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January 2010

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s0124850

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Januari 2010

Rhyming is a critical competence for reading success. For children with a cochlear implant, the development of rhyming is not an automatic process. It has to be educated by practicing and repeating it frequently. This paper elaborates on the design of a game to support the development of rhyming skills for children with a cochlear implant. For the designing process, the waterfall model is used. The requirements of the game were derived from a literature study and discussions with teachers (n=6) and therapists (n=4) (speech, movement and play) based on two questions. First: how do children with a cochlear implant learn rhyming to develop their phonological awareness? And second: what kind of educational method should be designed to support the learning process of rhyming in children with a cochlear implant? The final product of the study is a blended game. It concerns domino-like stones with pictorial signs and an audio-visual support package. The game is tested at the professor Huizingschool in Enschede, the Netherlands, with four children with a cochlear implant. The children enjoyed playing the game and were motivated to try to find rhymes and win the game, especially when played one by one. Also the teacher and a speech therapist were enthusiastic about the game. A firm conclusion about the effect of the game cannot be drawn however, because of the limited amount of test subjects. A quantitative study will be useful to compare the game with other methods or to include a control group.

For the development of rhyming skills in children with a cochlear implant, very little methods to support the learning process are available. The methods that are available are seen as unsuitable. Therefore, in this study, the goal is to design an educational game to support the development of rhyming skills in children with a cochlear implant. This will be done on the basis of a 'waterfall model', which will be described later.

It is important that children learn how to read because reading is a basic requirement in education and someone's career. Most of the information, especially at school, has to be collected through reading (Vernooy, 2007). In education a classification is made between preparations on reading, novice reading and advanced reading. Advanced reading is divided in advanced technical reading, reading comprehension and studying text/information

processing. Technical reading is the first aspect of advanced reading, which has to do with the decoding of words and with the speed of reading. Technical reading is the basis for reading comprehension (Hoover & Gough, 1990; Vernooij, 2007). Reading comprehension is in turn the basis for requiring good skills in studying text. However, before being an advanced reader, someone is a novice reader. Novice reading can be seen as technical reading for beginners. The preparation phase therefore focuses on technical reading and it starts with recognizing phonemes, which are the smallest pieces of speech. They are the pieces of sound which indicate changes of meaning, like the different sound of the first consonants in 'rose' and 'nose' (Berk, 2006). The next step in the preparation phase, is the phase in which children learn that words consist of different sounds and syllables. This is called phonological awareness. Phonological awareness is a very important part of the preparation phase. It is seen as the foundation of the development of reading (Colin, Magnan, Ecalle & Leybaert, 2007; Harris et al., 2006; Narr, 2006, 2008; Sterne & Goswami, 2000). Usually this awareness develops spontaneously between the age of 2 and 3 (LaSasso, Crain & Leybaert, 2003).

Rhyming plays a key role in the development of the phonological awareness. It supports awareness of the fact that words consist of different sounds and it supports rhythmic sensitivity (Spencer & Tomblin, 2008; Wauters, de Klerk, van der Eijk & Knoors, 2008). Hearing children develop rhyming skills automatically. These children are able to hear that some words sound the same and automatically develop a 'sound based' connection between these words. But what if a child cannot hear?

When a child is born deaf, the automatic development of rhyming is hampered. It starts during pregnancy, when the child never hears the mother's voice. Deaf born children have little to no access to the phonological part of language (Charlier & Leybaert, 2000; Knoors, 2001; Wauters et al., 2008). When they do have access, they show slow and inaccurate skills of decoding (Knoors, 2001). Even when children get the instruction to pay attention to phonological aspects, they prefer using an orthographic code (Wauters et al., 2008). Using an orthographic code means that they pay attention to the spelling of the words. A lot of words that rhyme are written similar at the end, so they will frequently be correct. Some words, however, rhyme although the spelling is different. Deaf children will not recognize these words as rhyming. In short, the development of rhyming of deaf children starts late, is poor and is based on another way of thinking (Charlier & Leybaert, 2000).

It is important however for deaf children to develop rhyming skills. Rhyming, the key factor in developing phonological awareness is a critical dimension for reading success (Narr, 2006). There are methods to teach deaf children how to rhyme in a sound based manner (Narr, 2006). One is called ‘Cued speech’. In this method the speaker holds one of his/her hands close to the face while talking. The speaker supports lip-reading with a cue (Charlier & Leybaert, 2000). The shape of the hand indicates which consonant has been used. The location of the hand indicates the vowel following that consonant. Eight shapes of the hand and four locations close to the face are enough for the English sound system, which can be found in figure 1. The hand signs always have to be interpreted together with lip-reading. The way someone gives a cue also relates to speed, melody and accentuation of talking.

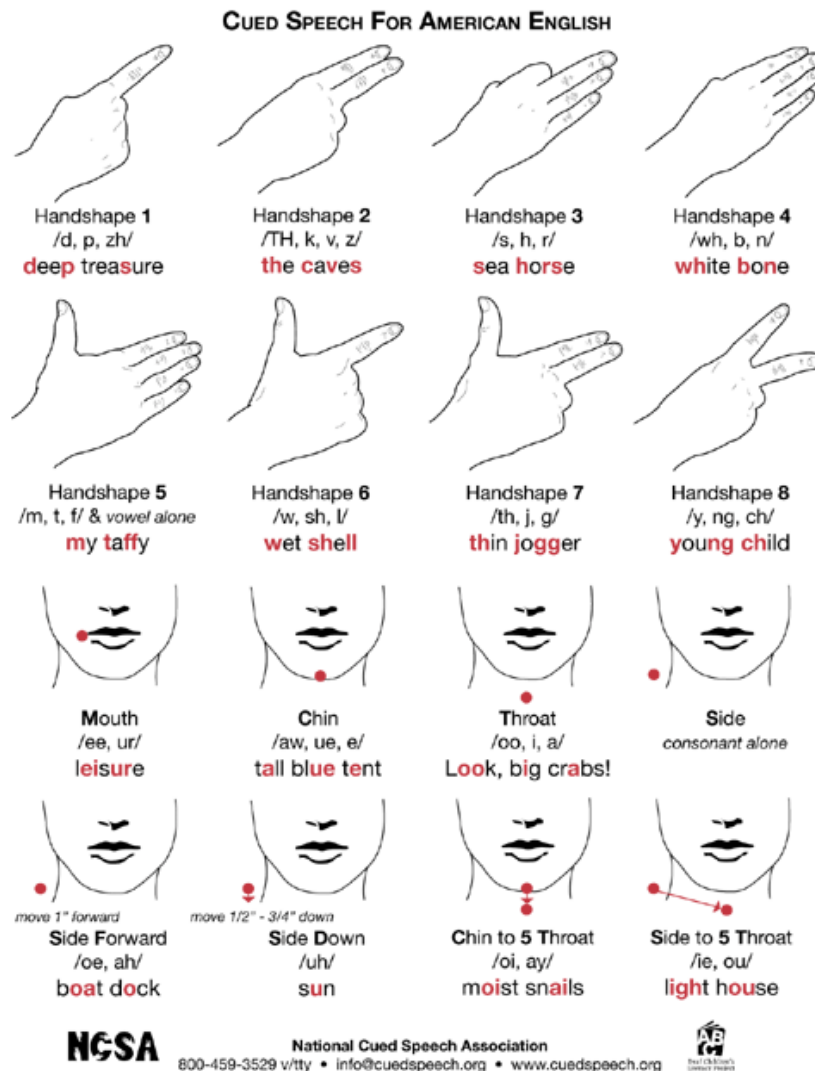


Figure 1. Cued speech for American English

Another method, which is based on the same principle, is called ‘Visual phonics’ (Narr, 2006; 2008). Visual phonics consists of 45 hand and grapheme cues. The hand cues provide visual and kinaesthetic information that can be associated with the way a sound is produced verbally. An example is the ‘p’ sound. This sound is represented with a hand cue that simulates the ‘explosiveness’ of how a ‘p’ is produced verbally; the air being released from the lips (Narr, 2006; 2008). Another example is shown in figure 2.

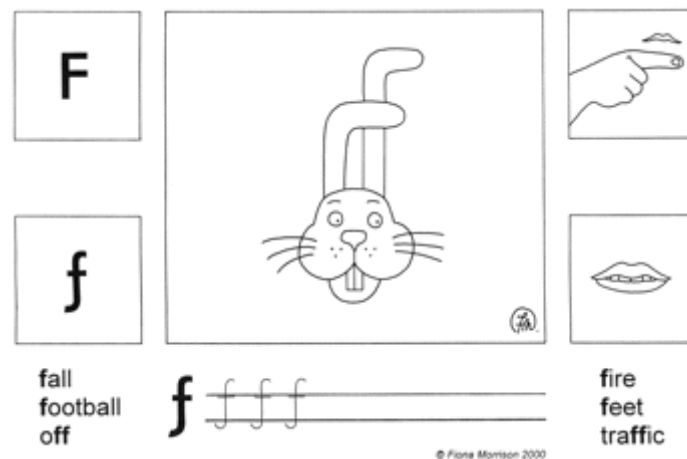


Figure 2. Visual phonics of the letter ‘f’

These two methods were used in the eighties/early nineties. Nowadays they are not used anymore because of developments in neonatal screening, hearing aids and especially cochlear implantation. Forty years ago, the possibility to (partially) repair the hearing of deaf people with a cochlear implant was discovered. A cochlear implant (CI) is a surgically implanted electronic device that provides a sense of sound to a person who is profoundly deaf or severely hard of hearing (Loizou, 1999). Unlike hearing aids, the cochlear implant does not amplify sound, but works by directly stimulating any functioning auditory nerves inside the cochlea with an electric field.

Children with a CI often use sign language to comprehend the context of conversations. The need of these signs however, does not mean that they learn rhyming in the same way as deaf children, who learn rhyming with the use of an orthographic code. The fact that they have access to language in an auditory way however, neither means that these children learn

rhyiming in the same way as hearing children, who learn rhyiming automatically in a fully auditory way. This is a pitfall for a lot of parents/guardians, as well as for teachers. Speech of children with a CI is often pretty good, which does not mean that the development of language has an appropriate level. Articulation and language skills are different issues (Connor & Zwolan, 2004; Marschark et al., 2007). A lot of research has been done on this topic. For example, a study of Svirsky et al. (2000) and a study of Vermeulen et al. (2000) shows that children with a CI have significantly better reading and language skills than deaf children, but score significantly lower than hearing children. Another study, of Spencer and Tomblin (2008) shows that children with a CI score better on rhyiming tasks than deaf children, but they score lower than hearing children.

Summarizing what is mentioned before; rhyiming is a significant predictor of word reading for deaf children using CIs (James, Rajput, Brinton & Goswami, 2009). It is a key factor in developing phonological awareness which is a critical dimension for reading success (Narr, 2006). The development of the cochlear implant provides improvement in developing rhyiming skills in former deaf children. However, they still score significantly lower than hearing children (Svirsky et al., 2000). The phonological processes do not arise automatically. They have to be educated explicitly, which needs a lot of practice.

The problem is, a lacking possibility for children with a CI to practice rhyiming. Some methods are fully based on sign language, which is not necessary for children with a CI. Other methods are fully based on hearing children, which is also not applicable for children with a CI. Children with a CI perform best when two ways of communication can be offered: speech and sign language. Those two support each other and make children understand the complete information (Marschark et al., 2007). Next to the lack of methods, 35% of the children with a CI struggle with additional problems like lower intelligence, which influence the development and learning (Langereis & Vermeulen, 2009). These children often have a low attention span and problems with concentration. Fifteen minutes of concentration is already long. The existing methods, for regular education and for deaf education, are most of the time games. Games seem to be suitable for educational goals. A study of Vygotsky and Elkonin (in Gastão Salies & Starosky, 2008) in the developmental psychology shows that a positive relation exists between playing games and language and cognitive development. Next to this, a game makes an appeal on behavioural aspects, like learning to cooperate and improving awareness and motivation. Figure 3 shows a motivation model of Jovanovic

(2008) for playing a game. The aspects of a game will trigger intrinsic motivation. Intrinsic motivation is one of the three categories in which the term ‘motivation’ often is divided. The second category is extrinsic motivation. This category is about doing things due to external factors like punishment or a reward (Dondlinger, 2007). The third category is called ‘amotivation’. This is the situation when motivation is completely absent (Dondlinger, 2007; Jovanovic et al., 2008). When motivation is absent, information will not be stored correctly, which diminishes personal development (Jovanovic et al., 2008).

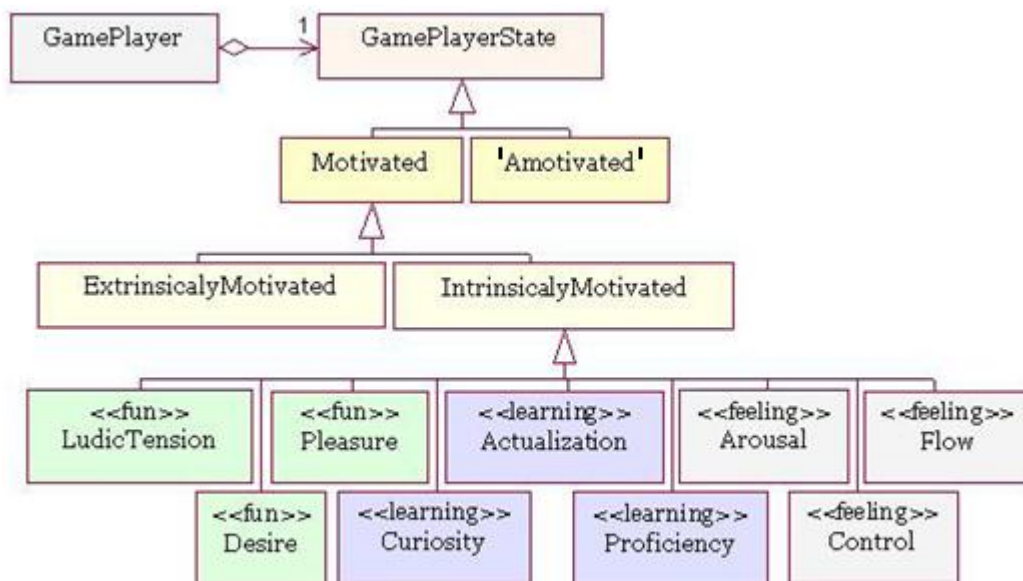


Figure 3. Model of motivation (Jovanovic et al., 2008)

The fact that a positive relation exists between playing games and language and cognitive development and that a game makes an appeal on learning to cooperate and improving awareness and motivation are considered of great importance for this design study. It indicates that a game could be especially suitable for supporting the practice of rhyming skills in children with a CI, also because of their additional problems.

The fact that there is a lack of educational methods for children with a CI, and the fact that a game seems to be very suitable, is the inducement in this study to design an educational game to support the development of rhyming skills in children with a CI.

Waterfall model

Many design studies use an iterative model. An iterative design model denotes feedback loops between the individual steps. This way, a process and the final design can be improved. However, because of lacking time in this study another model is used. The model which is used is called the waterfall model, a model in which every step leads to the following step. Figure 4 shows the model for this study. The model is straight forward. First a preliminary examination is done which supports creating the requirements and design conditions. Second, the design starts. The third step is the realisation and the construction of the game. Fourth, when the prototype of the game is finished, the game is played with children out of the target group, to test the game. Fifth, an evaluation of the game itself and of all the steps taken before is done, so recommendations to revise the game and/or process can be given.

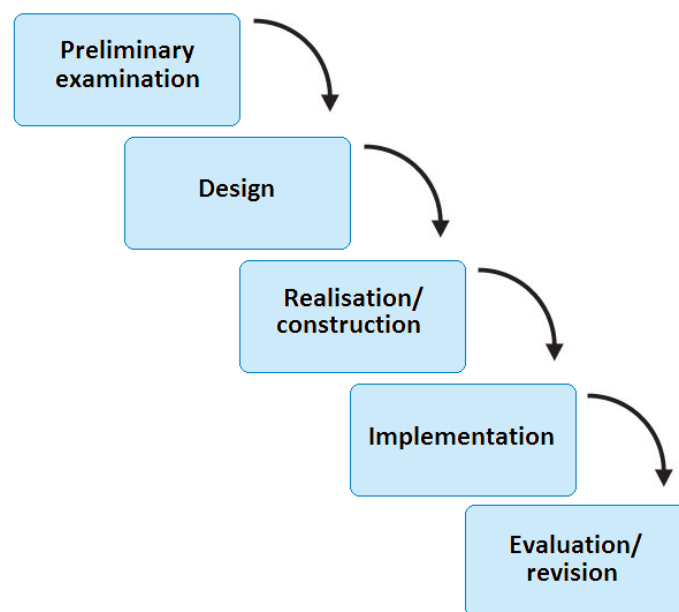


Figure 4. The waterfall model for designing the game.

Requirements

The first step in the design process is to define requirements. To define these requirements, four types of analysis are done. First, an audience analysis is done to state the

target audience for the study. After this, a needs analysis is done and an analysis of the content. Requirements for the needs and the content of the game are derived from a literature study and from extensive conversations with different kind of therapists (speech, play and movement), teachers and researchers. The last part is a task analysis. The four kinds of analysis are described in more detail in the next paragraphs.

Audience analysis

The audience is often referred to as the end user. This means that it is about the people who are supposed to play the game and what their characteristics are. In this study the audience will be children with a cochlear implant who just started to learn rhyming. At the moment, for children with a CI, that means these children are 8-11 years old, depending on their deprivation in the development of phonological skills and also depending on the age of implementation. Because the age of implementation is declining, the expectation will be that the target age for the next years, will also be lower.

As described before, children with a CI got back a part of their hearing. However, the degree to what their level of hearing recovers varies a lot and often they need sign language or other visual information to get the context of words or sentences. Also 35% of the children with a CI struggle with additional problems like lower intelligence, which influence the development and learning. These children often have a low attention span and problems with concentration.

Needs analysis

A need indicates a difference between what currently exists and a more desirable state (Bartholomew et al., 2000). That means that it is important to find out what games currently exists with regard to the support of rhyming for children with a CI in the Netherlands, and what is needed to complement these games.

First, a description of games, used in regular education, to support rhyming is given. These games are not especially focused on children with a CI, but they are focused on children who just started rhyming. The first game in this area is a 'rhyme domino'. The game

is from publisher 'Zwijssen', the Netherlands. It consists of 28 cards, 1 joker and a description of the game. The idea is to make a chain of cards by linking cards based on rhyme. The game should stimulate the language, the cognitive and the social development. A second game from the same publisher is called the 'ri-ra-rhyme game'. This game is based on rhyming spoken words, so it is about rhyming in an auditory way. The game should also stimulate the language, the cognitive and the social development. Another game is based on rhyming with the use of an orthographic code. Children have to make rhyming connections with different written words. The last applicable rhyme game in regular education is a game from the Mini Loco series from publisher Noordhoff. This game is based on connecting drawings based on rhyme. The games described above are not used in special education for children with a CI because they are not suitable for these children. The games miss some extra rehearsal on the auditory aspect of rhyming and they do not include different ways of communication (signs and spoken language).

Second, a description is given of available methods to support rhyming on the prof. Huizingschool. The first method at the school is a DVD with movie poems in sign language. These poems are very complicated and therefore not accessible for children. But the most important disadvantage of this method is the specific focus on totally deaf children. The rhymes are based on signs (signs that look the same) and have nothing to do with phonological awareness as a predictor for reading. A second DVD at the school is called 'this is how you rhyme'. This method also uses rhyming based on signs and is not suitable for developing phonological skills.

In short, there are some educational games/methods which support the development of rhyming. However, these games are made for either hearing children or for deaf children. Children with a CI need extra visual information (signs, pictures), but can learn rhyming in an auditory way. Another disadvantage of the games/methods mentioned before is that feedback, which is important for learning (Kirriemuir et al., 2004; Parras & Bizzocchi, 2005), is not included, is given indirectly or can only be given by fellow players or by the teacher who in turn has to be included in playing the game. As these types of games do not reach the full needs of children with a CI and lack an efficient use of feedback, another game/method has to be designed to meet these requirements.

Content analysis

In this study, the content analysis is concerned with the requirements definition of the content of the game. The first requirement is that an educational game needs a goal, a learning goal and some rules (Dondlinger, 2007; Fu & Yu, 2008; Garris et al., 2002; Jovanovic et al., 2008; Kirriemuir et al., 2004; Parras & Bizzocchi, 2005). The goal of a game is not necessarily the same as the learning goal. The learning goal of the game in this study is to develop rhyming skills, but the goal of the game can be to score the most points or to lose or win cards as fast as possible. The learning goal in an educational game however, is of bigger importance. A requirement of the content is that children learn the principle of rhyming and that they not only remember the rhyming words from the game. The final goal is that they can apply this skill in different situations and contexts. The idea of remembering, understanding and applying is based on the lowest layers of Bloom's revised taxonomy (Schultz, 2007). The full model is shown in figure 5. Remembering, understanding and applying are lower order thinking. Analysing, evaluating and creating are mentioned as higher order thinking (Schultz, 2007). In this study, only lower order thinking will be important.

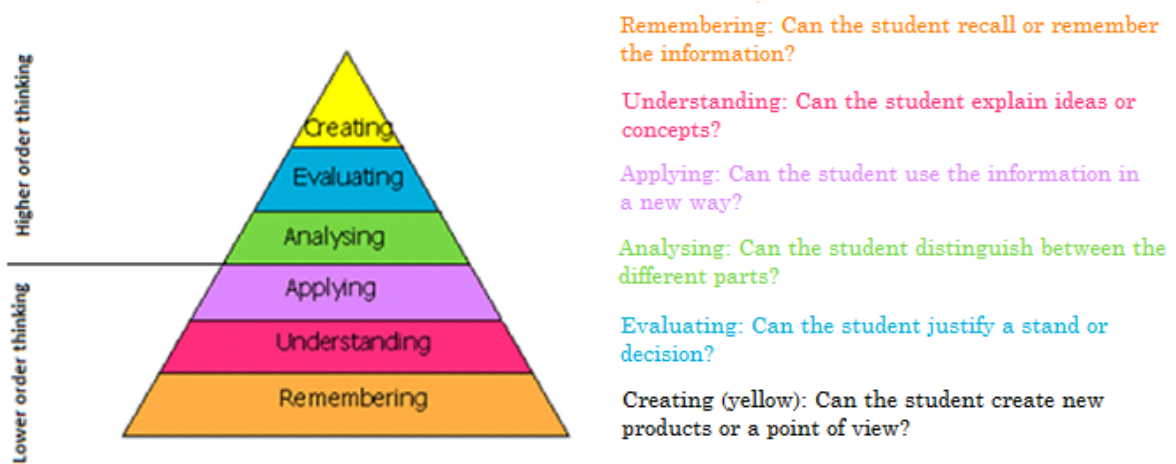


Figure 5. Bloom's revised taxonomy (Schultz, 2007)

Second, to motivate players and to keep them motivated, the game needs to challenge them (Amory, 2007; Fu & Yu, 2008; Garris et al., 2002; Kirriemuir et al., 2004; Parras & Bizzocchi, 2005). Challenge is important to get players involved in game play. When the level of challenge is too high for the skills of the player, he/she might become reluctant. When the level of challenge is too low, someone gets bored. Both of these situations interfere

with the process of the game (Fu & Yu, 2008; Parras & Bizzocchi, 2005). Players wish for an optimal level of challenge (Garris et al., 2002).

Third, a game has to include interactivity. Interactivity in a game is in the first place a mutual exchange of information between two players (Gunter et al., 2008). This exchange of information is, according to recent learning theories, one of the most important components of learning (Amory, 2007). When the meaning of a game is to learn something, it is necessary that some interactivity is integrated in the game (Dondlinger, 2007). Social interactions can be cooperation, competition or a combination of both (Dondlinger, 2007). Often, competition is the most important part of a game, which gives the player a feeling of achievement and success (Wideman et al., 2007). In this game, competition is the most important aspect of interactivity as well. It is about who loses his/her cards first. When the game is played with opened cards, also cooperation can play a role, because players can help each other finding rhymes. A second aspect of interaction is 'action-reaction'. During the game, an action that is taken by one of the players, will lead to a different situation in the game (Leemkuil & de Jong, 2004). By the action of the player, a reaction of the system or of another player is triggered (Leemkuil, 2006). This action-reaction gives a meaning to the interaction (Salen & Zimmerman, 2004) and enables the player to determine if he/she is closer to his/her goal or already achieved it (Leemkuil, 2006). For children it is very important that action-reaction exists in a game to keep them involved in the game. For children with a CI it is even more important because for these children it is often difficult to maintain concentration. A reaction on an action is also feedback to a player. Feedback is of great importance in a game (Kirriemuir et al., 2004; Parras & Bizzocchi, 2005), as mentioned before. Through feedback, a player stays involved in the game because he/she can find out if a goal is near or if the right steps are taken to achieve a goal (Kirriemuir et al., 2004).

The fourth important requirement of the content of the game, which has to do with the target group in this study, is that the game has to be tangible but needs support from the computer. Children with a CI perform best when two ways of communication can be offered: speech and sign language. Those two support each other and enables children to understand the complete information (Marschark et al., 2007).

The fifth requirement for the content of the game is that rhymes in the game has to be based on the auditory aspect and not on signing aspects, as in the existing games for deaf education.

The last requirement, discussed with teachers and therapists is that the game has to fit in the language method “Leepad”, which is used at different schools in the Netherlands for deaf and hearing impaired children and for children with speech difficulties.

Task analysis

The task analysis in this study is about which tasks the audience has to perform when playing the game. This is straight forward. They have to make rhymes by focusing on the auditory aspect of rhyming with the support of drawings and signs.

The design

The game designed during this study is a, so called, blended game to make the game suitable for children with a CI, who need different types of communication (visual and auditory). It consists of cardboard cards and an audio-visual support package.

The cards in the game are the tangible aspect of the game. In total, 55 cards are included so playing the game with a group of about 8 to 10 children is possible. A card consists of two parts that are different most of the time, but can also be similar. Each part consists of a picture of an object and a small picture of a person who shows the related word in sign language. This is because children with a CI need extra visual information (sign language) to learn in an efficient way, which is mentioned before. Examples of the cards are shown in figure 6.

All the cards will be turned around so that the drawings cannot be seen. Every player gets a certain amount of cards with the two drawings on it, depending on the amount of players. The other cards will be left aside and will be used later. The player with two houses starts. When no one has two houses, then the one with two mice starts. When no one has two mice, the one with two chickens starts (etcetera). The player that starts has to put the card in the

middle of the table. Now, it is the next player's turn. One of the words on a card he/she has to rhyme at a word on the card on the table. When the player has a rhyming word, he/she can connect his/her card to the card on the table. When the player does not have a rhyme or the rhyme that is made is incorrect, he/she has to get an extra card. It is the next player's turn (etcetera). When someone wants to connect a card to the cards on the table, he/she can only rhyme at the cards at the end of the chain, the cards with three free sides, shown in figure 7.

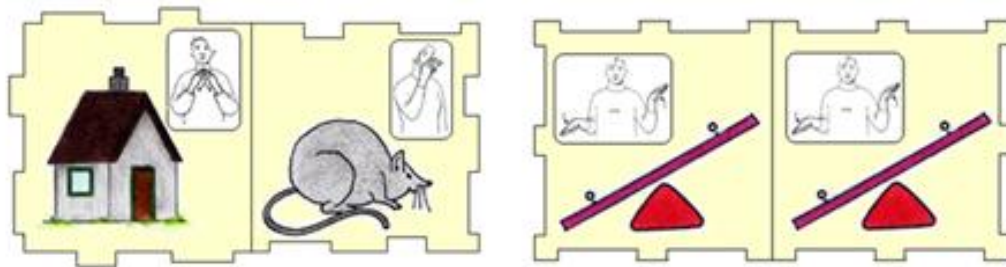


Figure 6. Two cards of the game, one with different parts and one with similar parts.

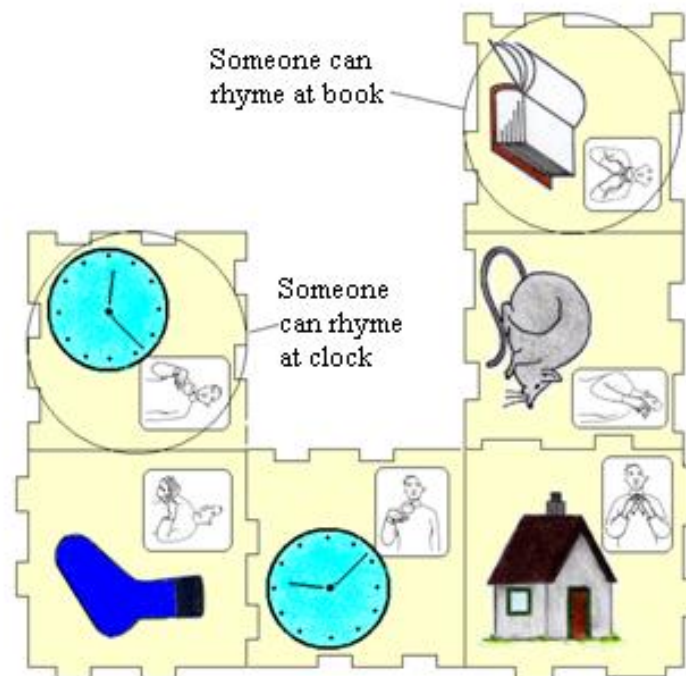


Figure 7. A situation in the game with a description of where it is possible to rhyme

There are three levels in the game. In all levels, every player gets a certain amount of cards, depending on the amount of players. One of the words on a card has to rhyme at a word on another card. The words are not written because children with a CI do not have to learn rhyming by using an orthographic code, which is mentioned before. The goal of the game is to lose all your cards as soon as possible.

The first level is characterised by the form of the cards, which can be seen in figure 6. They are all pieces of a puzzle. The puzzle is a way of feedback and support for the children. If they do not know what rhymes, they can also try to puzzle. When the puzzle does not fit, they know that they did not rhyme correctly. When a rhyme is correct, the puzzle will fit on all the three sides of that picture. In figure 8, an example is given of a correct and an incorrect rhyme.

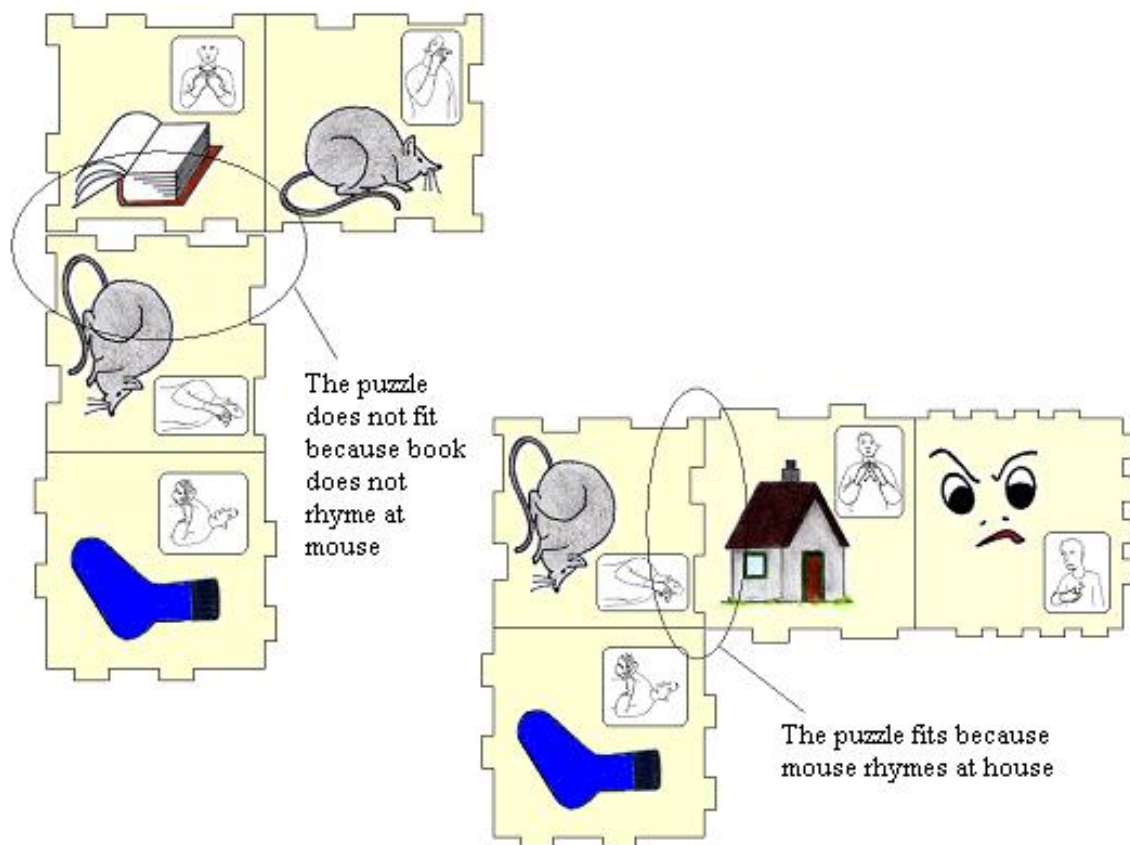


Figure 8. A correct and an incorrect rhyme

In level two, the puzzle aspect disappears. Drawings are the same as in level one, but the cards are rectangular. An example of a card from level 2 is given in figure 9. In this level children cannot use the puzzle as feedback or support. This makes it a little more difficult because they have to know the rhymes.

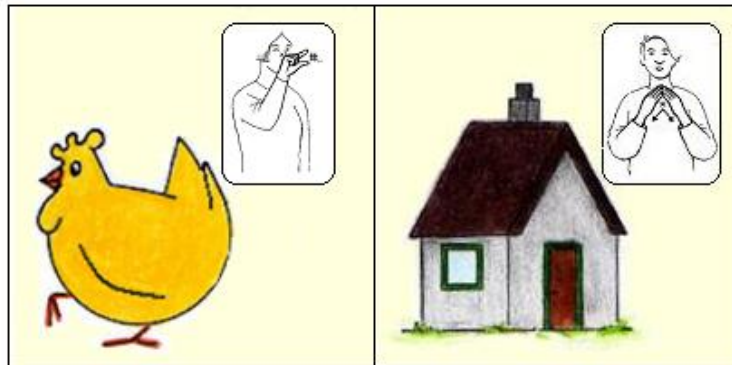


Figure 9. A card of level 2 of the game

The only difference in level three is that the drawings (rhymes) are different. A card from level three is shown in figure 10. The words used in level three are more difficult to rhyme because the words have more syllables or the words rhyme, but are written differently. So when children imagine the words with an orthographic code they cannot recognize these words as rhyming. When they concentrate on the auditory aspect, they hear that the words sound the same, so that that is what makes it rhyme.

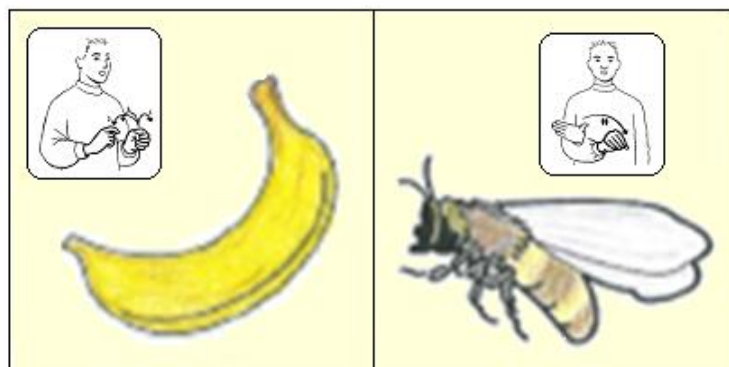


Figure 10. A card of level 3 of the game

The next part of the game is the audio-visual support package. This package is added for different reasons. It gives an introduction to goals and rules so it can be played without the assistance of a teacher and it serves as auditory support and feedback. The audio-visual support package can be run on the digital blackboard or on a computer screen. The game can be started immediately. In the first screen of the program, children can choose the level they want to start with (figure 11).



Figure 11. The first screen of the audio-visual program

After the selection of a level, the program of that level will start. Step by step, the rules of the game become clear by following the steps in the program. Besides the rules, the program includes sounds and feedback. Children can decide their own volume of the sounds by using speakers connected to the computer or digital blackboard. They can click on a picture and listen to the sounds of a word (the auditory aspect). This is the aspect with which someone learns rhyming. Someone with a CI also has to *hear* that words sound the same and not (only) look the same (the use of an orthographic code when words are written, or pictures that look the same). In figure 12, the screen is shown, in which children can click on different pictures to hear the sounds of the words.



Figure 12. The screen in which children can click on a picture to hear the sound of the word

In level two and three the puzzle aspect, which functions as feedback, disappears to make it more difficult for the children. To control themselves and other players, another way of feedback is included in the audio-visual program. The screen which is shown in this case can be found in figure 13. In the screen in figure 13 someone tried to rhyme at rose. They have to click on the button (with a speaker) next to the drawing they think that rhymes at rose. The voice, recorded in the program, will tell whether or not this combination of words is a rhyme. Every possible combination (rose rhymes at clock, rose rhymes at chicken, etc.) is shown to make it really clear for the children.



Figure 13. A feedback screen in the audio-visual program

The words used in the game are similar to the words used in an educational method for children with a CI, called 'Leespad'. Also the layout is based on pictures used in a book from that method. The game is designed step by step, on the base of the requirements stated before.

Realisation of the prototype

The game has been constructed by hand. All the cards in the game are of cardboard. The drawings are found on the internet. They are printed, coloured by hand and scanned in again. The coloured drawings on the computer are put into puzzle pieces and for the other levels in rectangles. They are printed out on sticker paper and are pasted on cardboard. All the cards were made by hand and a box was created to put them in. The computer program is created with support of Microsoft Office PowerPoint. Pictures were linked to other pictures, slides or sounds, which were recorded.

Evaluation of the prototype

Introduction

The evaluation of the game will be presented as a separate study and will be described as two parts: the process evaluation and the effect evaluation. The evaluation is based on the evaluation part in ‘Intervention mapping’, a book from Barholomew, Parcel, Kok & Gottlieb (2000).

The effect evaluation describes the difference between the rhyming skills before playing the game and after playing the game. So, it is about whether or not the learning goals are met; it evaluates the effect of the game. In the former paragraphs, important assumptions have been made. First the assumption that children with a cochlear implant do not learn the same way as hearing children, nor as deaf children. A way to support these children has to contain auditory information and visual information for the best result. The second assumption is that playing a game motivates and leads to learning. These two assumptions lead in the design process, through concerning the content (rhyming skills) and functional (motivational game elements) design decisions, to the final form of the game. The game has to lead to achievement of the learning goals. The key questions in this effect evaluation are:

-Do learners with a cochlear implant learn rhyming skills through playing the rhyme domino?

-Do learners play the game in a motivated way?

Next to the effect evaluation, a process evaluation will be done. The process evaluation is a critical review on the process of implementation.

Method

Participants

The implementation of the game was done at the ‘professor Huizingschool’, in Enschede, the Netherlands. This school is a special ground school for learners included in cluster 2 of the Dutch system for special schools. Cluster 2 includes schools for deaf and hearing

impaired children, and for children with speech difficulties, often in combination with other disabilities.

One complete class that consists of five children (four of them with a cochlear implant) participated in the study to determine whether the game is useful to support the development of rhyming skills. To determine if the children learn something by playing the game, it was necessary to collect some prior knowledge. For this, the teacher was asked to fill out a questionnaire about the children with a cochlear implant. The results are shown in table 1a and 1b.

Table 1a

Prior knowledge about test subjects 1 and 2

	Test subject 1	Test subject 2
Date of birth:	20-10-1999	26-01-1998
Cochlear implant since:	January 2002	December 2002
Grade:	6th grade	6th grade
Additional problems:	Cluster 2 education Lower intelligence	Cluster 2 education Lower intelligence Dutch as 2th language
Linguistic intelligence:	Low	Really low
Level of rhyming:	2/3	1

Table 1b

Prior knowledge about test subjects 3 and 4

	Test subject 3	Test subject 4
Date of birth:	08-08-2001	25-05-1999
Cochlear implant since:	Augustus 2004	February 2005
Grade:	5th grade	7th grade
Additional problems:	Cluster 2 education Lower intelligence Dutch as 2th language	Cluster 2 education Lower intelligence Syndrome 'Charge'
Linguistic intelligence:	Really low	Low
Level of rhyming:	1	1

Note: Primary education in the Netherlands contains 8 grades. Grade 1 and 2 are kindergarten. From grade 3, children in regular education learn how to read and write. Cluster 2 education is for children that are deaf or hearing impaired, or children with speech difficulties, possibly in combination with additional problems. The linguistic intelligence was defined by comparison with hearing children. The level of rhyming was asked on a 5 point scale, whereby 1 stands for no skills in rhyming and 5 stands for perfect rhyming skills.

The table shows that the children did not know how to rhyme at all, except test subject 1, who was able to recognize some rhyming words. The children are 8 to 11 years old and got their implants since the age of 3 to 6. They have additional problems which influence the learning process. All of them have lower intelligence and their linguistic intelligence is low to really low compared to that of hearing children of their age. Two of the children do not have Dutch as their mother tongue and one of the children has the syndrome of 'CHARGE' (Coloboma of the eye, Hart defects, Atresia of the choanae, Retardation of growth and/or development, Genital and/or urinary abnormalities and Ear abnormalities and deafness).

Procedure

The game was played three times in one week, on a Monday, Tuesday and Thursday morning. The first time the game was played with the whole class: the four test subjects and their classmate with a regular hearing aid. The teacher and the designer of the game were present during playing. They could eventually elucidate the game with signs or they could assist in using the computer. The audiovisual program was run on a laptop on the table so that everyone could see the screen. Two big speakers were connected so that the children could hear the sounds used in the program. The children started the game by following the instructions on the computer screen. The first day they only played level 1. The second day, at first the game was played with the whole group again. They started with level 1 but also tried level 3. Level 2 was left away, because the children wanted to try new words. After this, the game was played one by one with players who had difficulties playing in the whole group. The third day, the game was played with two children at the same time and the speech therapist. That day, level 1, 2 and 3 were played.

After the week, in which the game was played, a test was administered to see if the children learned something from playing the game. The test can be found in figure 14. One word is bolded. Children had to find the word that rhymes at this bolded word. They had to choose the right answer out of three possibilities. The look and feel is different from rhyming in the game. In the game, no written words are used to avoid the use of an orthographic code during the learning process. In the test, only written words are included to see if children can make the switch from visual information to written words. This way, it can be seen if children only remember the combination of pictures within the game or that they can also apply their

skills to written words. One rhyme is included in the test of which words are written differently. When they apply their skills in an auditory way and not with the use of an orthographic code, they also have to recognize these words that are written differently, as rhyming. In the test also five rhymes are included which are not present in the game to find out if children can also apply their skills on words they did not use in the learning process.

Welk woord uit de drie mogelijkheden rijmt op het dikgedrukte woord?

- | | | | |
|-------------------|---------------------------------|---------------------------------|---------------------------------|
| 1. kip | <input type="checkbox"/> wip | <input type="checkbox"/> ballon | <input type="checkbox"/> thee |
| 2. huis | <input type="checkbox"/> raam | <input type="checkbox"/> muis | <input type="checkbox"/> lach |
| 3. bus | <input type="checkbox"/> sok | <input type="checkbox"/> kip | <input type="checkbox"/> kus |
| 4. sok | <input type="checkbox"/> konijn | <input type="checkbox"/> lach | <input type="checkbox"/> hok |
| 5. plassen | <input type="checkbox"/> ijsje | <input type="checkbox"/> grap | <input type="checkbox"/> wassen |
| 6. maan | <input type="checkbox"/> banaan | <input type="checkbox"/> klok | <input type="checkbox"/> huis |
| 7. vlag | <input type="checkbox"/> huis | <input type="checkbox"/> lach | <input type="checkbox"/> bij |
| 8. klok | <input type="checkbox"/> sok | <input type="checkbox"/> broek | <input type="checkbox"/> pijn |
| 9. reus | <input type="checkbox"/> boos | <input type="checkbox"/> neus | <input type="checkbox"/> staart |
| 10. ei | <input type="checkbox"/> knop | <input type="checkbox"/> bij | <input type="checkbox"/> nat |

Figure 14. The test after a week of playing the game

In another part of the test, five questions about the game were asked. The questions were about the appearance of the game, the difficulty, the motivation in the game, the audibility of the support program and whether or not they want to play the game again.

Next to testing the children, during the test phase and afterwards, teachers and a speech therapist were asked to give their reactions about the game.

Results

Effect evaluation

Rhyming

The first question in the effect evaluation is whether or not children with a cochlear implant improved their rhyming skills by playing the designed game. To decide if children

learned something by playing the game, it was necessary to determine the starting level of the children. In table 1, in the method part, is shown that children started playing the game without any rhyming skills, except for one player, who knew something about rhyming. Table 2 shows whether or not the children gave the right answers on the 10 rhyme questions of the post-test.

Table 2

Answers of the children on the 10 rhyme questions

	Player 1	Player 2	Player 3	Player 4
Question 1	Correct	Correct	Correct	Correct
Question 2	Correct	Correct	Correct	Correct
Question 3	False	Correct	Correct	Correct
Question 4	Correct	Correct	False	Correct
Question 5	False	Correct	Correct	Correct
Question 6	Correct	Correct	Correct	Correct
Question 7	Correct	Correct	Correct	Correct
Question 8	False	False	False	Correct
Question 9	Correct	Correct	Correct	Correct
Question 10	Correct	Correct	Correct	Correct

Note: Bolded questions are rhymes present in the game, the others are new

A few faults were made. Player one gave the most incorrect answers, whereas the starting level says that this player already knew something about rhyming and in figure 9 it can be seen that he evaluated the game as easy. During the game he knew a lot of rhymes. He often whispered the answers to the others and he played as if it was too easy for him. Maybe for him, there was too little of a challenge, so he was less concentrated and less motivated during the final test. Player 4 ended up with no incorrect answers. He started with no knowledge about rhyming. He made a big improvement during playing. He indicated the game as being

difficult and he had difficulties with hearing the sounds, especially when the other children were noisy. But, he was very motivated to find the correct rhymes and to win the game.

Question 8, is done wrong by three of the players (table 2). This could be a coincidence but it is interesting to take a closer look at the kind of question. However, by considering question 8, it appears to be a very common rhyme, which is used in the game and of which the words only have one syllable. There was no problem with this rhyme during the game. More problems during the game were demonstrable for words with more syllables. They had to think longer about these words. Expected was that the words of which the end was written differently but still rhyme should also cause problems. However, the players were able to recognize the rhyme in an auditory way (they said: “It sounds the same.”), so that did not give any problems.

All in all, by observing playing and based on the measurement afterwards, for these children, in this school, in this time of the year, it can be stated that the game has had a positive effect on the rhyming skills of these children. One of the children indicates for example that he could hear that two words both end on “oos”. In fact, this is what rhyming is about and because this child could not rhyme at all before playing the game, he seems to have learned something during playing.

Motivation

The other question in the effect evaluation is whether or not children were motivated during playing the game. Stated was that the game should trigger the intrinsic motivation. To determine if the children were motivated, they had to answer five questions about the game and were observed during the implementation phase. The answers on the questions afterwards can be found in table 3. The children like the game, want to play it again and think it is a beautiful game. The opinions about the sound and about the difficulty are more divided. Player one describes the game as easy, whereas the other players found it difficult or at least a bit difficult. Two of the children had difficulties hearing the voice in the audiovisual program. They had to concentrate fully and everyone else had to be silent.

Table 3

Answers of the children on the questions about the game

	Player 1	Player 2	Player 3	Player 4
Enjoyable game?	Yes	Yes	Yes	Yes
Beautiful game?	Yes	Yes	Yes	Yes
Want to play the game again?	Yes	Yes	Yes	Yes
Difficult game?	No	A bit	Yes	Yes
CD-rom audible?	A bit	Yes	Yes	A bit

Teachers and therapists

The effect evaluation can be completed with data from conversations with the teacher and the speech therapist. They were really enthusiastic; they think it is an ingenious and nice game. The speech therapist asked if it is possible to buy the game for further use at the school. They also recommended to contact a publisher.

Process evaluation

The first idea was to implement the game in the third class of special education because hearing children already start rhyming in this phase and learn how to write and read. In mutual agreement with teachers and therapists, it was decided to play the game with older children, from form 5/6/7. This was because children within this specific special education school do not have rhyming skills in these forms yet. Their reading level is comparable to the reading level of children from form 3 in regular education. The game was also more applicable for these children because the audiovisual program, which is included in the game, is difficult for children in form 3. Reading skills are needed to use the support program.

Before playing, the level of rhyming of the children was determined through a questionnaire, which had to be filled out by the teacher. This method was chosen because it was thought to be difficult to ask these children themselves about their level. Next to this, these children do not have a lot of concentration and they have difficulties to express themselves. It is possible that they act as if they have better skills than they actually have. At the beginning of the game, the level of the children could also be determined by observing them. One of the players directly understood that words have to sound the same, but the others had no idea.

Per day, the process of playing was registered. It describes what problems were met, such as what words were the most difficult and whether or not motivation was triggered. The results are bundled in table 4. The table shows that motivation is higher when playing the game only with one or two children. Also understanding and concentration are much better this way and this way, the children played more on the base of rhyming principles than on imitating others. Remembering seems to be a difficult factor but the measurement afterwards shows that children can also rhyme words that are not used in the game.

Table 4

Days of implementation

	Day 1	Day 2 a.	Day 2 b.	Day 3
Way of playing	With 5 children	With 5 children	With 1 child	With 2 children
Degree of understanding	Low	Average	Good	Good
Concentration	Low	Low	Good	Average
Rhyming vs. imitating and remembering	Rhyming by one, but a lot of imitating the one who understood	Remembering and imitating	Rhyming and remembering	Rhyming and remembering
Motivation	Begin→High End→Low	Low	High	High

Note: Rhyming vs. imitating and remembering means if the children played the game on the base of the principle of rhyming, they imitated other children or they only remembered the rhymes from the day before.

Discussion

In this study, a blended game is developed to support the development of rhyming skills for children with a cochlear implant. This study is mainly qualitative because the design of the game is the main goal of the study. To test the game however, it would be better to do a quantitative study. Due to a limited number of test subjects in this study, it is not possible to determine the exact effect of the game. A quantitative study is needed to compare the game with another learning method or to include a control group.

Another method to support teaching of rhyming is a 'rhyme domino' for hearing children (from publisher Zwijssen). This game is without an audiovisual support program. It would be interesting to discover whether the game designed in this study is more effective for children with a CI than a regular 'rhyme domino'. That way it is possible to see if the special characteristics of the target group are met. Do the signs that are added support the understanding of the context of the words? Do the sounds on the computer support hearing the sounds in a word? Does the computer program improve interest or does it cause distraction? These questions are interesting to study for improving the game. The publisher of this regular 'rhyme domino' also has another game to support the development of rhyming skills. This is also made for hearing children. In this game children have to dial a wheel and shout the word on which the wheel holds. The first one to say a word that rhymes at the word on the wheel, deserves a point. The player, who gets the most points in a certain amount of time, is the winner. Interesting is to find out what the difference is between games. What kind of games make children with a CI learn most efficiently? Another advantage of a quantitative study is that it can be done over a long period of time. In this case, also the long term learning goals can be analysed. When children play the game with longer pauses in between, do they still know how to rhyme, or do they only remember words of playing the last time? This is about the aspect of remembering, understanding and applying which is mentioned in the article. A disadvantage for a quantitative research is that a lot of players are needed to obtain significant results. This means that a lot of schools have to be willing to cooperate because classes for these children are small.

To test the prototype of the game in this study, some choices should be subjected to discussion. The first one is the questionnaire about the motivation of the children. The question is how reliable the answers are. It is not sure that the children understood the

questions, the children change opinions very easily and it is not sure if they are telling the truth. Player two, for example, did not want to play the second and third time but in the questions about the game he said that he likes the game and wants to play it again. The teacher was asked for clarification and she said that this is common behaviour for this child. He always changes opinions very quickly. In short, a real conclusion about the motivation within the players cannot be drawn, also because of the small number of test subjects.

A second point of discussion is for which children the game is most applicable. The children who played the game in this study were 8 to 11 years old. Usually rhyming starts at the age of 3/4, and maybe because the age of implantation declined drastically, it could be good to play the game with younger children. However, for younger children the computer program is too complicated. A teacher or therapist has to be included in that case.

A third point of discussion is the post-test in this study. In the post-test, written words are used. However, the children have to learn rhyming in an auditory way, supported by visual information. It is useful to see if they can make a switch to written words, because in the end they also have to recognize rhymes when words are written. However, it could be useful to first test the children in the same way as they learned it. This means in an auditory way, supported by visual information.

The last paragraph in the evaluation leads us to the last points of discussion. First, the implementation phase showed that the children are not concentrated, less motivated and understand less of the game when played with 5 children (i.e. the whole class). When played one by one, the effect is much bigger. In the requirements however, was stated that it has to be possible to play the game with the whole class. The game is designed to realise this, with a total amount of 55 cards. After playing, it seems to be better not to play the game with more than one or two children and with not too many cards for one player. This leads to too much complexity. Second, it should be practical when children can play the game themselves, without the help of a teacher. This seemed to be difficult however, because of the complexity of the audiovisual program.

Conclusion

A blended game is designed to support the development of rhyming skills within children with a CI. The game meets all the requirements stated through a literature study and conversations with teachers and different kind of therapists (speech, movement and play). One of these requirements is that it should be possible to play the game with the whole class. This however, seems not to be a good requirement because playing one by one causes a bigger learning effect. A short period of testing the game has taken place. Although there are no significant results because of the limited number of players, it can be stated that the game is a good way to support the development of rhyming skills, at least for the included players in this study. After playing the game they became to understand rhyming. To test the game in a better way, however, it is recommended to do a quantitative study to compare the game with another learning method or in which a control group can be included.

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