussed in section 2.1.

3. Music, human perception and meanings

This chapter firstly explores how musical structure conveys meanings and emotions – the language of music. Then, the chapter illustrates associations between music and human emotions and perceptions. Next, it looks at some previous studies in music and human perception to explain the effect of music on people’s emotions and perceptions. Fourthly, it explains that a human being has innate perception and feeling of emotional expression in music. Finally, the chapter describes important factors of influencing human perception of music.

These theories of music will be the design guidelines for selecting appropriate music to represent contents or emotional contents of messages.

3.1. How does music convey meanings and emotions

Music has certain language or means to express meanings and emotions. Research has clearly indicated that music does convey meaning, because people “hear it as an intentional pattern rather than a random occurrence” [Whaley, 1998]. Marc Landry [2004] has stated that “the human brain endows musical sounds with meaning. These sounds become symbols representing more than pure sound, and are attributed with the potential to make people laugh or cry, to like or not like, to be moved or to remain indifferent.”

Musical language has the same elements of pitch stress, volume and speed that people use in spoken language to signal when they are happy, angry, excited or telling a beautiful story [Whaley, 1998]. Also, these elements can be translated into music and the translation of these elements is usually clear in music, and listeners will usually agree that a certain piece of music is happy, gloomy or tense [Whaley, 1998]. For example, there are many different tones of lullabies in different countries. Even though the lyrical contents and languages are different, all of the melodies of lullabies are tender, beautiful and warm. The rhythm of lullabies is slow and goes with the breath, and the harmonies in the lullabies are usually consonant. Thus, people feel peaceful, sweet and sleepy when they listen to every lullaby even if they cannot understand the lyrics.

Musical language has also phrases and sentences to express meanings. In some famous composers’ music, such as Mozart’s, one has a clear sense of hearing a statement and a response, or a question and an answer. We can hear that a motive is stated, developed, varied, contrasted and finally confirmed. [Whaley, 1998]

There are several dimensions allowing composers to express meanings and emotions, such as melody, rhythm, form, dynamics, harmony, sound and colour (orchestration). The following four fundamentals are most important for guiding the selection of proper music to represent messages, which are melody, harmony, sound and colour (orchestration) and rhythm.

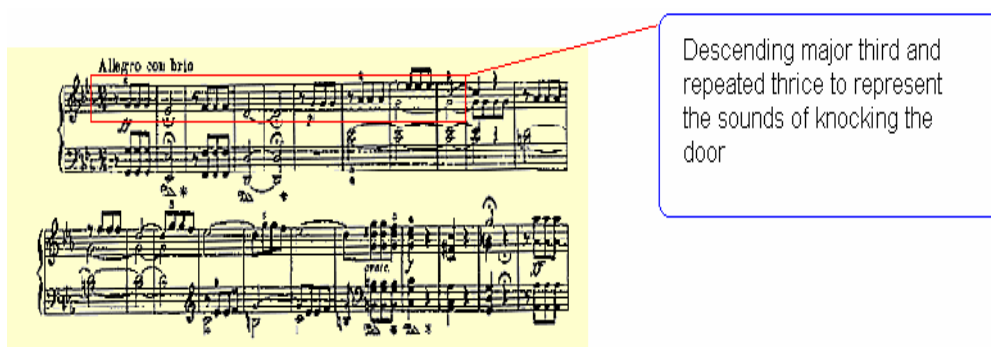
3.1.1. Melody

Melody is the most memorable aspect of music, and it is crucial in enabling listeners to enjoy the music and judge which music is good.

The melody is a means of expression. Composers can write melodies for different purposes. Firstly, in a song, opera or other vocal works where the music is composed for a text, composers write the melody to express the meaning of words. The melody should be concordant to reflect the meaning of the lyrical contents. Consequently, if the textual content is about happiness, the melody should be a major mode, since which could be better to represent glory and jollification. If the text is about melancholy, the melody should be composed in a minor mode, since which could be better to represent sadness and depression.

For example, the theme of Beethoven's famous "Ode to Joy" in his ninth Symphony was written for a poem by German poet Friedrich von Schiller. The text is a hymn about brotherly love and jubilation, and this joyful, hopeful and hymn-like character is fully represented and intensified by Beethoven's melody.

Secondly, different musical sequences can be used to express different emotional states [Landry, 2004]. For example, in the theme of the first movement of Beethoven's Fifth Symphony, the melody is used to represent the sounds of knocking the door by fate. This four-note motive has been represented by descending major third and first tone repeated three times [Minsky, 1981]. Listeners usually feel stressed and nervous when they listen to this theme. Figure 2 shows the theme of Beethoven's Fifth Symphony [Minsky, 1981].



Allegro con brio

Descending major third and repeated thrice to represent the sounds of knocking the door

Figure 2. The theme of Beethoven's Fifth Symphony [Minsky, 1981].

Thirdly, a certain type of melody can be used to imitate natural sounds or to depict natural scenery. A good example is Bedrich Smetana's most famous work "Vltava", which is second in his *Ma Vlast* (My Fatherland) set of symphonic poems written for his native Czechoslovakia. In this music work, the composer has used continuous

semiquavers and broken chords to vividly depict the river flowing through the forest (Figure 3.). Listeners can image that they are viewing the scenery when they listen to this music.

The image shows a page of a musical score for Smetana's "Vltava". The score includes staves for Oboe (Ob.), Bassoon (Fg.), Cor Anglais (Cor.), Trumpet (Tpt.), Violin I (Vl. I), Violin II (Vl. II), Viola (Vla.), Violoncello (Vc.), and Contrabass (Cb.). A red box highlights the string parts (Vl. I, Vla., Vc., Cb.) which feature continuous semiquaver patterns and broken chords. A blue box on the left contains the text: "These continuous semiquavers and broken chords are used to depict the scenery of river flowing." The score is marked with "dolce" and "pp dolce" dynamics. The page number "40" and the publisher "B. & H. 8898" are visible at the bottom right.

Figure 3. The example of using continuous semiquavers and broken chords in Smetana's "Vltava".

According to these above-mentioned theories, the following approaches can be used to compose melodies to convey different meanings and emotions:

- Using different keys to express different meanings and emotions. For example, a dominant tune means happiness and victory. The major key is better to represent cheerfulness, but the minor key is better to represent melancholy.
- Musical sequences in one way or another denote certain emotional states. The intervals of the diatonic scale represent different emotional qualities. For example, consonant melodic interval notes, such as the perfect fifth can express brightness. The dissonant interval notes, such as the diminished fifth represented terrible and tense objects. [Landry, 2004]
- Using different compositional techniques to represent or depict different things or scenery. For example, the glissandi of violins suggesting the howling of the wind during a storm [Landry, 2004].

3.1.2. Harmony

Harmony is the vertical aspect of music, which are the notes underneath the melody giving the melody context and colour. Melody and harmony work together, and the same melody can be played with different harmonies that bring unbelievably variable

results. Harmony is very expressive, and it creates an atmosphere and character for the melody to represent the specific meaning.

Harmony has rules to fit notes together, and the rules of harmony are very complex and they have changed during different periods of the history. Generally, in traditional classical musical theory, the rule of harmony is based on homophonic music. Therefore, every note, musical interval and chord is in the tonality system, and different chords of different number of scale step express different emotional meanings in the tonality system. For example, in a major mode, the chords of tonic, dominant, subdominant and super-dominant are considered steady, and listeners feel tranquility and calmness through these chords. In contrast, the chord of subtonic is considered very unstable, listeners feel tension and expect that chord will be resolved into the tonic soon. Figure 4 shows some examples of stable chords and unstable chords in C major mode (The sound sample of Figure 4 is in attached CD2).

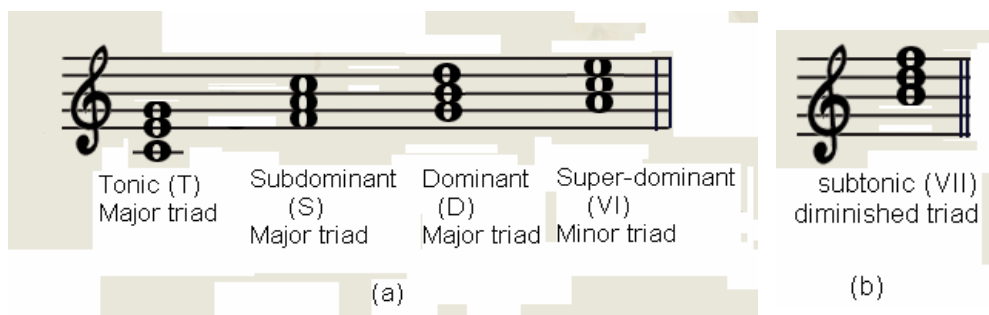


Figure 4. The examples of (a) stable chords and (b) unstable subtonic in C major mode.

Consonant chords and dissonant chords can convey different emotional meanings in music. Consonant chords include major triad and minor triad and their inversion. The major triad expresses brightness, and the minor triad expresses tenderness. Dissonant chords include diminished triad, augmented triad and seventh chord. Usually, the diminished chords, such as diminished triad and diminished seventh express sorrow and despair, but the augmented triad represents terrible and unpleasant feelings. Figure 5 gives examples of augmented triad and seventh chord (The sound sample of Figure 5 is in attached CD 2).

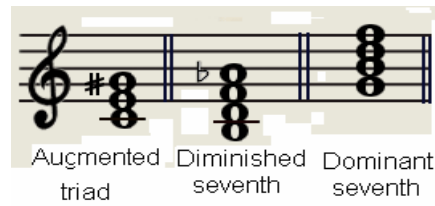


Figure 5. The examples of augmented triad, diminished seventh chord and dominant seventh chord.

Generally, composers apply harmony that is based on the following principle: the harmony always goes from the stable and consonant chords to the unstable and dissonant chords and then back to the stable and consonant chords again. Thus, listeners can feel dynamic inhesion of the music, they always expect the resolution of dissonant chords, and they will gain satisfaction from the resolution. If harmony is always consonant and stable, listeners will feel this music is boring and sleepy. However, if the harmony is always dissonant and unstable, listeners will feel uncomfortable and restless.

3.1.3. Rhythm

Rhythm is another fundamental element of music, and it is an inseparable part of melody and harmony. Rhythm is the way of organising notes through time. Cooper and Meyer [1960] have defined that rhythm is “the way in which one or more unaccented beats are grouped in relation to an accented one”. Different rhythm grouping has different weak and strong syllables, which can cause various emotional impressions of music works. Meanwhile, different rhythm can convey different meanings in music works. For example, the “Barcarole” always uses three-four time, three-eight time or six-eight time, because the rule of strong and weak beat is “stressed/unstressed/unstressed” for three-four time and three-eight time, and the rule of strong and weak beat is “stressed/unstressed/unstressed/hypo-stressed/unstressed/unstressed” for six-eight time. These rules of strong and weak beat are very impressive to represent and portray tossed boats moving back and forth on a river, and a peaceful, beautiful night. Moreover, the four-four time is always used for “March”, since the rule of strong and weak beat is “stressed/unstressed/hypo-stressed/unstressed” of four-four time, which can accord with the rhythm of people walking.

In addition to using different time to represent different scenes and emotion, tempo is another important element of rhythm in music to evoke different emotions. Sadness,

cry, reminiscence and tenderness can be evoked by slow music. Happiness, humour and anger are normally experienced in fast music. Dowling and Harwood have reported that music with a fast tempo and a smooth-flowing rhythm produced more joyous feelings in participants than music with a slower tempo and firm rhythm [Johnson, 2001].

3.1.4. Sound and colour

The colour of music means the orchestration or instrumentation of a piece of music. A note played by different instruments sounds very different, since each instrument has its own tone colour. Composers use these different tone colours to depict different things and scenes, to represent a certain image or to express a certain emotion. For example, woodwind instruments are always used to depict a pastoral view or to perform the melody of “Madrigal”. However, brass winds are always used in the “March”. The harp is very expressive of a beautiful dream world or fairyland.

Furthermore, sounds in different voice or range also can have various effects on expression. For example, a melody in higher range of piano can be used to represent an image of a lady, but a melody in lower range of piano can be used to represent an image of a man.

There are two good examples of using different tone colours to represent different images. The first example is Weber’s “Invitation to the Dance”, which was originally composed for piano, and then composer Berlioz recomposed it as an orchestral work. In this piece of music, the composer has tried to use different timbres of different instruments to portray the following scene: a young lady receives a courtly invitation to a ball from a gentleman who asks for the honour of the first dance. Her initial acceptance is demure, but as the musical narrative unfolds, the couple’s waltzing becomes ever more passionate and unbridled [Goldsmith, 2004]. The scene ends almost as it began: the young man takes courteous leave of her. In order to portray a vivid scenario and image, the violoncello played melody that represented the image of the gentleman, and the clarinet played melody that represented the image of the young lady. Orchestra played waltz that represented the scene of dancing. This work is the masterpiece of Berlioz’s orchestration, because it is a charming piece of using different timbres to represent different images and narrate scenes. Harris Goldsmith [2004] has pointed out that “this work is so musically self-evident that it needs no detailed explanation.”

Another example of using different instruments to represent particular image is Prokofiev’s orchestral work “Peter and Wolf”. This is a children’s story spoken by a narrator accompanied by an orchestra. Each character in the story has a particular instrument and musical theme. For example, Peter’s grumpy grandfather is the bassoon, because the timbre of bassoon is low, husky and thick. The bird is the flute, because the timbre of flute is bright, liquid and delicate. Moreover, the wolf’s theme is played

by French horns, and Hunter's theme is played by Timpani Drums. In this work, the characteristic timbre of each instrument is showed clearly, thus listeners can distinguish each character in the story from a particular instrument.

3.2. Music and human perception

There are associations between music and human emotions and perceptions. Music will influence human perception and interpretation of an ambiguous situation. Music can affect listener's emotions and moods. People have an innate ability to interpret or understand particular emotions or meanings of a particular music. However, some factors can affect people's perception on music. Music can be a powerful means or cue in representing specific meanings, but the important factors affecting human perception of music must be carefully considered in the design of using music to indicate specific contents.

3.2.1. Associations between music and human emotions and perceptions

There are associations between music and human emotions and perceptions that can illustrate why music can be used to represent emotions and meanings and people's emotional responses to the music.

Emotions are sometimes evoked by thinking of an event that is very important to the individual. Music is a very powerful cue in bringing emotional experience from memory back into conscious mind. There are two reasons for this phenomenon: first, music is quite pervasive in people's social life and it accompanies many significant events in a people's lives, such as religious ceremonies, message, special trips and celebrations. Thus, there are many associations between music and emotionally charged memories. Second, music may be treated at lower levels of the brain that are particularly difficult to be modified by later input. Therefore, a particular music work may just have a special meaning for a particular person. [Scherer and Zentner, 2001]

Scherer and Zentner [2001] have indicated that emotions are sometimes evoked by "just observing another person being affected by an event that is very important to him or her but not necessary to us." Thus, we share the emotions with other people. For example, people always cry while watching a sad movie or watching a character in a movie experiencing a very sad event, since they share the feelings with the character in the movie. Listening to expressive music is very close to this example. We may feel musical empathy with the emotional experience produced by an underlying idea that is expressed by a performer. For example, listeners feel the longing of the composer for his homeland when they are listening to Dvorák's "New World Symphony". [Scherer and Zentner, 2001]

The adaptation of the emotion model to music-generated emotion is shown in Figure 6. We may expect that the expressive movements in the music will lead to some kind of

contagion, for example, we may move our body synchronous with a certain rhythm while listening to a musical performance [Scherer and Zentner, 2001].

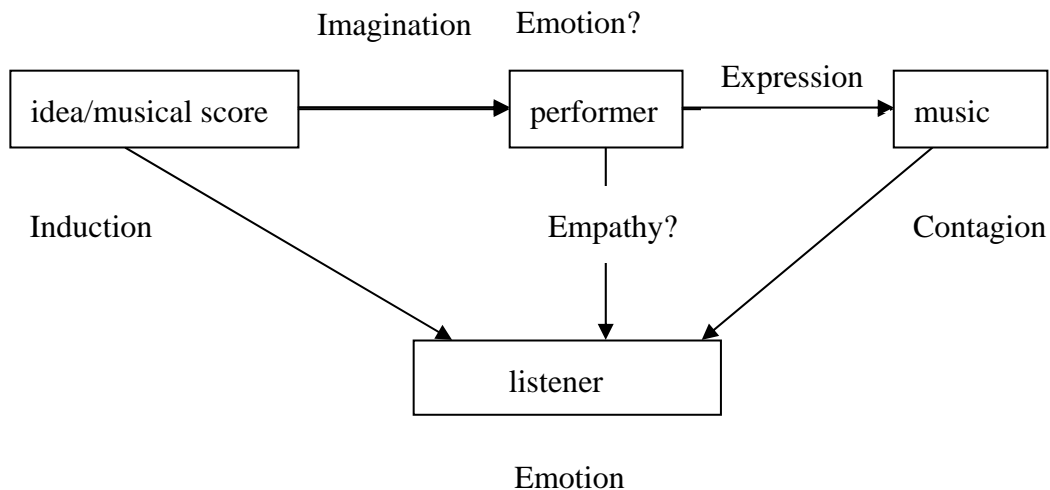


Figure 6. Adaptation of the emotion model to the case of listening to emotionally expressive performance, based on the Scherer & Zentner’s commotion model [2001].

In addition, certain musical works transmit particular meanings and emotions that are realized by most people. Firstly, for some best-known pieces of classical music and popular music, people will identify with an authoritative annotation or a popular annotation of the meanings and emotions of these certain pieces of music. For example, Barber’s “Adagio for Strings” originally was the second movement of a string quartet. However, this piece of music became an unofficial American anthem of mourning, since it has been played in the funeral of presidents Roosevelt and Kennedy. And then this music has been used in the movie “Platoon” as incidental music to set off the scene of cruel war and people being distressed by it. Therefore, people generally recognized this musical work that is very expressive to represent misfortune, grief or a tragic scene.

Secondly, some music was composed for a certain festival, special event or movie, thus these musical works contain specific meanings and emotions, and almost every listener knew it. For example, Christmas carol and the song “Happy Birthday”.

Finally, for some program music, the titles of the music give clear indication of the meanings of the works, thus listeners can very easily understand and interpret the meanings and emotions of the music. For example, Jean Sibelius’ hymn-like “Finlandia” is appreciated by most people with even a superficial knowledge of classical music. Almost every listener recognized the meanings of this music that was to glorify Sibelius’ homeland and to promote nationalism and freedom.

3.2.2. Previous studies in human perception and music

Many researchers have tried to experiment with the hypothesis that different types of music, as characterized by their emotional content (i.e. music with happy, somber or aggressive content, etc.) will influence participants' responses when evaluating an ambiguous stimulus.

Fred D. Johnson described Rodriguez's experiment in his research. Rodriguez's experiment attempted to prove that different types of music will have either a positive or negative effect on participant's interpretation of an ambiguous piece of art work. In this experiment, Rodriguez placed 42 psychology students in three separate groups to evaluate a painting with ambiguous content under one of three conditions: happy music, depressing music or no music. The result was that the group who listened to depressing music evaluated the picture gloomier than those participants who listened to happy music or no music at all. [Johnson, 2001]

Johnson [2001] has designed another experiment to demonstrate the extent to which music can be used to affect individual's perception of ambiguous stimulus. In this research, 35 participants were divided into four groups to evaluate an ambiguous stimulus – Mona Lisa - by using a semantic differential scale. Each group was placed in a classroom where aggressive, somber, and uplifting or no music was played. The result partially supported the hypothesis that uplifting music will lead to a more cheerful evaluation of a painting, somber music will lead to a more negative evaluation and aggressive music will create a more aggressive evaluation. Moreover, there was a significant difference between mean scores for males and females on affected mood: males were more affected in the experiment.

Furthermore, some researchers have tried to demonstrate that particular musical structure may specify emotional content. If this is true, then adult listeners, as well as musically naive and very young listeners, should have same feelings of emotions from music. Researchers have also tried to prove that infants would be sensitive to emotional contents in music. [Nawrot, 2003]

Nawrot [2003] has made a series of experiments to investigate the perception of emotion from music across three age groups: children, adults and infants. The first study compared the interpretation of music by pre-school children and adults. 24 pre-school children and 20 adults matched nine pieces of music to five photographed facial expressions (happy, sad, angry and neutral). In addition to the choices of the facial expression, children were also asked to give a verbal label to each piece of music. The result shows that both children and adults consistently judged the emotional quality of most of the musical selections.

Meanwhile, both children and adults chose the neutral face as their interpretation of some pieces of music in this research. The choice of a neutral face might indicate that some pieces of music are not so obvious in communicating an emotion. Or listeners

might be using this neutral face to a less intense emotion, especially when it is a less intense emotion to sad music. [Nawrot, 2003]

In Nawrot's [2003] second study, she presented happy and sad music along with videotaped facial expression to 5-to-9-month-old infants, and measured the total amount of watching time for each facial expression for the two music conditions in the experiment. The result has showed that infants preferred affectively concordant happy display but did not look longer to the affectively concordant sad display. This study and Nawrot's first study have begun to explore people's innate emotional perception in music from infants to children.

Furthermore, Brewster et al. [1993] have conducted research to discover how well earcons can be recalled and recognized. They compared test results between trained and untrained participants. The result has indicated that a non-musical person would have no more difficulties than a musician in recognising earcons. However, if there are only small, subtle changes between earcons, then untrained users may not notice them but only musicians can capture these changes. For example, there are some limits for pitch and intensity ranges, if only the pitch is used to indicate differences in earcons, then large-scale of pitch should be used.

3.3. The factors affecting human perception of music

These factors affect human perception of music: the quality of music (timbre), personalities of listeners and cultural elements. They should be considered when designing musical cues for messages.

3.3.1. Quality of music (timbre)

The quality of music (timbre) is one factor affecting human perception of music. Isaacs et al. [2002] have designed a Hubbub system that used sounds to provide contextual awareness for users among distributed groups of using Instant Messengers. They used MIDI-0 sounds to produce sound IDs which are quite primitive. In their study, several people complained that the sounds were annoying. One person found the sounds to be grating due to the low quality. Some people complained that Sound IDs were sometimes hard to recognize because they did not do justice to the real songs. [Isaac et al., 2002]

Brewster et al. [1993] conducted experiments to evaluate the effect of earcons on auditory human-computer interfaces. The results indicate that complex timbres of musical instruments may be more effective than simple tones. The timbre is a very important factor in the recognition of earcons, and the musical instrument timbres were more easily recognized than the simple tones in their experiments. Therefore, research has suggested using timbres of different musical instruments with multiple harmonics to help perception and avoid masking. [Brewster et al., 1993]

3.3.2. Characteristics of listeners

Scherer and Zentner [2001] have stated that the same music can evoke or induce a relatively stable and universal emotional effect on all types of listeners. However, some characteristics can also affect listeners' interpretation of music.

Listeners' personalities are based on their individual and sociocultural identity, such as cultural background, including cultural expectations about musical meaning, musical talent, personality and prior experiences. All of these factors affect emotional understanding of music. [Scherer and Zentner, 2001]

3.3.3. Cultural elements

Culture is a significant element in the composition and interpretation of music. Listeners' ability to interpret an expression of emotion in music is influenced both by their familiarity with the conventions of the musical culture and by their sensitivity to acoustic cues (e.g. melody, tempo, timbre) [Laura-Lee et al, 2004].

Listeners with the same cultural background can have interpretation rules (e.g. musical systems) that are shared by all the members of the cultural group [Scherer and Zentner, 2001]. Also, within the same musical culture, listeners generally agree on the general emotional interpretation of a given piece of music, without hearing it before [Landry, 2004].

Musical systems are quite different between Western, Japanese, Chinese, Indian, Middle East and African cultures. For example, traditional Chinese music uses pentatonic scale instead of the major and minor mode typical of Western music. Some nations have their unique musical instruments, which have special timbres that can evoke particular emotional responses to the music within the same cultural group. For example, the Scottish bagpipes, Chinese Xiao and Zheng.

In addition, some pieces of music describe or represent particular or significant events in the history of composers' homeland. Some musical works were composed for a certain religion. Thus, these culture-specific cues are most noticeable to listeners of that same culture, because they have the ability to decode cultural conventional cues of emotion in the music [Balkwill and Thompson, 1999].

Balkwill and Thompson [1999] have indicated that emotion is conveyed through both culture-specific and acoustic cues in a piece of music. If the number of cues is greater in the music (both culture-specific and acoustic), the expression of emotion should be stronger to listeners. However, when culture-specific cues are absent, listeners may still interpret the emotional meanings in music through acoustic cues, such as melody, tempo and loudness. These cues provide listeners with a general understanding of the intended emotion. [Balkwill and Thompson, 1999]

Balkwill et al. [2004] conducted an experiment with Japanese listeners to rate the expression of joy, anger and sadness in Japanese, Western, and Hindustani music. The

results show that Japanese listeners were sensitive to interpret the emotional meanings in music from all three cultures, even though they are not familiar with Western and Hindustani music. Therefore, the sensitivity of emotion is mainly associated with the perception of acoustic cues that transcends cultural boundaries. [Balkwill et al., 2004].

However, culture-specific cues help listeners to understand emotional meanings in music when acoustic cues provide ambiguous emotional information. For example, whereas anger in Western music was associated with faster tempo, in Japanese music anger was associated with slower tempo [Balkwill et al., 2004].

3.4. Designing music-tags for mobile short messages

According to these aforementioned theories and studies, the following aspects are suggested in the design of using composed music to represent contents or emotional contents in mobile short messages:

- Music is a powerful means to convey emotion through musical structure. Almost every person has an innate ability to interpret the emotional meanings of music. Thus, using composed music to represent emotional contents can also be effective for untrained users.
- The selection of music is significant in the design. The pieces of music must be very representative and transparent to indicate certain emotional contents.
- The emotional meanings in music are conveyed by acoustic cues and culture-specific cues. However, people may sometimes interpret the emotional meanings in music without familiarity with culture-specific musical conventions. Therefore, acoustic cues are particularly powerful signals, such as tempo, melody, loudness and harmony. [Balkwill and Thompson, 1999]
- Different persons may interpret the meanings or emotional meanings of a certain piece of music in different ways, and people may have special emotional feelings to particular pieces of music, because of their different experiences and cultural backgrounds. Thus, music can be an individual language for users. Meanwhile, music also can be a universal language for users, since some pieces of music convey certain meanings that every listener understands, such as the song “Happy Birthday”.
- Mobile phones are with users from home to work and to places of spare time activities, they become a part of users’ identity – full of personal meanings and individual experiences [Sacher and Loudon, 2002]. Consequently, it is human to design different music for different users in different cultures and countries. For example, using traditional or popular Chinese music as music-tags to represent mobile phone short messages for Chinese users.

- Timbre is also an important element for users to recognize music. Thus, using pre-recorded motif of original music may be better for users to recognize music and interpret the meanings of the music correctly.

4. Music in user interface design

The chapter reviews previous research of using music in user interface design. Firstly, the chapter introduces research of using music to design earcons to represent parts of interface. Previous studies have tried to use music as an output with graphical output to improve interaction or provide information for blind users.

Secondly, the chapter discusses studies of using music or sounds to support contextual awareness for messages.

4.1. Using music in user interface design

Researchers have discussed various characteristics of sounds that listeners can discern, such as pitch, volume, duration and harmonic content. The patterns of sound are easily recognized and remembered even in a very noisy environment.

Mansur [Buxton et al., 1985] has indicated that different timbres of audio cues can be used to label differences between critical errors and warning messages. Audio cues can also be used to indicate the process of the file handler, display editor or electronic mail system.

4.1.1. Using music to provide graphical information for blind users

Alty and Rigas [1998] have designed the AUDIOGRAPH system for investigating the use of music in the communication of graphical information to users who are blind or have a poor eyesight. AUDIOGRAPH uses music as input and output feedback for blind users to catch all information about the interface and guide them to control the commands. Therefore, the music has been used to represent the following graphical information in the system:

- The current position of the cursor or the position of a graphical object. For example, the distance of pitch can be used to describe the co-ordinate value, (a higher note describing a larger co-ordinate value) and X and Y co-ordinates are distinguished by timbre (Organ and Piano).
- The property of a graphical object. For example, using music to describe the shape and size of objects. However, there is no explanation about how to use music to represent such information in the report.

Moreover, they have used earcons to represent different control actions. For example, they used the up sequential notes to represent the EXPAND command, and the CONTRACT was represented by the inverse of this pattern. Figure 7 shows the example of the earcons of the EXPAND command. [Alty and Rigas, 1998]



Figure 7. Example of the earcons of EXPAND command. [Alty and Rigas, 1998]

This AUDIOGRAPH tool is designed for users with an average musical ability. No special musical ability is required for using this system. Experiment's results concerning the use of the system showed that users were able to follow the music to identify the shapes of graphics and their approximate size and to adjust the size of the graphics by using the tools. Also, users were able to use musical control to do things such as expand, contract and drag shapes. [Alty and Rigas, 1998]

However, in the AUDIOGRAPH system, the music has been used to describe the size and shape of graphical objects that are quite non-figurative concepts to be represented by music. Thus users need to be trained to interpret the meanings of these musical messages. For example, there are significant differences between before training (60%) and after training (90%) in recognition of vertical line.

There are some useful suggestions for designing musical auditory interface in this report: [Alty and Rigas, 1998]

- Making musical messages shorter will make them easier for users to interpret.
- The designer must produce recognisable and distinguishable musical messages by using appropriate musical structures, such as rhythm and timbre.
- The designer must design the perceptual context for listeners because interpretation of the music will depend on the expectation of the listener.
- The designers could design higher level musical messages that allow users to understand meanings of musical messages without further training or instruction.

4.1.2. Combining sounds and graphical menus to overcome usability problems

Brewster and Crease [1997] have investigated how to combine sound and graphic to improve interaction. They have conducted an experiment to investigate how to use sound as feedback in standard graphical menus to reduce or overcome the incorrect selection of a menu item.

The problems of action slips and accidental mouse movements cause incorrect selection of menu items due to inadequate feedback. Brewster and Crease [1997] have

suggested using auditory feedback to solve the problems, since the non-speech sound has the following advantages:

- The sound can be heard from all around
- The user can focus on or look at something else, but still get feedback
- The sound feedback does not disrupt users' visual attention

They have designed three earcons to deal with the problems of an item slip, a menu slip and a slip of a divider or disabled item:

- Firstly, an earcon of different timbres was used to indicate different menus. If the user moved the cursor out of the menu, the sound stopped.
- Secondly, they combined two earcons to deal with item slips. They have used alternative sound in pitch from B2 for even numbered items and E3 for odd numbered items with the timber of the menu that the cursor was in. If the user moved the mouse out of the menu or moved over a divider or disabled item, the sound stopped.
- The final earcon has been used to indicate either a correct selection or an item slip. For a correct selection, the pitch and timbre of current menu and item were used. For an incorrect selection, a discordant interval was played.

The result of the experiment indicates that participants need to make less effort to notice and recover from menu and item slips. In auditory condition, both menu and item slip error recovery rates have improved significantly. [Brewster and Crease, 1997]

In summary, the following points can be concluded from this study:

- Only pitch and timbre have been used to indicate the status of menu, item and selection. There are no other perspectives of music which have been investigated in this study.
- The participants did not find auditory feedback annoying.
- They have used discordant intervals to indicate incorrect selection, because discordant intervals are good for catching attention. Therefore, some special characters of music are good for using in a certain requirement.
- It is easier for users to capture information if designers could make the sound of earcons distinct.

4.1.3. Using musical grammars to design earcons

Hankinson and Edwards [1999] have tried to apply musical grammars to earcon design. They used discordant chords to indicate incorrect combinations of actions and objects, and harmonious chords to indicate correct combinations. For example, if the user selected the action of "Copy" or "Delete" and then selected the object "Files", the

following earcon should be played to indicate that it is the correct combination of action and object.

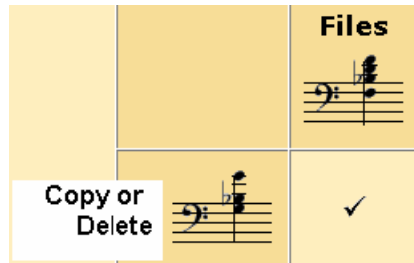


Figure 8. An example of chords that indicates correct combinations of action and object.
[Hankinson and Edwards, 1999]

Furthermore, they have designed a number of melodies to represent some actions and objects. The melodies are based on underlying chords, thus the melodies and underlying chords will maintain their grammatical nature regardless of whether melodies and chords or melodies are played. [Hankinson and Edwards, 1999]

The idea of using discordant and harmonious chords to indicate incorrect and correct selection is good, because normally discordant and harmonious chords are very easy for users to distinguish. However, some disadvantages of this design should be considered:

- The minor seventh chords are discordant chords in music, because there is a minor seventh interval in the chord, which causes the dissonance of the chord. Consequently, minor seventh chords are regarded as discordant chords. However, in Hankinson and Edwards's study these minor seventh chords are regarded as harmonious chords.
- It is very difficult for users with average musical ability to distinguish minor seventh chords and other discordant chords.
- There are too many melodies to represent different actions or objects. It is difficult for users to distinguish and remember each of them.

4.1.4. An evaluation of earcons in auditory human-computer interfaces

Brewster et al. [1993] have conducted two experiments to evaluate whether earcons are effective in communicating information in sound or not. They also tried to discover how well earcons can be recalled and recognized.

The first experiment attempted to explore if earcons are better than unstructured bursts of sound to communicate information. They have also tried to identify the best types of timbres to convey information.

They have created three sets of sounds in their first examination. The first set uses synthesized musical timbres with rhythm information. The second set was simple timbres with rhythm information. The third set had no rhythm information. It was just one-second bursts of sound similar to normal system beeps.

Three groups of 20 subjects were asked to listen to a different set of earcons in different phases of the test. The musical group heard set 1 described in the paragraph above, the simple group heard set 2 and the control group heard set 3. [Brewster et al., 1993]

The earcons were used to indicate different icons and menus in different phases of testing. For icon identification, the timbre has been used to indicate different families of related items. Items of the same type used the same rhythm. Different pitches indicated different items in the same family and type. For menu indication, each menu had its own timbre, and the items in each menu differed by rhythm, pitch and intensity. The subjects were presented with the screen shown in Figures 9 and 10 [Brewster et al., 1993]

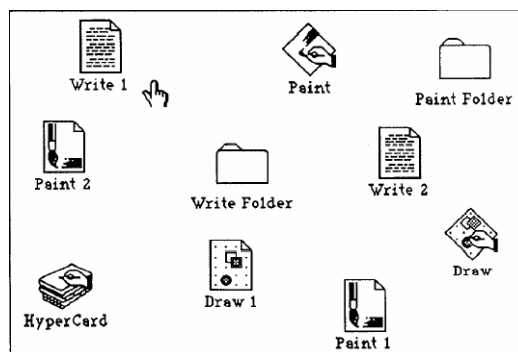


Figure 9. The icon screen in the experiment [Brewster et al., 1993].

MENU 1	MENU 2	MENU 3
OPEN	SAVE	UNDO
CLOSE	COPY	EDIT
DELETE	PRINT	
CREATE		

✎

Figure 10. The menu screen in the experiment [Brewster et al., 1993].

Designers also designed tasks to discover how well the earcons can be recognized and remembered. Moreover, designers have tried to combine earcons for subjects to

point out each sound they heard. For example, subjects listened to two earcons (i.e. it could be menu then icon, icon then menu), then they were asked to give information about these two earcons. [Brewster et al., 1993]

The first experiment in this research showed the following results:

- The musical instrument timbres were recognized easier than simple tones. The timbre is a very important factor in the recognition of earcons.
- If the rhythms are used correctly, then they will be very helpful in improving the recognition of earcons.
- The pitch is very difficult to use.
- Subjects could remember the earcons after a short time of learning. Subjects could remember earcons even after doing another similar task.
- Combined earcons were difficult to recognize by subjects.

Brewster et al. [1993] have conducted another experiment. The earcons were redesigned in the second experiment so that there were more differences between each earcon. New rhythms were designed for files, folders and applications. Different numbers of notes were used to represent rhythms. In addition, the pitch structure was more complex in the second experiment. Meanwhile, two timbres were used for each family of objects in order to allow greater differences between families.

A single group of same subjects was used for comparisons with the previous results. The results of the second experiment showed that new earcons worked better. [Brewster et al., 1993]

The following guidelines of earcons design have been suggested based on the results of the experiments. Some points of these guidelines also support or show the ideas of using composed music to represent messages that could be applicable.

- Harmonics and musical instrument timbres help perception of earcons and avoid masking [Brewster et al., 1993]. Thus, the quality of sounds is an important factor that should be considered when designing musical tags for messages as mentioned in section 3.4.
- Only pitch is very difficult for users to distinguish differences between earcons [Brewster et al., 1993]. Thus, using melody, especially using users' familiar melodies are better for perception and distinction.
- Make rhythm as different as possible. Using different numbers of notes to represent different rhythms can be very effective [Brewster et al., 1993]. Using composed music to represent messages has the advantage of applying rhythm, since the best type of rhythm already has been used in these composed music pieces. Moreover, different music with different styles of rhythms can be used to represent different emotions. For example, happiness can be represented in

music with a fast tempo and smooth-flowing rhythm. Sadness can be represented with a slow rhythm.

- In these two experiments, there were some musicians in the subjects. However, the recognition levels made by the musicians were not better than the levels of non-musicians. This means that non-musical users would have no more difficulties than a musician would in recognising earcons [Brewster et al., 1993]. This is also a good result for applying music to present messages. However, the music pieces still need to be carefully selected based on users' perceptions.

4.2. Using sounds or music to support awareness of messages

This section reviews some previous studies on using sounds or music (earcons) to provide contextual awareness for users in different systems.

4.2.1. Audio Aura – background awareness

In the Audio Aura system, auditory cues are used to provide background awareness for people in work environment. Designers have explored the use of different sounds to represent information: speech, musical and sound effects. [Mynatt et al., 1998]

Audio Aura has been used to represent the following information via these different types of sounds:

- Number of new email messages and sender's ID in these emails.
- Person's information represented by auditory cue. For example, an auditory cue conveys information about has the person been in or out that day.
- The information of a "group pulse" indicates people's activities to collaborators. For example, whether people are working with shared artifacts (databases) or whether they are having a meeting currently.

Audio Aura system offers four types of sound designs: voice only, music only, sound effects only and a rich sound environment using all three types of sound. The following descriptions show sound design variations for email indication and "group pulse" in the Audio Aura system: [Mynatt et al., 1998]

- Voice world: a voice is used to inform the users of email amount, e.g. "You have no email" or "You have 5 new messages". However, there was no voice to indicate group pulse in the Audio Aura system.
- Sound effect world: this design uses "auditory icon" where the meaning is carried through sound sources. The sound scope of a beach is used in the system so that the sound of wave activity is used to indicate group activity, email number is mapped to seagull calls and the sounds of various seaside animals indicate different email senders.

- **Music world:** this design uses “earcons” where meaning is expressed through short musical phrases (motives). Changing melodies, pitches and rhythms of a set of musical phrases indicated various numbers of emails. For example, if there was no new email, a high, short bell melody with rising pitch at the end was played. If there were some emails, then a low, longer melody was played. However, there is no clear explanation about how to use musical earcons to indicate sender’s ID. In addition, changes in melody, pitch, rhythm and length are used to indicate different office occupancy. Group activity is presented by a single low vibe sound that is played in different pitches which portray group activity level.
- **Rich world:** this design combines sound effects, music and voice into a multi-layered environment. The combination of sound effects and music earcons is used to indicate group pulse. For example, a combination of closer wave sound and vibe is used to indicate medium level of activity. However, there is no difference between rich sound and sound effect for email indication.

Table 1 shows the summary of advantages, disadvantages and design notes for each type of sound design based on the study of “Audio Aura”.

Voice World	
Advantages	<ul style="list-style-type: none"> • Information transfer is accurate and clear. • Specific information can be carried, e.g. email numbers and sender’s name. • No training needed for users to interpret information.
Disadvantages	<ul style="list-style-type: none"> • Demands more attention than a non-speech sound. • It may be inappropriate for a user who is walking through an area. • Difficult to understand the words if users are in a noisy environment. • It may interrupt when user concentrates on an important task.
Sound effects	
Advantages	<ul style="list-style-type: none"> • Do not require users’ attention to capture the meanings. • Particular sets of functionality can be naturally mapped with the sound. For example, the amount of emails is mapped to seagull cries. Therefore, users could interpret meanings through the semantic roles of sounds. • Do not require users to shift their attention to the auditory sound while they are doing another task.
Disadvantages	<ul style="list-style-type: none"> • Specific information cannot be conveyed through sound effects. For example, room number, person’s name. • Meanings of sounds are different to remember.

	<ul style="list-style-type: none"> • Some training is needed for users to interpret particular meanings, for example, interpret a particular person or group through various beach birds. • Sound effects have no particular meanings originally, unless designers have defined meanings for them. Thus, users may ignore that sound sometimes.
Design Note	<ul style="list-style-type: none"> • Sounds remain at a peripheral level and the design of the auditory cues must avoid the “Alarm” responses in listeners.
Music World	
Advantages	<ul style="list-style-type: none"> • Different variations of musical elements can be used to indicate different subjects. For example, the amount of emails was indicated by changing the melodies, pitches and rhythms of a set of related musical phrases in the Audio Aura system. • Does not require users to shift their attention to music earcons while they are doing another task. • It is easy to attract users’ attention.
Disadvantages	<ul style="list-style-type: none"> • Some learning is required. For example, the different meanings of different melodies in the Audio Aura system. • The meanings of changes in melodies, rhythm and pitches somehow are difficult to remember. • The specific information cannot be conveyed through music earcons.
Design Note	<ul style="list-style-type: none"> • The sounds remain at a peripheral level and the design of the auditory cues must avoid the “Alarm” responses in listeners. • The meanings of music works are not used to represent anything in Audio Aura music earcons design.
Rich World	
Advantages	<ul style="list-style-type: none"> • “It allows wide variations in the sound palette while maintaining a consistent feel” [Mynatt et al., 1998].
Disadvantages	<ul style="list-style-type: none"> • It maybe annoying if many different sounds are attached together.
Design Note	<ul style="list-style-type: none"> • “Requires very careful design work to avoid combining too many sounds together in the same frequency range or rhythmic structure” [Mynatt et al., 1998].

Table 1. Summary of advantages, disadvantages and design notes for each type of sound design.

4.2.2. Using earcons to support awareness and opportunistic interactions

Hubbub system is a sound-enhanced mobile Instant Messenger that uses earcons and visual cues to provide awareness information among distributed groups. The sound has been used in two aspects of Hubbub system to support awareness: indicating sender ID and Sound Instant Messages (SIMs). [Isaacs et al., 2002]

Firstly, Hubbub system provides for each user a Sound ID that is a part of a song. Each time a user becomes active after being idle or offline, a sound is played, followed by user's Sound ID, so that people know who became active without looking at the display. When a message arrived, the recipient heard the Sound ID of the sender so that the sender could be identified without looking at the display. [Isaacs et al., 2002]

Secondly, users can send Sound Instant Messages (SIMs), which are earcons with associated meanings. Designers have chosen 14 messages that use sounds to convey the meanings, e.g. "Hi", "Thanks", "Cool". When a user sends a sound message, his or her Sound ID will be played and followed by that sound message, so the recipient can hear and interpret it and identify the sender. [Isaacs et al., 2002]

Sound IDs are short motifs from songs with strong melodies that can be identified from just a few notes. Some well-known, distinctive songs are used in the Hubbub system, so users can choose which Sound ID they want to use to represent them. Designers have made all sound messages shorter and two octaves higher than the Sound IDs in order to make the Sound IDs distinguishable from the sound messages. Moreover, they used MIDI-0 sounds on the Palm, which are quite primitive. These sounds are played on a piano with only one note at a time (no chords) on PC. [Isaacs et al., 2002]

The result of evaluation for the Hubbub shows that many people seem to appreciate the sound interface for providing background awareness, but it is somehow difficult for them to learn the meaning of more than a few sounds. Several people complained that sounds were annoying, because they were of low quality. Some people complained that the Sound IDs were difficult to recognize sometimes because of low quality of the sounds, so the Sound IDs did not do justice to the real songs. [Isaacs et al., 2002]

The following comments were generated from the study of the Hubbub system:

- Senders choose the Sound IDs, so recipients have to learn and remember each Sound ID for every sender in Hubbub system. This will overload the recipient's burden of learning the sound, it will be very difficult for users to learn and remember all of these Sound IDs if there are more than 10 members in the list. Consequently, it is a better approach if recipients define the Sound IDs for senders. It will reduce the burden of recipients, since the recipients need not learn how to recognize the Sound IDs. Also, it is easier for recipients to remember the Sound IDs, since they can select each Sound ID actively instead of remembering them passively. Moreover, the recipients can define the

number of senders who have Sound ID so that they are not compelled to remember or recognize many Sound IDs for many senders, and they can only define the most important senders to have these Sound IDs.

- Designers have created the sounds and defined their meanings for SIMs in the Hubbub system, but they did not use the meanings of music to convey the meanings of messages. Thus, users have to learn and remember the meanings of these SIMs. The sounds of SIMs are less melodic in the Hubbub system so that is not easy for users to identify and remember their meanings.

4.2.3. Using non-speech sound to summarize the important properties of messages

Hudson and Smith [1996] have designed an electronic mail system by using non-speech sound to portray the overall properties of each email message for users. Thus, users can use this email glances system to quickly preview an email message to determine its important properties, e.g. the sender, the keyword of the content or the category of the message.

Email glances are a stream of short sounds that were constructed from up to four components. These components include an optional preamble sound, a main audio icon, a recipient's icon and an optional content flag. Firstly, the preamble sound was used to notify the user that the message is important. Secondly, the main audio icon was used to identify the category of message that includes sender ID and whether it relates to certain important subjects or message threads. In addition, the size of main audio icon was modified to indicate the overall size of the message. For example, a short sound is played for short messages, and a long sound is played for long messages. Thirdly, the recipient icon was used to indicate the recipients of the message, e.g. a single user, a group of users, or a mailing list. Finally, the content flag sounds were designed to portray special features of the content of the message, such as key words or phrases in the message. [Hudson & Smith, 1996]

This email glances system was using non-speech sounds but not music as audio cues to summarize the important properties of a message. Designers only described one sound as example for the system in their paper: a throat clearing "hmmphmm" was used as a preamble sound [Hudson & Smith, 1996]. Thus, it is hard to estimate whether these sounds are effective or not to convey all information of the message.

Some ideas of this paper should be considered for designing auditory interface in an office environment:

- these sounds should be potentially faded into the background,
- all of the sounds should not be harsh or attention demanding,
- the sounds should be designed to fit together without being too discordant, and

- different sound groups should be distinguishable from one another.

4.2.4. Using auditory cues to provide peripheral awareness of messages

Nomadic Radio is a messaging application that uses auditory cues to provide peripheral awareness of email, voicemail, news broadcast and personal calendar events. In this application, synthetic speech has been used for textual messages, such as email, calendar events, voicemail and broadcast news segments, while some auditory cues have been used to indicate system activities, message notification, and confirmations. [Sawhney and Schmandt, 2000]

In Nomadic Radio, the message was presented at varying levels that are based on the alleged priority of the message and user context. There are seven increased levels of notification:

1. **Silence:** in this level, all auditory cues and speech feedback are turned off. This mode will be set when message priority is judged to be too low to play, or if the system has been set to know that the user is currently engaged in other important tasks, e.g. having conversation with other people, or having a meeting.
2. **Ambient cues:** the ambient auditory cues use the sound of flowing water to provide a continuous awareness of status of incoming messages. For example, the sound of fast flowing water indicates that messages are being downloaded, and a short email message is presented by the sound of splash.
3. **Auditory cues for notification and identification:** users assign different auditory cues for group recipients, personal, timely, and important messages that are priority cues for notification. Also, the VoiceCues provide identification of the sender of an email in Nomadic Radio. The VoiceCues are created manually by taking one to two second audio samples from the voice messages of callers.
4. **Message summary:** a spoken description of incoming message informs the name of the sender and the subject of the message.
5. **Message previews:** a spoken description of incoming message extracts the first 100 characters of the message.
6. **Full body of the message:** this mode reads the full text of the message by using speech.
7. **Foreground rendering:** an important message will be played in the foreground of the listening space allowing it to be heard louder and the message will gradually begin to fade away after playing four-fifths of its duration.

Some comments are based on the study of Nomadic Radio:

- There are many auditory cues used for different purposes in Nomadic Radio, e.g. auditory cues for group, personal, timely and important messages, it might be confusing and annoying for users to assign so many different auditory cues and try to remember them. Auditory cues should provide some idea of contextual awareness when not reading messages, consequently, some additional information need not be represented by auditory cues that in order to reduce users' cognitive load of remembering different sounds. The evaluation results of Nomadic Radio showed that "knowing the actual priority of a message was less important than simply having it presented in the right manner" [Sawhney and Schmandt, 2000]. One user found "the overall auditory scheme somewhat complex, preferring instead a simple notification consisting of ambient awareness" [Sawhney and Schmandt, 2000].
- Speech has been mainly used in Nomadic Radio, but the speech requires users to focus on listening. Thus, the evaluation results of Nomadic Radio showed that users preferred to listen to ambient and auditory cues while concentrating on other tasks, and these cues do not require them to turn their attention immediately to incoming messages [Sawhney and Schmandt, 2000].

4.3. Summary

Some referenced comments of designing auditory messages that are generated from aforementioned researchers. Firstly, it is easier for users to get information if designers could produce recognisable and distinguishable musical messages by using proper musical characters and structures, such as rhythm and timbre.

Secondly, the designers could design high-level musical messages that allow users to understand the meanings of musical messages without further training or instructions. [Alty and Rigas, 1998]

Thirdly, it is difficult for users to recognize and remember many different earcons or auditory cues. The auditory cues should provide a hint of contextual awareness instead of reading the texts. Thus, some additional information need not be represented by auditory cues to reduce users' cognitive load of remembering different sounds.

5. Design principles for musical short messages – Musical Theme

This chapter describes the design of using music to present SMS in mobile phone devices. Firstly, the chapter illustrates the work flow of musical short messages system. Then, the chapter describes the quality of the sound that should be used in this design and how to use music to represent sender's identification.

Thirdly, the chapter discusses the message categorization of contents and emotions of SMS and how to use music to present them in this design. Next, the chapter explains the selections of appropriate music to present contents or emotions of SMS messages. Finally, the chapter discusses the privacy issues of this design.

5.1. Diagram of system work flow

This musical short message system - Musical Theme processes received messages in the following steps: firstly, the Sender's ID is played by music. Secondly, if the system couldn't find Sender's ID for the message, the content of message is described by a musical theme. Thirdly, if there was no content to be represented (the system could not match the text with a predicted category), the system should parse the received message into a corresponding emotional category if possible, and the music of that emotion is played. Finally, if there was no Sender's ID, content and emotional content that could be represented for the received message, the music of unknown message is played.

Figure 11. is a diagram of system work flow, which illustrates the categorization of the Musical Theme system.

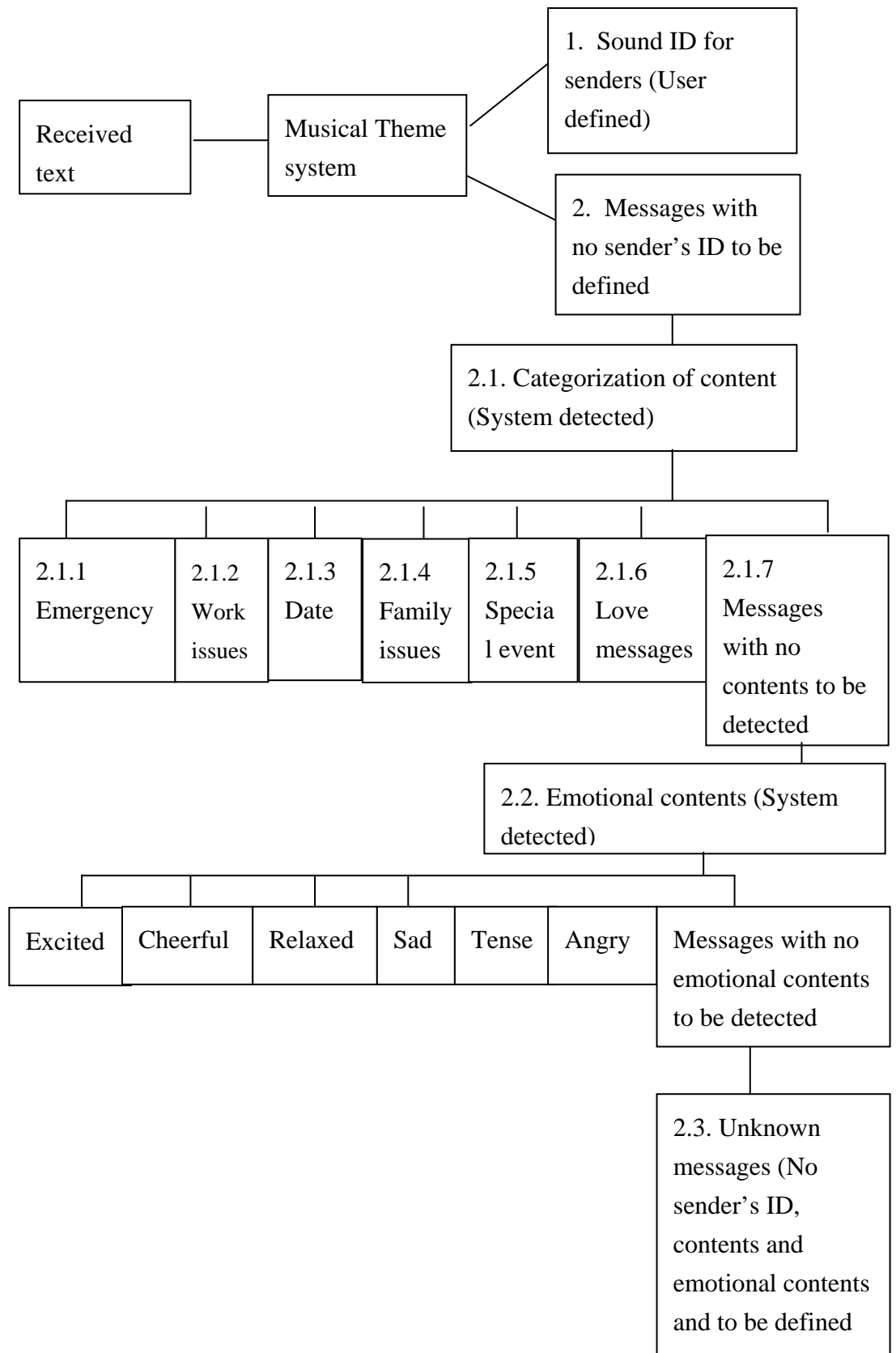


Figure 11. The diagram of system work flow

5.2. The quality of sound

Sound quality is a significant element for users to recognize the music correctly, and users may do not feel annoyed if the quality of music is good. Thus all of music works used in the system should adapt the original sound quality, harmonics, sound and colour (instruments) as well as possible. One choice of sampled sound is the Advantaged Audio Coding (AAC) format. The AAC is a compression format of good enough music quality that reduces the amount of data needed to convey high-quality digital audio [Vialicensing, 2005].

Moreover, only the motifs of music will be used in the Musical Theme system, it will not play the whole piece of the music. The music should fade in and fade out so that users will not become annoyed or suddenly disturbed, especially when they are in work environment.

5.3. How to use music to present sender IDs

In the Musical Theme system, the user (recipient) defines the music (Sound IDs) for different senders so that the user does not need to learn to recognize different music (Sound IDs) for different senders. The recipients can define the number of senders to have Sound IDs so that they are not to be compelled to remember or recognize many Sound IDs for many senders.

Musical Theme system provides music (Sound IDs) for users to choose so that the music works should be pre-stored in the system and the user can select music from the list in the system to present different senders. Meanwhile, the music should be categorized in different groups based on the different characters of different people, thus users can select particular music that corresponds with the sender's character. This will be easier for users (recipient) to remember the music (Sound ID) for each sender.

There can be six groups of music (Sound IDs) in the Musical Theme system based on different characters of people, and the groups of music represent lively, gentle, impassioned, calm, serious and impatient character. The following music works are examples for each group of characters.

- Lively: Motif of John Strauss "Chit-Chat Polka, Op.214"
- Gentle: Motif of Henry Mancini and Johnny Mercer "Moon River"
- Calm: Motif of Debussy "Moonlight"
- Impassioned: Motif of Tchaikovsky "Piano Concerto No1 in B flat minor, Op.23"
- Serious: Motif of Beethoven "Piano Sonata No. 8 in C minor ("Pathétique") Op. 13"
- Impatient: Motif of Paganini "Perpetual Motion"

In this design, all music pieces in each group should be selected to correspond with the described tempers. For example, the melody of John Strauss's "Chit-Chat Polka" is very vivo so that is selected to represent lively characters. Consequently, the design uses the meanings of musical languages to depict sender's character that help users (recipients) to associate them with the character of a particular person.

The user can select one music piece as a Sound ID for a particular sender based on the sender's distinct temper. For example, the user can select Motif of Beethoven's "Piano Sonata No. 8" as the Sound ID for his or her boss, if the boss is a very serious person. Every time, when the user receives messages from his or her boss, the motif of Beethoven's "Piano Sonata No. 8" is played synchronously with the message, then the user knows that the message was sent from the boss without reading it.

There could be several (3-5) pieces of music for each group which the user can use for different persons if they have the same character.

5.4. Message categorization

The aim of this design is to use music to present the sender, content or emotions of the text short messages in mobile phone devices. However, it is impossible to present the vast amount of messages without message categorisation.

This section will discuss the idea of message categorisation for content and emotions in this design, and how the mapping between content, emotion and music is performed.

5.4.1. Message categorization for content

In the Musical Theme system, the system will parse and categorize the messages by some keywords or phrases of the messages. The system will categorize the received messages into different categories by recognizing keywords and phrases of the messages, and then it constructs music when a message matches the predicted categories.

The system stores several regular text expressions in a file and compares the received messages to match the text (keywords and phrases) into a predicted category. Then, the corresponding music of that particular category will be played for the user, so the user will have some idea of the content of this message without reading it.

There are six content categories of messages that can be used in Musical Theme, and each category has particular music to represent corresponding content. The user can also change the music of each category based on their preference. Table 2 shows the categories of the content, the keywords and phrases for parsing by the system.

Categories of contents	Keywords and phrases for identifying the content
Work issues	Meeting, Office, Work,

	Discuss work with you...
Family issues	<ul style="list-style-type: none"> Some special identities of senders can be used for parsing messages as Family issues: Father, Mother, Sister, Brother, Grandfather, Grandmother... Other keywords and phrases: Go back to home, See you at home I will be home...
Date	Meet you at... I will be there at... Party...
Emergency	Please call me back as soon as possible... Immediately... Urgent...
Special events (e.g. Birthday, Christmas, New Year, General greeting)	Happy Birthday... Merry Christmas... Happy New Year... Congratulation...
Love messages	<ul style="list-style-type: none"> Users define a special sender ID for this “Love message”, when the system detects this sender’s name, the music of Love message is played. Other keywords and phrases: I love you... Kiss you... Sweetheart...
Not predictable messages of contents	<p>If there was no keyword or phrase that can be detected to predict content for some messages, the system will process these messages with the following methods:</p> <ul style="list-style-type: none"> The messages will be categorized in corresponding emotional content; If the message could not be categorized in the emotional content neither, then the music of “Unknown messages” is played.

Table 2. The content categories in the Musical Theme system.

There are two reasons of using music to present different content categories of messages. Firstly, as aforementioned, it is impossible to use music to present each specific content of all messages. Thus, the music is used as a crucial cue for users to acquire some necessary ideas about the content of received messages.

Secondly, it is impossible for users to remember a mass of music pieces for different messages.

Meanwhile, the system provides some pre-defined subject headers for senders to choose, and these headers are corresponding to these 7 categories in the system. For example, the headers for Emergency category can be “Emergency message”, “Most urgent...” etc. Thus, it is easier for the system to identify the content’s category for the messages with pre-defined subject headers.

5.4.2. Special cases for content

The special cases mean that one message contains different keywords for different content categories. For example, in message “We are in meeting room, please come here immediately”, the keyword “meeting” is in the category of work issues, but the keyword “immediately” is in the category of emergency. For these cases, the system could play different music for different categories, however the system needs to determine which category of content should be firstly represented.

Consequently, the priorities of different content categories need to be defined in the system. The definition of priorities could be based on two rules. Firstly, the system counts the number of keywords in different categories and plays the music for the category with the most keywords. Secondly, if the first rule cannot be applied, thus the priorities of different categories should be arranged as 1. Emergency; 2. Work issues; 3. Date; 4. Family issues; 5. Special events; 6. Love messages.

5.4.3. Categorization of emotional contents

If the system could not identify the content of the message, then it will identify emotional content of the message. Through creating the emotional category based on Russell’s circumplex model of affect [Fagerberg et al., 2004] (Figure 12.), the system could express users’ emotional contents that best suit their messages.

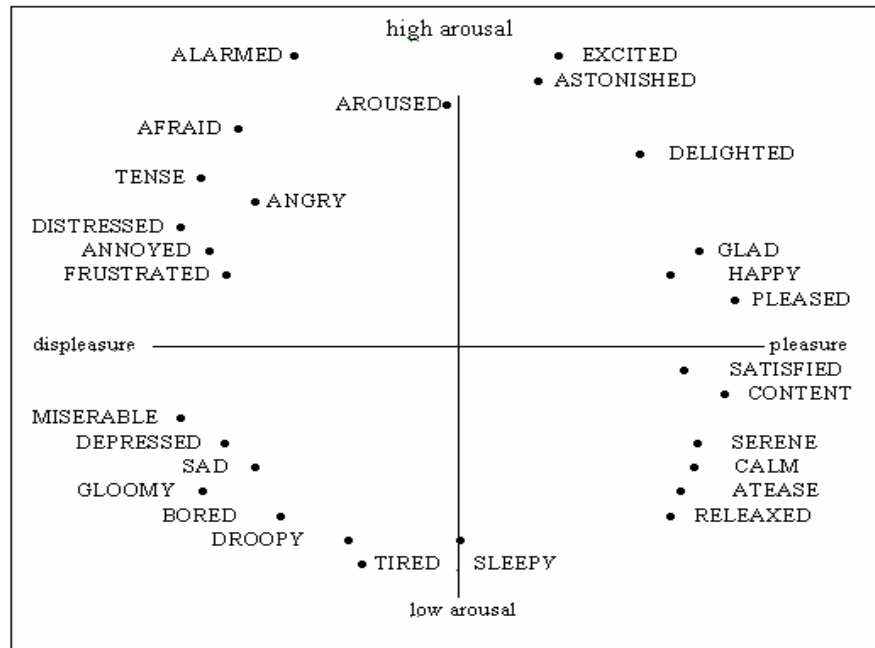


Figure 12. Russell's circumplex model of affect [Fagerberg et al., 2004]

Based on this Russell's model of affect, we could categorize emotional contents in the following categories with the corresponding keywords and phrases (Table 3.).

Categories of emotional contents	Keywords and phrases for identifying the emotion
Excited	Exciting... Excited... I have found (got) a job... I am graduated... I have passed the examination... I will be married with (on)... I got a baby (boy, girl)...
Cheerful	Good news... I am happy... I am glad to... It's nice... Good...
Relaxed	Nothing to worry... I am free... Nothing special...

	It's ok (fine)... I have finished my work...
Sad	Bad news... Not happy... Unhappy... Sad... I am tired... Feel bad...
Tense	I am worried about... Nervous... I am (very) busy...
Angry	Angry (anger)... I can't endure...

Table 3. The emotional content categories in Musical Theme.

The reasons for choosing these six emotional categories are:

- These emotions can be expressed by music.
- These emotions could represent most emotion types.
- It is impossible for users to identify many different emotions by music. It is rather difficult for users to identify similar emotions (e.g. gloomy, sad and depressed) by music.

5.4.4. Unknown messages

Unknown messages are those messages that cannot be categorized as predicated contents or emotional contents by the system, and there is no sender IDs defined for those messages.

A neutral sound or music can be used to represent unknown messages. One solution is to continue using this “Beep” sound for unknown messages, since this sound is distinct from other music so users could quickly notice that they are unknown messages.

5.5. Music selections for different contents and emotional contents

This section discusses the possible music works and the reasons for choosing these music works for each category of contents and emotional contents.

5.5.1. Music selections for contents

The music selections for contents are not cultural specific at this point. The music selection suits different users with different cultural backgrounds. Consequently, I try

to select universal popular music works for each category of contents. The following music works are examples for each category of contents.

- Work issues: The theme music of the movie “Mission Impossible”.
- Family issues: “Country Road Take Me Home”.
- Date: Weber and Berlioz’s “Invitation to the Dance”.
- Emergency: Rimsky-Korsakov “The Flight of Bumble Bee”
- Special events (e.g. Birthday, Christmas, New Year, and general greeting): “Happy Birthday” is for Birthday, and some Christmas songs can be used for Christmas and New Year. “Brindisi” from “Verdi: La Traviata” is for general greetings.
- Love messages: “My Heart Will Go On”

The reason for choosing these music works for birthday, Christmas and New Year is quite obvious, since those music works were composed for these particular themes. The “Brindisi” from “Verdi: La Traviata” was selected for general greetings, since this famous music work depicts an excited and congratulatory spectacle.

The theme music of movie “Mission Impossible” is a widely known piece of music, since this movie has been shown worldwide. Thus, when users hear this music, they may think of the name of the movie – “Mission Impossible”, hence they may associate it with “work issues”. Another reason of selecting this music for “Work issues” is because of its melody and rhythm. They could make listeners tense which can be suitable to represent the atmosphere of working.

“Country Road Take Me Home” is a very famous song which expresses people’s feelings of yearning and love for their homes. Thus, it is proper music to represent the content of “Family issues”.

Furthermore, Weber and Berlioz’s “Invitation to the Dance” can be used to represent the “Date” category, since a waltz played by an orchestra that represented scenes of dancing in this piece of work. The style of music for “Date” category should be romantic, moving and delightful. Thus, other waltzes could also be used in this category.

Next, Rimsky-Korsakov’s music work “The Flight of Bumble Bee” makes listeners feel like they are in a hurry or there is an emergency, which should be suitable to represent “Emergency” messages.

Finally, for “Love messages”, there are huge amount of love songs (or other music works) that can be used to represent them.

Note: All of these music works that have been listed in this thesis are only examples of possible choices.

5.5.2. Music selections for emotional contents

The selections for emotional contents are corresponding to the emotion of each category. Music works for excited emotion should be passionate and happy. Music for cheerful emotion should be bright. Music works for relaxed emotion should be calm and comfortable. However, the music for sad emotion should be slow and blue but beautiful. For tense emotion, the music should express tension, stress and unhappiness. Moreover, the music works for angry emotion should be rough and manic. The following music works are examples of each category of emotional contents.

- Excited: Beethoven's "Ode to Joy" in "Ninth Symphony"
- Cheerful: "Full House", a music segment from Korea TV serial program "Full House"
- Relaxed: "I Think I", a music segment from Korea TV serial program "Full House"
- Sad: Sarasate's "Zigeunerweisen, Op.20"
- Tense: Wagner's "Die Walkure"
- Angry: Beethoven "Symphony No.5 in C minor"

5.6. Privacy issue and customization

There should be several music works for each category of contents and emotional contents and users could also download other music works or compose their own music for particular contents, for example birthday. Thus, users have possibilities to change all music in each category and define particular meanings for music works by themselves in order to keep privacy.

6. Pre-evaluation of the design of the Musical Theme

This chapter illustrates the procedure, goals and methods, subjects and test environment of the experiment for the pre-evaluation of the system.

6.1. Research procedure

To accomplish my evaluation task, I used a combination of quantitative (5-point scale rating questions and statistical analyses of accurate music-matching result) and qualitative (open-ended questions) data collection methods and analyses methods. [Hansen, 1997]

The evaluation procedure was conducted as follows: firstly, I found participants for two groups (Western and Asian); secondly, the subjects answered the first questionnaire and accomplished three music-matching tasks. Then they answered the second questionnaire.

6.2. Research design and methods

The general goal with the evaluation was to:

- to obtain an in-depth view of the user's perspective and to determine improvements needed to redesign the system
- to collect cognitive and statistical data from users performing three music-matching tasks using a combination of both qualitative (questionnaire) and quantitative (statistics of accurate music-matching) data collection methods
- to analyze collected data according to how users use the mobile phone short message system to make suggestions for categorising contents based on user's needs in the user interface redesign
- to analyze cultural differences between Western and Asian users in music cognition according to the performance results between two groups in three music-matching tasks and to make suggestions for culture specific design in the user interface redesign
- to analyze whether selected music works can be used to represent the character of senders, contents and emotions properly or not

The evaluation was divided into three parts: 1. Questionnaire 2. Music-matching tasks 3. Post-interview (questionnaire).

6.3. The design of questionnaire

The questionnaires were used in the first part (before music-matching tasks) and the third part (after music-matching tasks) of the evaluation. The first questionnaire consisted of closed questions and 5-point scale rating questions. These questions were chosen to produce standardized data that can be analysed. This first questionnaire collected demographic data and data about user's conventions, experiences, intentions

and goals of using SMS system, also data about user's perspectives of the categories of the contents, and user's preferences of using this Musical Theme system.

The post-research questionnaire consisted of open-ended questions that allowed the participants to answer in their own way. These questions examined factors such as user's perspectives or feelings about using music to represent sender's ID, contents and emotions, music selections, function usefulness and system overview. Furthermore, the data collection for the questionnaires was done through an interview.

6.4. The design of music-matching tasks

The goals of the music-matching tasks were to evaluate user's perceptions of different music works, and whether the selected music works could express or represent the characters of senders, contents and emotional contents properly.

I edited 20 musical segments from different music works as MP3 files that have been burned in a CD, and the length of each musical segment was from about 30 seconds to one minute. Only the length of these music works has been edited (shortened), but the sound quality, harmony and sound colour of the music have not.

These 20 musical segments were divided into three tasks in the experiment. The first task for the characters of senders included six music samples. The second task for the contents included eight music samples. The last task for the emotional contents included the rest of the six music samples.

These music samples were played in a particular order during the experiment. The participants could read the list of options before I started to play the music. After playing each music sample, I would give participants 1-2 minutes to select corresponding choice in the questionnaire, and then continued to play the next music sample. All music samples could be played again if participants asked for it. However, I noted the playing time for each music sample as reference criteria to judge whether these music works were used properly to represent these three features. If there were more than one participant in a single test session (two participants at the most), and if only one participant requested to listen to the musical samples again, I played the music to another participant as well, but another participant was not allowed to modify their answers of the re-played music samples. Furthermore, I did not provide any hints about answers to any of the music samples, and if there were two participants doing the test, they were not allowed to discuss the answers with each other. Thus, participants selected answers for each music work according to their personal feelings and interpretation of the music.

Moreover, during each music-matching task, I asked participants about their feelings and comments on the task when they finished answering. Thus, participants could express and reflect their opinions and thinking instantly.

6.4.1. The first music-matching task

The following music samples have been used in the first music-matching tasks (The sound samples are in the attached CD 1):

1. Beethoven's "Für Elise" was used to represent gentle character
2. Debussy's "Moonlight" was used to represent calm character
3. John Strauss's "Chit-Chat Polka, Op.214" was used to represent lively character
4. Paganini's "Perpetual Motion" was used to represent impatient character
5. Tchaikovsky's "Piano Concerto No.1 in B flat minor, Op.23" was used to represent impassioned character
6. The motif of Beethoven's "Symphony No.5 in C minor" was used to represent serious character

The aim of the first music-matching task was to acquire information about users' cognition of these music works, and test whether users could interpret these music works to the corresponding characters as I expected or not.

There were six choices (characters) for participants to select in the questionnaire. The participants should select different characters for each music sample, such as calm, gentle.

6.4.2. The second music-matching task

The following music samples have been used in the second music-matching task (The sound samples are in the attached CD 1):

1. The theme music of the movie "Mission Impossible" was used for "Work issues"
2. Weber and Berlioz's "Invitation to the Dance" was used for "Date"
3. The song of "Happy Birthday" was used for special event - "Birthday" greeting
4. The song of "Jingle Bell" was used for special event - "Christmas and New Year" greeting
5. "Brindisi" from "Verdi: La Traviata" was used for special event - general greetings
6. "Country Road Take Me Home" was used for "Family issues"
7. Rimsky-Korsakov's "The Flight of Bumble Bee" was used for "Emergency" messages
8. "My Heart Will Go On" was used for "Love messages"

The second music-matching task aimed to test whether these categories of content can be represented by music or not, and also whether these selected music samples could represent these categories of content properly.

There were eight choices for subjects to select in the questionnaire. I listed categories of content for subjects to select as music samples, such as work issues and emergency messages. I separated special events for different contents, such as special event for happy birthday, special event for Christmas and New Year and special event for general greetings. Moreover, I have written a message example for the “Date” category, since it would be helpful for subjects to understand the meaning of that category.

There were three songs with lyrics that have been used in the test: “Jingle Bell” (singing in English), “Brindisi” (singing in Italian) and “Country road take me home” (singing in English). I asked participants whether the lyrics affected their interpretation of these songs or not.

6.4.3. The third music-matching task

The following music samples have been used in this task (The sound samples are in the attached CD 1):

1. “I Think I” was used for relaxed emotion
2. “Full House” was used for cheerful emotion
3. “The theme of Schindler’s List” was used for sad emotion
4. “Ode to Joy” was used for excited emotion
5. Wagner’s “Die Walkure” was used for tense emotion
6. Another segment from Beethoven’s “Symphony No.5” was used for angry emotion

The aim of this third music-matching task was to evaluate whether these different emotions can be represented by the selected music samples or not.

There were six choices for subjects to select in the questionnaire that they were different emotions, such as sad and cheerful. I wrote message examples for these emotions in order to clarify the emotional contents to subjects.

Furthermore, only “Ode to Joy” has lyrics, which were in German. Also the influence of lyrics on participants’ interpretations of music will be taken into account.

6.5. Subjects

The target subjects were defined as two groups: 1. Western users and 2. Asian users. The aim of the interview in these two groups was to investigate how cultural background would affect user’s perceptions or interpretations of music in order to make culture specific design in the further user interface redesign.

There were totally 15 subjects, 7 of them were Finnish as Western users, and 8 of them were Chinese as Asian users. The age range of these subjects was from 25 to 40.

The occupations of subjects were software engineers and students from different disciplines, but nobody had professional musical training before.

6.6. Testing environment and time

The evaluation tests were conducted at my home, where a maximum of two subjects took the test at a time. The testing time was one hour each time. Before the test started, I had prepared all test material which included a questionnaire and a CD which contained all music works that would be played in the test of the music-matching tasks. I introduced the test procedure and goal to participants. The participants could also ask questions about the test.

Firstly, participants were asked to complete the first part of the questionnaire, which took about 10 to 15 minutes. Then participants were guided to select answers of three music-matching tasks, and to provide opinions and feedbacks on each music task among the tasks. There one participant asked to re-play all of 20 musical samples once again, and another 6 participants asked to re-play a total of 8 musical samples once again. The average time to finish the whole process of three music-matching tasks was about 30 minutes. Finally, I asked participants to write comments in the third part of the questionnaire. The last part of the test took about 15 to 20 minutes.

7. Analyzing test results

This chapter presents and analyzes the results of the evaluation test. Firstly, the chapter presents the results of mobile phone short message usage based on the first part of the test. Then, the chapter describes the testing results of three music-matching tasks, and also analyzes whether cultural differences affect subjects' interpretations of each music work or not. Finally, the chapter shows subjects' comments and opinions on the design of this Musical Theme system according to their feedback during the evaluation test and also their answers to the third part of the test.

7.1. The results of short message system usage

The data collected from the first part of the test are used to investigate the frequency of receiving and sending mobile phone short messages. The results are valuable to make future improvements in the design of the Musical Theme system based on users' needs.

I asked participants how often they were sending and receiving short messages (SMS) to evaluate the availability of this Musical Theme system. The most common frequency is 2 (2-6 times a week) among our subjects. The result seems that this Musical Theme system should be a valuable feature in practice (1=every day or more often, 3=about once a week, 4=about once a month, 5=never).

By looking at the survey data, I evaluated whether users typically receive these defined content categories and whether these defined categories of contents are important for users. When asked how "often" the following categories of messages were received, our participants rated them as the results presented in Table 4 (1=very often, 2=often, 3=some times, 4=rarely, 5=never):

Content categories	Frequency of receiving the messages
Special events	2.9
Family issues	3.1
Love messages	3.2
Date	3.3
Work issues	3.3
Emergency events	4.2

Table 4. The frequency of receiving messages of different contents

Moreover, six participants indicated that the following four categories of messages have also been received, and they rate them as information 2, small announcements 2, people's contact information 2.5 and advertisement 3.5.

When asked how "important" the following categories of messages were, our participants rated them as the results presented in Table 5 (1= the most important, 5= not important):

Content categories	Importance of receiving the messages
Emergency messages	1.7
Family issues	1.7
Work issues	1.9
Love messages	2.3
Date	2.7
Special events	2.8

Table 5. Importance of receiving messages of different contents

Two participants have indicated “advertisement” as another category in this question, but the rate of this category is 5.

These results illustrate that all defined content categories are important for users, even though the content is not frequently received by users, for example emergency events. Thus, all of these defined categories of content are worth designing musical tags to represent them for users. Furthermore, no other categories of content should be added in the Musical Theme system, since they are not important for users even though they have been quite often received.

I investigated which item (contents, emotions and senders) should be represented first by music in received messages. When asked how “useful” it was to have some idea about contents, emotions and senders of received messages without reading them, our participants rated senders 1.7 (1=highly useful, 5=useless), contents 2 and emotions 2.5. The result is completely in line with my design that the sender ID is first presented to users. If the sender ID is not available then the content should be presented. Finally, emotions will be represented to users if the other two features are not represented by music.

7.2. Analyzing the results of music-matching tasks

This section presents the total results of three music-matching tasks of all participants (Western and Asian users). The section also compares the results of three music-matching tasks of two different target groups, and analyzes how culture influences the interpretation of music with people from different cultural backgrounds. The aim is to make suggestions for culture specific design in user interface redesign.

7.2.1. The total results of music-matching tasks of all participants

The total recognition rate of six music samples in music-matching task 1 (for sender IDs) was 64%, and the total recognition rate of eight music samples in music-matching task 2 (for contents) was 71%. Moreover, the recognition rate of all of music samples in music-matching task 3 (for emotional contents) was 86%. Most of the participants said that it was easier for them to distinguish emotions rather than contents for different

music. The results illustrated that most of the selected music works can be used to represent the character of senders, contents and emotions properly.

To determine how suitably each musical sample was selected to represent corresponding meanings, I looked at the percentage of accurate selection of each musical sample in three music-matching tasks. Figure 13 shows the percentage of accuracy of each musical sample in the first music-matching task.

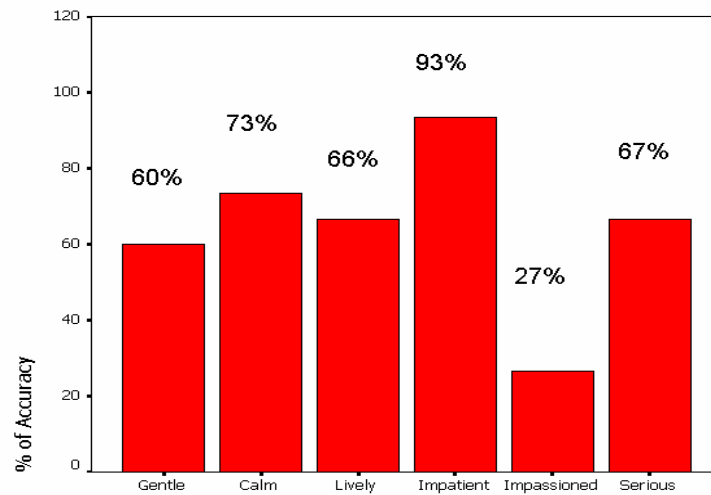


Figure 13. The percentage of accuracy of each musical sample in music-matching task 1.

There was no obvious difference in the accuracy of music interpretation between musical sample 1 (60%), musical sample 2 (73%), musical sample 3 (66%) and musical sample 6 (67%). The accuracy of the fourth music piece (Paganini's "Perpetual Motion"), which was used to represent impatient character, was quite high (93%). However, the percentage of accurate selection for the fifth musical sample (Tchaikovsky's "Piano Concerto No.1"), which was used to represent impassioned character, was very low (27%). Some people have commented that it was difficult to distinguish between calm and gentle, and lively and impatient characters by means of selected music.

The results of second music-matching task have shown that people's interpretations of the content meanings of some musical samples are quite different. Figure 14 shows the sum of accuracy of each musical sample in the second music-matching task.

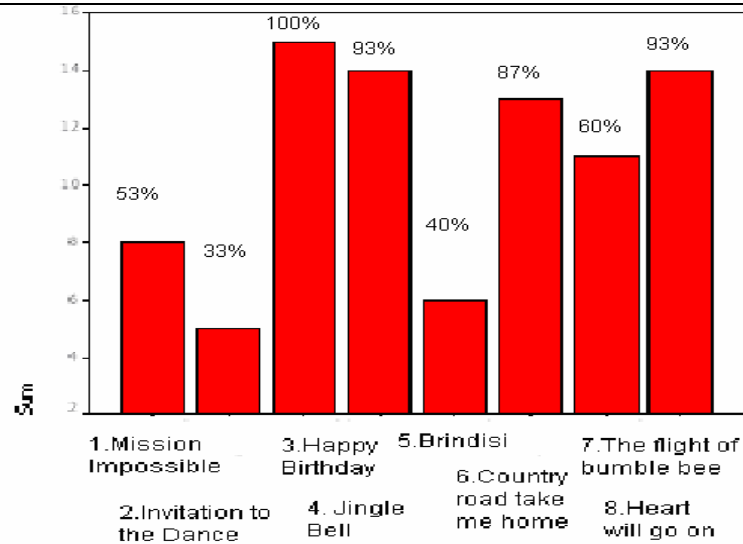


Figure 14. The sum of accuracy of each musical sample in music-matching task 2.

Only five (33%) of the 15 participants have recognized the meaning of the second musical sample (“Invitation to the Dance”) as “Date”, and these five participants are Asian. Only six participants (40%) have considered the meaning of the fifth musical sample (“Brindisi”) as expected for general greetings. However, the accuracy of interpreting “Happy birthday” (100%), “Jingle Bell” (93%), “Country road take me home” (87%) and “Heart will go on” (93%) is extremely high. Therefore, the result has illustrated that people have the same feelings with some popular thematic music works, thus using this kind of music to represent specific meanings is very effective.

Several participants mentioned that they have no idea about what kind of music can be used to represent “Date”. They also said that the music for “Work issue” and “Emergency” were hard to distinguish, since the feelings of both music should be the same. People thought that the lyrics of “Jingle Bell” and “Brindisi” were not useful for determining the meanings of these two musical samples, but the lyrics of “Country road take me home” were helpful. Moreover, some participants said that they would recognize those music samples easier if they could have training.

The results of the last music-matching task are very good (Table 6).

Musical Samples	Represented emotions	N of people	% of accuracy
Music 1 (I think I)	Relaxed	12	80
Music 2 (Full House)	Cheerful	12	80
Music 3 (The theme of Schindler’s List)	Sad	15	100
Music 4 (Ode of Joy)	Excited	13	87
Music 5 (Die Walkure)	Tense	12	80
Music 6 (Symphony No.5)	Angry	12	80

Table 6. The results of accuracy of music-matching task 3.

Majority of participants commented that it was much easier to interpret emotional meanings of music.

7.2.2. Comparison of cultural differences in music interpretation

I have made comparison results for the two target groups of the three music-matching tasks in order to analyze cultural differences in music recognition. Figure 15 indicates the overall differences between Finnish and Asian subjects in three music-matching tasks.

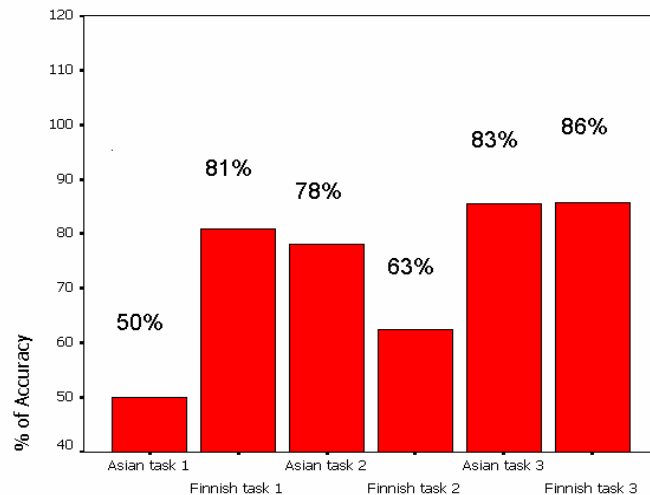


Figure 15. The overall comparison results of three music-matching tasks between Finnish and Asian subjects.

The overall comparison results showed remarkable differences between two groups in music-matching tasks 1 and 2. Compared with the results of Finnish participants in the first task (music for sender IDs), the accuracy of Asian group is quite low (50%), but the result of Finnish group is very good (81%). However, the accuracy of Asian group of the second task (music for contents) is obviously higher than Finnish group, which is 78%, but it is only 63% in the Finnish group.

I have also compared the differences in interpretation between two groups in each musical sample. Figure 16 shows the comparison results of each musical sample in music-matching task 1. The interpretation results of music “Chit-Chat Polka” (musical sample 3) between Finnish and Asian participants are very different. 100% of Finnish participants interpret this music as expected (lively character), but for Asian participants, the accuracy is only 38%.

Moreover, 57% of Finnish participants interpreted music sample 5 (“Piano Concerto No.1”) as for impassioned character, but there no Asian participant (0%) interpreted that musical sample as expected. Therefore, the music works for impassioned and lively characters need to be redesigned for Asian users.

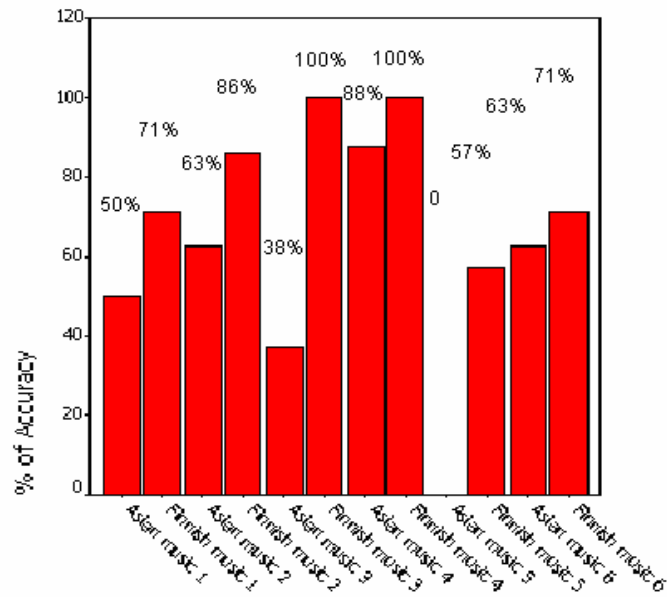


Figure 16. Comparison results of each musical sample in music-matching task 1.

The comparison results of each musical sample of music-matching task 2 showed big differences in musical sample 1, musical sample 2, musical sample 5 and musical sample 7 between the two groups (Figure 17).

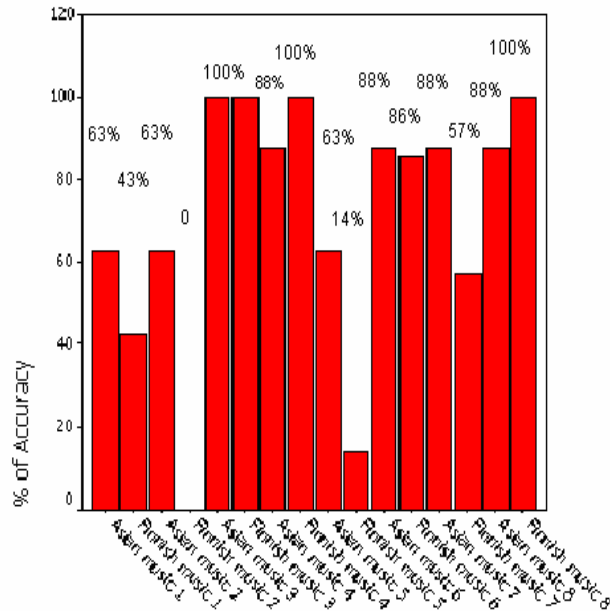


Figure 17. Comparison results of each musical sample in music-matching task 2.

The results of Finnish group of the above-mentioned musical samples are not very good when compared with Asian group.

Musical samples	Comparison results (Accuracy)			
	Finnish group		Asian group	
	Number of people	%	Number of people	%
Sample 1	3	42	5	62.5
Sample 2	0	0	5	62.5
Sample 5	1	14	5	62.5
Sample 7	4	57	7	87.5

Table 7. The comparison data of differences in music-matching task 2.

Table 7 indicates that the differences between two cultural groups of the musical samples with great contrast.

Consequently, the music pieces for “Work issue” (sample 1), “Date” (sample 2) and “General greetings” (sample 5) need to be changed for Finnish users in the user interface redesign.

Finally, the comparison results of each musical sample of music-matching task 3 indicated big differences in interpreting musical sample 1, musical sample 2 and musical sample 4 (Figure 18).

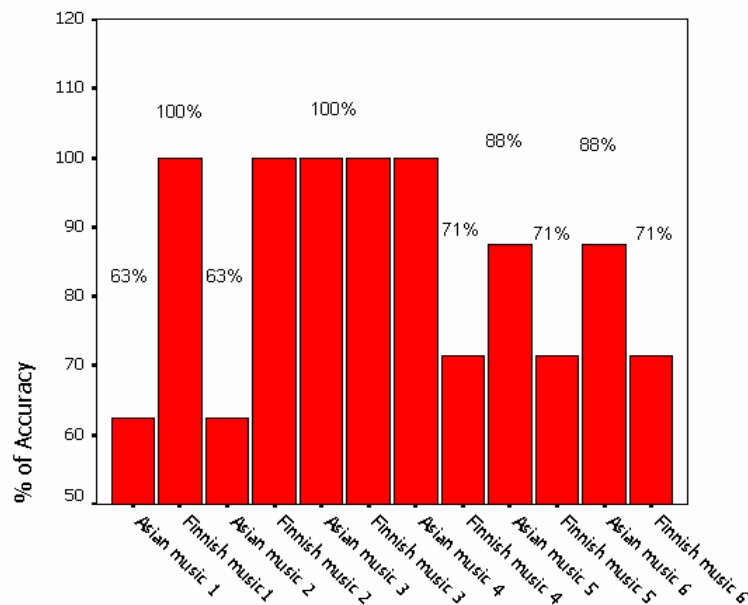


Figure 18. Comparison results of each musical sample in music-matching task 3.

The recognition rate of Finnish group of musical sample 1 (“I think I”) and musical sample 2 (“Full House”) is 100% in music-matching task 3. But the recognition rate of Asian group of these two musical samples is only 63%. However, the accuracy rate of Asian group of musical sample 4 (“Ode of Joy”) is 100%, but the accuracy rate of Finnish group with the same music is 71%.

There are only slight differences in interpretation results of musical sample 5 and musical sample 6 between two groups in music-matching task 3.

Consequently, the music pieces for relaxed and cheerful emotions can be redesigned for Asian users in the user interface redesign.

7.2.3. The results of post-interview for Musical Theme system

I have asked participants' opinions and feelings about using music to represent contents, emotions and sender's characters in the last part of the test. Nine (60%) of the 15 participants agreed that music can represent contents of messages properly, and four people have answered "Maybe", "It depends" or "Not totally". One participant said: "Not in all fields, in general, it's very hard". Two participants have commented that the categories of contents need to be reduced so that will be easier for them to recognize the music for particular contents. Also, one participant said: "For some music which has special meaning or is familiar to the public, it is easier to tell. But some others are not. Different people can have different ideas."

12 (80%) of the 15 participants thought that music can represent emotions of messages properly, and two people have commented as "Sometimes" and "it can represent much but not properly". Only one participant answered that perhaps it does not so well. Moreover, one participant said this: "It can add certain tone, or can be used with opposite meaning to create an ironic effect".

Eight (53%) of the 15 participants agreed that music can represent sender's character, but one participant disagreed. Three participants thought that the music could be used for some people they are familiar with. The rest of the participants said that the sender's character is difficult to represent by music.

In addition, 87% of participants would like to have this Musical Theme system in their mobile phones, since it is an easy way to notice what kind of message they have received before reading it. One participant said that music makes short messages livelier and adds more personality to them. However, one participant has answered that he would use this Musical Theme system depending on the situation, since the sound could be disturbing at work environment or school. Only one people did not prefer to have this system, since it is complicated for him to remember or predefine the music.

Participants have provided the following negative feedback on the Musical Theme system:

- Contents are difficult to recognize, and music cannot represent details of contents. The number of the categories needs to be reduced. Training is needed.
- If there are two conflict words (e.g. sad and happy) in a message, it will be difficult to represent them by music.
- Other people may hear the music as well. If other people (e.g. colleague) recognized the content (e.g. love message), you will feel embarrassed.
- If the music of sender's ID is similar with the music of content or an emotion it will be difficult to distinguish between them.

Participants have also provided the following positive feedback on the system:

- It is convenient for users to know the information of received messages before reading them, and it helps users to decide how to handle the messages without looking at the phone.
- If the message is positive and expected, the user will feel nice when he/she hears the music.
- It is useful for users to be able to identify which message is the most important one. If the user is very busy at that moment, he/she can ignore the messages.
- It is funny, refreshing, effective and efficient. It could show each person's personality and favourites.

7.3. Summary

The evaluation results indicated that senders' IDs should be the first thing to be represented to users. Meanwhile, all those defined content categories are important for users to notice the information.

The overall recognition rates of three music-matching tasks are satisfying. Most of the participants concluded that emotions were very easy to distinguish and recognize through the music. Furthermore, participants with different cultural backgrounds interpreted music differently.

Finally, the feedback from the participants showed that most of them would like to have this Musical Theme system. They also provided valuable comments for the improving the system.

8. Conclusion

Using music as auditory themes to inform the user about sender IDs, contents and emotions of received mobile phone short messages contains several benefits. Music is a universal language that can be interpreted by users without language limitations. Meanwhile, music can be used (defined and selected) by the users according to their personal preferences, thus the music can become a personal language so that it cannot be interpreted by other people but only the user.

It seems that the results are very good if using particular music works with certain meanings to represent corresponding or similar contents of messages. Users could interpret the meanings of these music works accurately without any training. For example, the accuracy was 100% with “Happy birthday” which was used to represent birthday greeting in my test.

Comparing the evaluation results of three music tasks for sender IDs, contents and emotions, the results indicated that emotions were easier and more accurately represented by music than characters of senders and contents of messages.

My evaluation showed that most of the music works in my design were recognized as expected by over half of the participants. The recognition rates can be even higher if the users could define or select music by themselves. According to participants’ feedback, different people can interpret the same music with different meanings depending on the people’s own experiences. However, people can learn to interpret music as expected by training. Consequently, customization of music is a very important and useful function for users, and the design should allow users to define, compose and download different music works for senders, contents and emotions as they wish.

Moreover, most of the participants regarded the idea of the design as useful. It will be helpful for users to plan their reactions to the received messages without reading them when they are busy.

However, some improvements are still needed in the further design of a real system. The lengths of musical samples in the test were quite long (30 – 60 seconds), the lengths should be shortened in the further design. All music works need to be edited to a maximum of 30 seconds, and the important music themes (motives) should be no longer than 30 seconds. Thus, users do not need to listen to a too long ringing tone, and they can understand the meaning of the music immediately.

In addition, the music selections of the system should be more careful. The selected music works must be typical samples of their category to properly convey the meanings and information of represented messages.

Furthermore, the comparison results of the two cultural groups showed that cultural differences affect the user’s interpretations of different music. Some music can be used for different cultural groups of users. However, some music can be used only for one

cultural group, but not for another. Thus, the music should be carefully designed for different cultural groups of users in the further user interface design so that the understanding of the musical culture for different cultural groups could be most advantageous.

Finally, the issues of copyright protection should be considered in the real product design.

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Possible music works for sender IDs, contents and emotions

Groups of music	List of music for each group
Lively	<ul style="list-style-type: none"> • Motif of Mozart “Symphony No.40 in G minor, K550” • Motif of Mozart “Starlet Variationen in C major, K264” • Motif of John Strauss “Chit-Chat Polka, Op.214”
Gentle	<ul style="list-style-type: none"> • Motif of Chopin’s Nocturne No.1 in B flat minore Op.9, No.1. • Motif of Beethoven “Fur Elise” • Motif of Henry Mancini and Johnny Mercer “Moon River”
Calm	<ul style="list-style-type: none"> • Motif of Debussy “Moonlight” • Motif of Saint-Saens “Swan” • Motif of Burgnueller “Pastorale Op.100 No.3”
Impassioned	<ul style="list-style-type: none"> • Motif of Chopin “Piano-Etude Op.10 No.12” • Motif of Beethoven (“Appassionata”) Piano Sonata in E flat, Op.57” • Motif of Tchaikovsky “Piano Concerto No1 in B flat minor, Op.23”
Serious	<ul style="list-style-type: none"> • Motif of Beethoven “Symphony No.5 in C minor” • Beethoven “Piano Sonata No. 8 in C minor ("Pathétique") Op. 13”
Impatient	<ul style="list-style-type: none"> • Motif of Moszkowski “Piano-Etude Op.72 No.2” • Motif of Paganini “Perpetual Motion (Moto perpetuo), Op.11”

Table 1. Possible music works for Sender IDs

Categories of contents	Music works
Work issues	The theme music of the movie “Mission Impossible”
Family issues	<ul style="list-style-type: none"> • “Home Sweet Home” • “Country Road Take Me Home”
Date	Weber and Berlioz’s “Invitation to the Dance”
Emergency	<ul style="list-style-type: none"> • Rimsky-Korsakov “The Flight of Bumble Bee” • A music segment from cartoon film “Mickey’s upon Twice A Christmas”
Special events (e.g. Birthday, Christmas, New Year, General greeting)	<ul style="list-style-type: none"> • “Happy Birthday” is for Birthday. • “Silent Night” (or other Christmas songs) is for Christmas. • The song of “Happy New Year” is for New Year. • “Brindisi” from “Verdi: La Traviata” is for general greetings.
Love messages	<ul style="list-style-type: none"> • “Casablanca” • “Beauty and Beast” • “Heart Will Go On” • “I Will Always Love You”

Table 2. Possible music works for each category of contents.

Categories of emotional contents	Music works
Excited	<ul style="list-style-type: none"> • “La Copa De La Vida (The Cup of Life)” • Beethoven’s “Ode to Joy” in “Ninth Symphony”
Cheerful	<ul style="list-style-type: none"> • “Full House”, a music segment from Korea TV serial program “Full House” • Johann Strauss II “Frühlingsstimmen; Walzer; Op.410”
Relaxed	<ul style="list-style-type: none"> • “I Think I”, a music segment from Korea TV serial program “Full House” • Bandari’s “Childhood Memory” • Music theme from Chinese cartoon film “Zhuang Zi”
Sad	<ul style="list-style-type: none"> • A music segment from Korea TV serial program “Full House” • A music segment from Sarasate’s “Zigeunerweisen, Op.20” • Music theme from the movie “Schindler’s List”
Tense	<ul style="list-style-type: none"> • Wagner’s “Die Walkure” • Music segment “The Encounter” or “Night Fight” from movie “Crouching Tiger, Hidden Dragon”
Angry	<ul style="list-style-type: none"> • The third movement of Beethoven’s “Moonlight Sanata” • Beethoven “Symphony No.5 in C minor”

Table 3. Possible music works for each category of emotional contents.

Test Plan

Step 1: Determining subjects

The analysis will involve two groups: 1.) Subjects with Western culture background
2.) Subjects with Asian culture background.

Step 2: Designing the evaluation tasks

Designing questionnaire and evaluation tasks based on the goal of the testing.

Step 3: Recruiting participants

Reserving time with the participants for the test, and the test will be started on week 11 (13th March), 2006.

Step 4: Choosing the location

The test will be conducted at my home.

Step 5: Preparing test materials

Preparing all test materials before the test including a questionnaire and a CD which contains all music works that should be played in the test for the music-matching tasks.

Step 6: Conducting a pilot test

Conducting a pilot test early in order to ensure testing procedure and check if the questionnaire needs to be modified.

Step 7: Conducting evaluation test (about 1 hour for each subject)

- 7.1. Introducing the testing procedure and goal to subjects. Participants can ask questions about the test.
- 7.2. Asking participants to complete the first questionnaire.
- 7.3. Explaining the first music-matching task and the idea of using music to represent different characters of senders as Sound IDs. The task requires participants to listen to six pieces of music, and select corresponding character for each piece of music.
- 7.4. Participants can ask questions about this task, and they can read all of the choices before I start to play the music.
- 7.5. Playing music works for the first music-matching task. Participants could have time to select answers for each music work when the music is stopped. I will play the music again if participants asked.
- 7.6. When participants finish this task, I will ask their comments for this task.
- 7.7. Explaining to the participants the idea of using music to represent content categories in the second music-matching task. This requires participants to listen to eight pieces of music, and select corresponding content for each of them.
- 7.8. Participants can ask questions about this task, and they can read all choices before I start to play the music.

- 7.9. Playing music works for the second music-matching task. Participants could have time to select answers for each music work when the music is stopped. I will play the music again if participants asked.
- 7.10. When this task is finished, I will ask participants' comments for this second task.
- 7.11. Explaining to the participants the idea of using music to represent emotional contents for the third music-matching task. This requires participants to listen to six pieces of music, and select corresponding emotional content for each music work.
- 7.12. Participants can ask questions about this task, and they can read all of choices before I start to play the music.
- 7.13. Playing music works for the third music-matching task. Participants could have time to select answers for each music work when the music is stopped. I will play the music again if participants ask.
- 7.14. Asking participants' comments for the third task when the task is finished.
- 7.15. Participants will be asked to complete the last questionnaire.

Step 8: Collecting data

All participants' answers will be collected after they complete the test.

Questionnaire for the evaluation of mobile phone musical short message system

Part 1: Questionnaire

Nationality:

Age:

Gender: Female Male

Occupation:

1. *How often do you use mobile phone short message system (SMS) to send messages?*1) Every Day or More Often 2) 2-6 Times a Week 3) About Once a Week 4) About Once a Month 5) Never 2. *How often do you receive text messages via mobile phone short message system (SMS)?*1) Every Day or More Often 2) 2-6 Times a Week 3) About Once a Week 4) About Once a Month 5) Never **Please indicate your personal ranking about each listed question below from (1) very often, (2) often, (3) sometimes, (4) rarely, (5) Never.**3. *What kinds of message do you usually receive from other people?*

Work issues (includes study issues)

1 2 3 4 5
○ ○ ○ ○ ○

Family issues

1 2 3 4 5
○ ○ ○ ○ ○

Special events (e.g. Birthday Greeting or other greetings)

1 2 3 4 5
○ ○ ○ ○ ○

Date

1 2 3 4 5
○ ○ ○ ○ ○

Emergency event

1 2 3 4 5

	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Love messages (e.g. messages from your girlfriend or boyfriend; messages express some special meanings)	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
Others <input style="display: inline-block; vertical-align: middle; margin-right: 10px;" type="text"/> (Please specify)	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>

Please give a ranking for the following question. 1: The most important 5: Not important

4. *What kinds of message are important for you to read?*

Work issues (includes study issues)	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Family issues	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Special events (e.g. Birthday Greeting or other greetings)	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Date	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Emergency event	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Love messages (e.g. messages from your girl girlfriend or boyfriend; messages express some special meanings)	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Others <input style="display: inline-block; vertical-align: middle; margin-right: 10px;" type="text"/> (Please specify)	1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Please give a ranking for the following three questions. 1: Highly useful 5: Useless

5. *Would it be useful to have some idea about the contents of received short messages without reading them?*

1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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6. *Would it be useful to have some idea about the emotions of received short messages without reading them?*

1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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7. *Would it be useful to know the senders of received messages without reading them?*

1 2 3 4 5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
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Part 2: System evaluation

- 1 Please listen to the following music works and select corresponding character or personality for each music work.

*Character (Personality): 1.Lively 2.Gentle 3.Calm 4.Impatient 5.Serious
6.Impassioned*

Music works	Please write corresponding character (or number of the character) in this column
Music piece 1	
Music piece 2	
Music piece 3	
Music piece 4	
Music piece 5	
Music piece 6	

- 2 Please listen to the following music works and select corresponding content for each music work.

Contents of messages:

1. *Work issues*
2. *Special event: for example: "happy birthday."*
3. *Family issues*
4. *Special events: for example: "Merry Christmas and Happy New Year."*
5. *Emergency messages*
6. *General greetings: for example: "Congratulations!"*
7. *Date: for example: "The party will be started tomorrow at 7:00PM".*
8. *Love messages*

Music works	Please write corresponding content (or number of the content) in this column
Music piece 1	
Music piece 2	
Music piece 3	
Music piece 4	
Music piece 5	
Music piece 6	
Music piece 7	
Music piece 8	

- 3 Please listen to the following music and select corresponding emotional content for each music work.

Emotional contents:

1. *Sad: for example "I am not very happy today".*
2. *Relaxed: for example: "I have finished my work."*

3. *Excited: for example: "I have got a job!"*
4. *Cheerful: for example "I have heard good news."*
5. *Angry: for example: "I am so angry because of his rude manner."*
6. *Tense: for example: "Our examination will be started in two minutes."*

Music works	Please write corresponding emotional content (or number of the emotional content) in this column
Music piece 1	
Music piece 2	
Music piece 3	
Music piece 4	
Music piece 5	
Music piece 6	

Part 3: Post-interview for musical short message system

Do you think that music can represent contents of messages properly?

Do you think that music can represent emotions of messages properly?

Do you think that music can be used to represent sender's character?

Would you prefer to have this musical short message system in your mobile phone? Why?

Are there any negative points for using music to represent sender IDs, contents and emotions for mobile short messages?

Are there any positive points for using music to represent sender IDs, contents and emotions for mobile short messages?

Do you have any other special comments on the idea of using music to represent sender IDs, contents and emotions for mobile short messages?

Thank you!

Note: This information is for research purposes and will be treated in confidence.