# *Animega – interactive sentences*
# Manual for *Animega-is*

*September 2023*



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# 1 Introduction

## 1.1 What is Animega – interactive sentences?

- *Animega-is* is an app developed for several platforms: iOS, Windows and Android. The app is based on an earlier computer program, Omega-is, that in several studies have been shown to have had positive effects on children's language and literacy development.
- Animega-is has been created to stimulate the development of language and communication in learners beginning to explore the mysteries of the written language. What do the letters represent? How can they represent words, sentences and events?
- The language matter of the program is meant to be explored by the learner with help from – and in interaction with – a teacher or parent. The language material and the appended animations do not only offer motivational literacy training but also give occasion for conversations where the learner can express his or her imagination and thoughts.

Animega-is consists of a total of 57 tasks (exercises) distributed over six levels. The material (> 250 words/phrases) can be accessed through two different routes: In *Create* mode the learner can produce interesting events by using text buttons to create sentences (>4400). In *Test* mode the learner can test his or her proficiency by first viewing the event, then choosing words and creating the sentence that best represents what he or she has just viewed.

In the app the language content is presented as buttons with text. When a button is selected in *Create* mode the word or phrase is spoken and placed into a sentence line. When a complete sentence has been created it is spoken and presented as a short animation or video clip. Thereby, the learner – within a limited-time window that supports the learner's working memory – is given support in three different forms (text, speech, animation) which facilitates his or her understanding of the concept and creates a lingual representation.

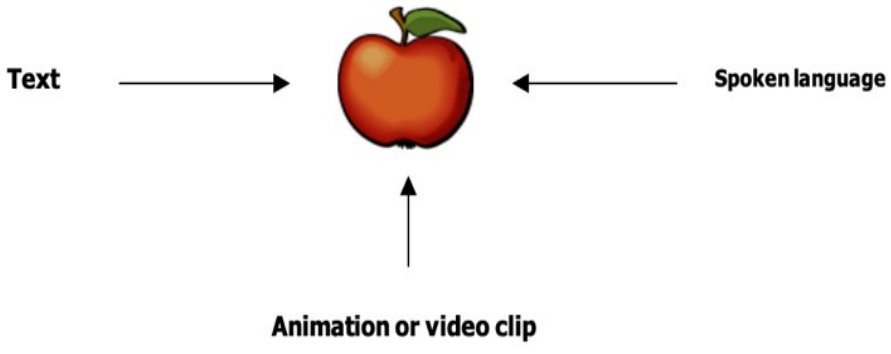



*Figure 1: The learner receives quick feedback in three modalities*

Our experience shows that learners improve faster if an adult is at hand to give positive reinforcement or support when needed, but also as a conversational partner when the learner wants to discuss his or her experiences in order to create a situation best described as joint media engagement. We recommend

using recasting, an often undervalued strategy. It is important, though, that the initiative stays as much as possible with the learner as the language material is perused. The learner must be driven by his or her own curiosity and delight. More on this in *Chapter 5 Educational Perspectives*.

# 2 Quick start:

## 2.1 Student Mode

Upon opening the app, one is immediately in Student Mode (see Figure 2) from where it is possible to start exploring the language material either by constructing events in Create or exploring one's language knowledge in Test. It is thus possible to start using the app without registering the student's name, just to play around anonymously with the content. However, in order to plan and adjust the tasks as well as to save the learners work the teacher needs to register the student. This is achieved by clicking on Go to Teacher Mode in the upper left corner of the start-up screen.

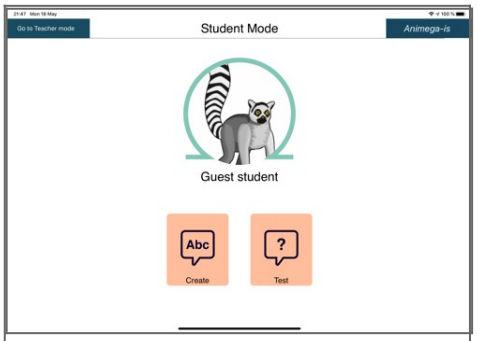



*Figure 2: Student Mode*

## 2.2 Teacher Mode – how to control and plan the teaching

Teacher mode makes it possible for the teacher to organize and plan the teaching content so that it fits each individual learner. In this mode it is possible to initiate a passcode, register a new student and make a number of selections regarding tasks, pre- and posttests, language, feedback, and the access method that best fits the learner. All of it accessible from the choices in the left column of the opening Teacher Mode screen, see Figure 3.

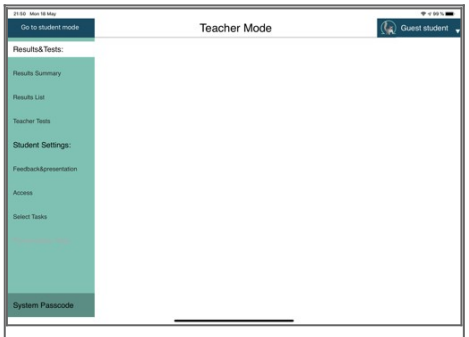



*Figure 3: Teacher Mode*

### 2.2.1 Create a passcode (Access code)

In order to prevent a learner from accidentally accessing the teacher mode and thus indivertibly change the settings it is recommended to start by selecting a System Passcode. Just click the button in the lower left corner of the teacher

mode screen in order to enable a teacher mode passcode. Then select a personal code by clicking Change. By enabling a passcode only the teacher will have access to Teacher Mode and individual students can only see their own results.

### 2.2.2 Register a new student

Mark the box Guest student in the upper right corner and select Create New Student. A box will open (Figure 4) asking for the student's first and last name as well as date of birth. Do note that a formal name is not needed, it can be any nickname of yours or the learner's choice. Date of birth is optional as is the option to select a personal photo. It is not needed for the registration of a student that those fields are filled in. The only thing required in order for the app to save the learners work is that the field First Name is not empty. An example of how the opening screen in Student Mode might look after successfully registering a student with name and photo is shown in Figure 5.

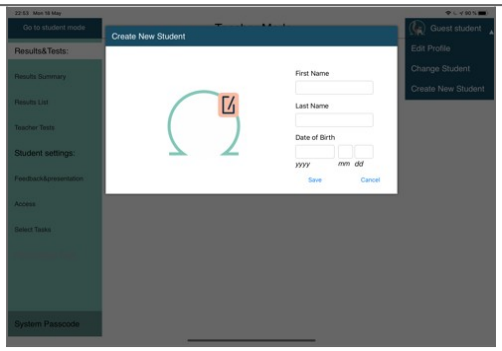



*Figure 4: Adding a new student*

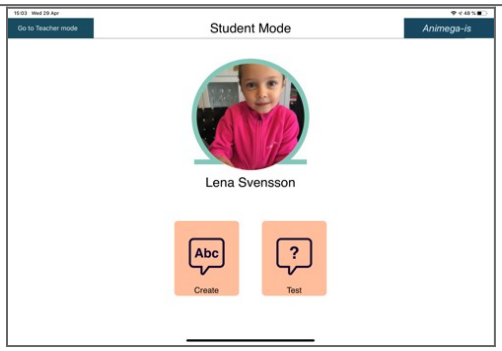



*Figure 5: A new student added*

*Clicking on <current student> gives two additional options: Edit Profile and Change Student. Edit profile makes it possible to change the student's name or to add/change a photo at a later time. It is also possible to delete the profile of a student. Change student is used when working with several students. Each student keeps his or her unique profile locally on the device (and only there).*

### 2.2.3 Results summary and Results List

See Chapter 4 Test Mode, page 14

### 2.2.4 Teacher Tests

How much did I learn and how much did I know before? These matters can be explored by selecting first Teacher Tests and then either Pre- or Post-test. The Pretest uses the same vocabulary as the Student mode tasks. The only difference between the two are how the test items are selected and logged in the results summary. Either way, pretesting means that the learner will find out how much he or she knows before starting to work at a certain level. It also gives the adult working together with the learner an opportunity to establish the appropriate level on which to start working.

A rule-of-thumb here is to use 20% correct as a starting point, as the learner usually needs some previous knowledge while still be motivated by the challenge to learn something new. However, this per cent figure should only be used as a rough measure, since our experience shows that some learners, despite scoring lower than 20% on the pretest, still benefit from the language exercises. It is important to find a balance between the learner's motivation to explore the material and the level of difficulty (a too difficult task might just cause frustration and make the material less attractive).

The *Posttests* can only be reached through teacher mode and they differ from the tests in student mode and the pretests in that they also include distraction words, words that are not part of the *Animega-is* tasks, but might be semantically or phonologically close to the words learnt. Thus, the learner cannot solve the test with rote memory but is forced to use decoding skills to identify the correct words. For more information see Chapter 4, Test.

### 2.2.5 Feedback & presentation

By selecting this option it is becomes possible to select language mode, to set the audio presentation, the visual presentation, and test feedback (see Figure 6).

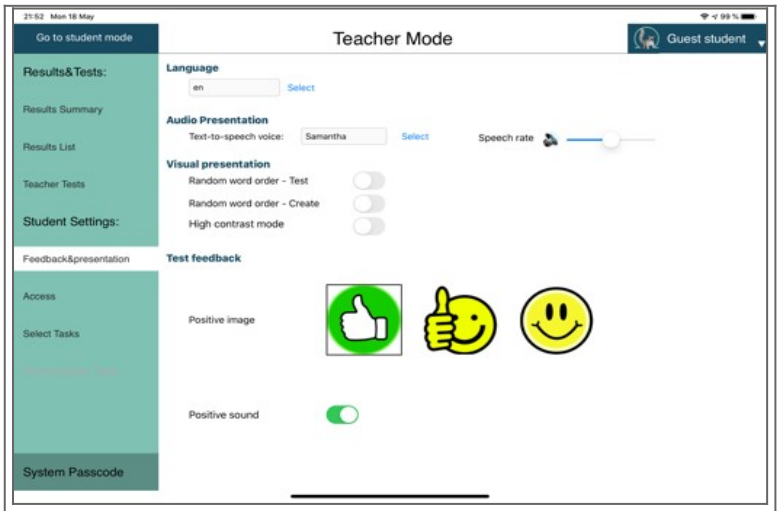



*Figure 6: Feedback & presentation*

For *Language* currently English or Swedish are supported. Selecting a language affects the content of the tasks in Create or Test. They will be presented in the language mode chosen. However, the system language will still influence the selection buttons. If your system language is English and you chose to train Swedish the Create button will still be named Create, not "Skapa" as it would if the system language had been Swedish.

*Audio Presentation* makes it possible to select the Text-to-speech voice if more than one voice is installed in the default system. It is also possible to adjust the speech rate to the learner's need.

The buttons under *Visual Presentation* makes it possible to change the word order to random in Test or Create. This makes the tasks more demanding since the learner cannot rely on a memory of the spatial location for a certain word. It is also possible to select a high contrast mode.

*Test feedback* gives the option to choose from three different positive images as well as selecting if the positive feedback sound should be on or off.

### 2.2.6 Access

Here one can change the access method from *Touch*, which is the default setting, to *Switch* (see Figure 7). In Switch mode there are further options that makes it possible to define the iterate and accept keys (the choices are tab, space or enter). This opens the possibility to make modifications for learners with varied motor abilities who are in need of alternative input modes.

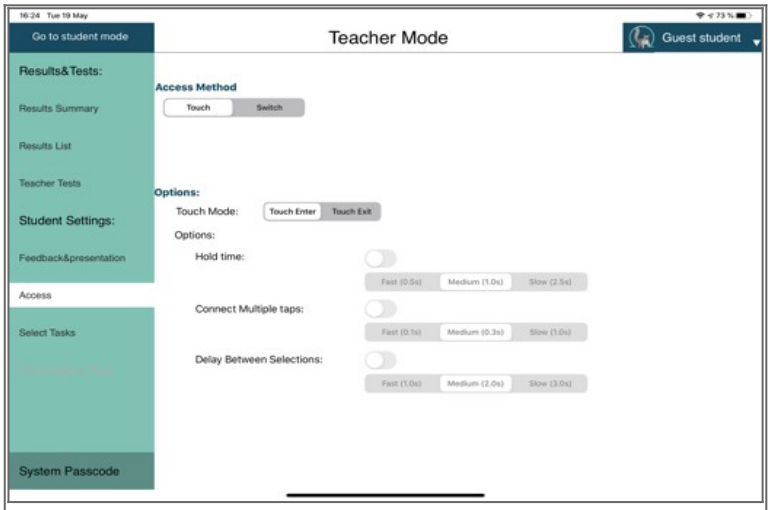



*Figure 7: Access settings*

Touch mode have some important further options. First, it is possible to select between *Touch Enter* or *Touch Exit* as the main touch mode. Second, there are time options for *Hold time*, *Connect Multiple taps* and *Delay Between Selections*. The choices are Fast, Medium or Slow. The default setting is Touch mode enter and medium for the time options.

### 2.2.7 Select Tasks

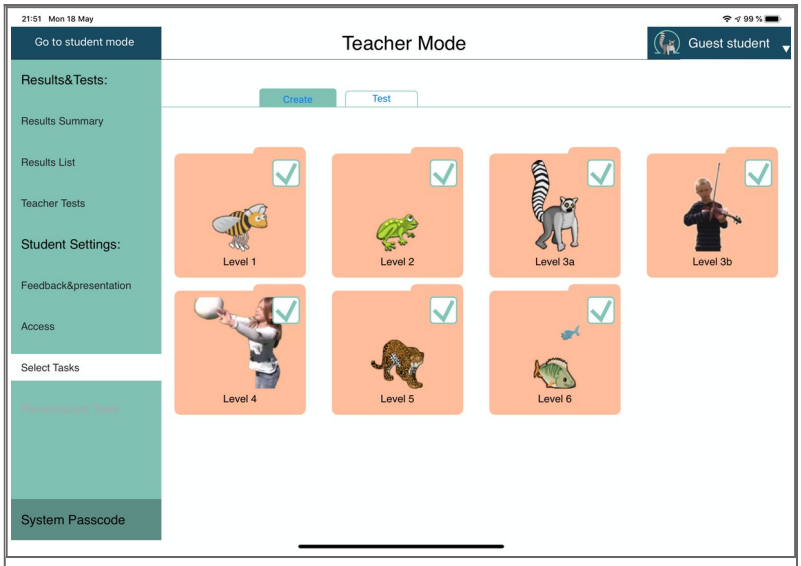
This gives the teacher/parent the possibility to choose which levels the learner should have access to. Separate selections can be made for *Create* and *Test*. By default, all levels are open to the learner. By limiting the tasks accessible for the learner, the level of distractions can be minimized as the learner will only be able to work with the levels that are aligned with his/her skills and educational goals.

Touch/click the check-boxes in the folder icons to select or deselect Levels available to the current learner.

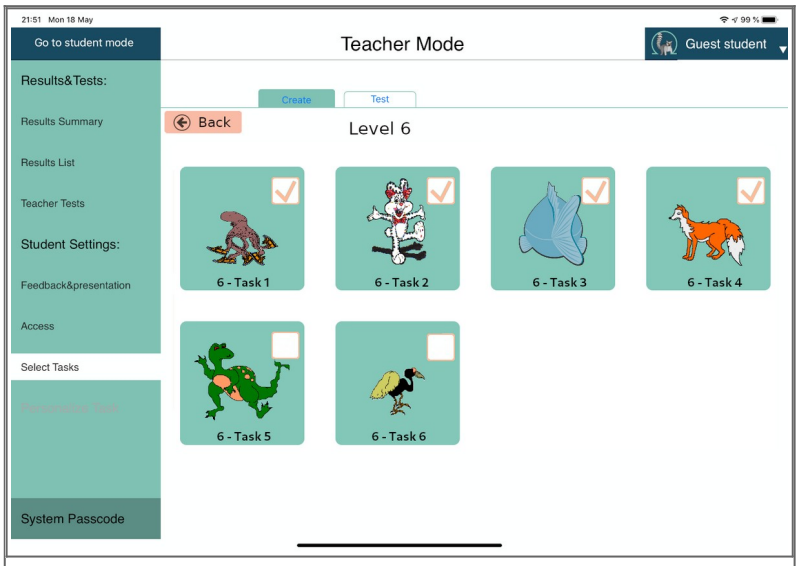
Touch/click on a Level folder to enter the Level for selecting Tasks that will be available for the current learner in that Level.

Go back to Levels selection display to make the corresponding selection of visible Tasks within the other available Levels.

All content is available for students by default.




*Figur 8: Selection of available levels*




*Figur 9: Selection of available tasks (in Level 6)*

# 3 Create – How to explore the language material

This is the central part of the app. Here the learner explores the program, gets acquainted with text and how to use new language skills. In total it possible to create over 4400 events in text that are then visualized as animations or through brief video clips. The language material is distributed over six levels (see Figure 10) representing different language complexities:

## 3.1 Level 1

In this section the learner explores individual words (see Figures 11 - 13). The idea being that the learner should understand how written words sometimes represents a concrete object, i. e. only nouns are represented. The simple structure can also help students who, due to motor disabilities, might have difficulties to use a tablet to gain insight into how to illustrate a text by clicking. The words have been selected in part because they compel a phonological (audible) and/or orthographical (pictorial) difference, such as two words of great similarity: “Hound, House”.

This initial level contains seven tasks and 55 unique words.

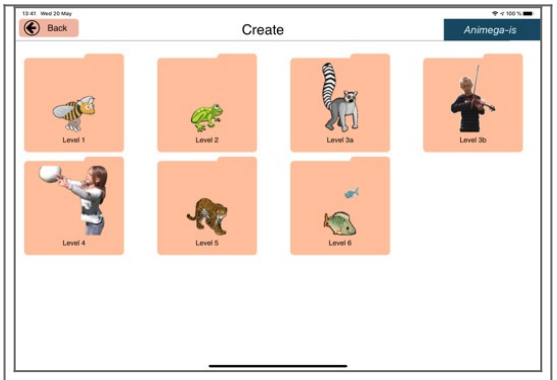



*Figure 10: Levels to choose*

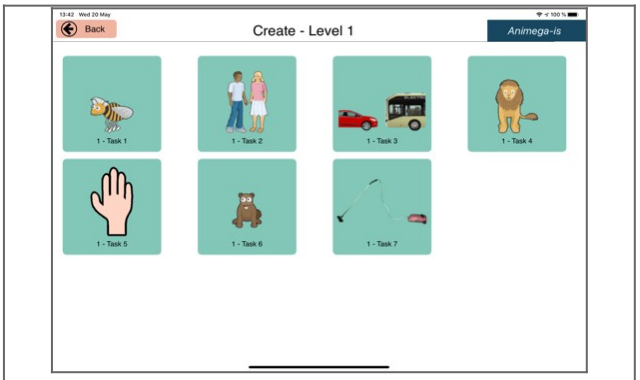



*Figure 11: Tasks in Level 1*

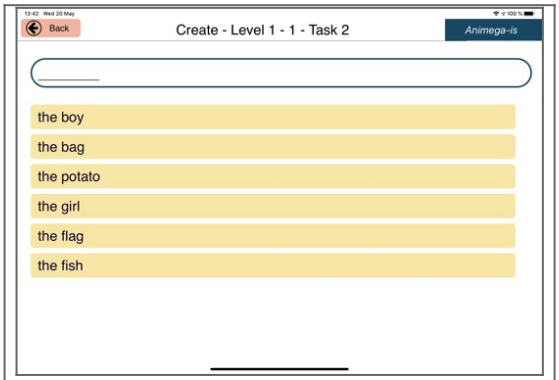



*Figure 12: Task 2 Level 1: Content*


*Figure 13: The effect of choosing “the girl”*

## 3.2 Level 2

The second level introduces two-word sentences with a noun and a verb in order to illustrate the notion that somebody does something and how simple grammar is built by a subject and a predicate (Figures 14 och 15).

This level includes six tasks making it possible to create 137 short sentences representing different actions/events.

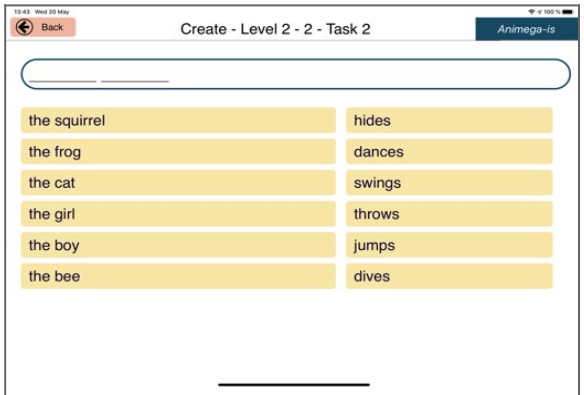



*Figure 14: Task 2 Level 2: Content*

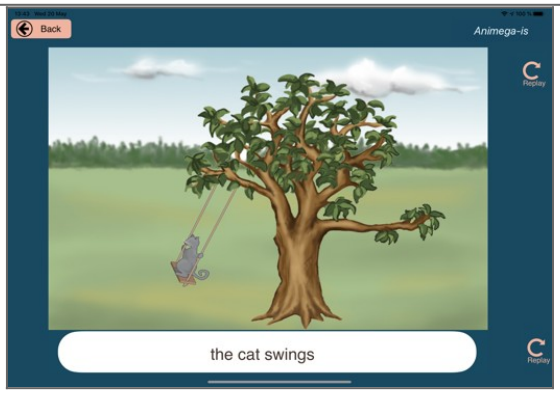



*Figure 15: Action created: "The cat swings"*

## 3.3 Level 3a and 3b

Here three-word sentences with subject, verb and object (S-V-O) are introduced (see Figures 16 and 17). Some words from previous lessons reappear, but there are also new words for additional phonological drilling. Words are sometimes placed according to a strict grammatical order where subject-predicate-object have given columns but sometimes also with nouns only in one column and verbs in another. The selected sentence will however always have a grammatically correct structure.

Level 3a includes 12 tasks with the possibility to create 444 sentences or actions.

Level 3b includes 15 tasks with the possibility to create 434 sentences or actions.

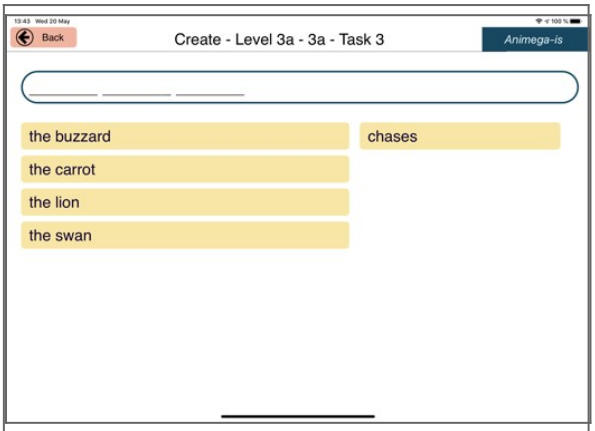



*Figure 16: Task 3 Level 3a: Content*


*Figure 17: Action created: "The buzzard chases the lion"*

## 3.4 Level 4

This level introduces more complex sentences (see Figures 18 and 19). The learner is often forced to make more choices in order to create a full sentence displaying an action. Social themes are included as is emotions, conjunctions and positions.

Level 4 includes 5 tasks with the possibility to create 620 sentences or actions.

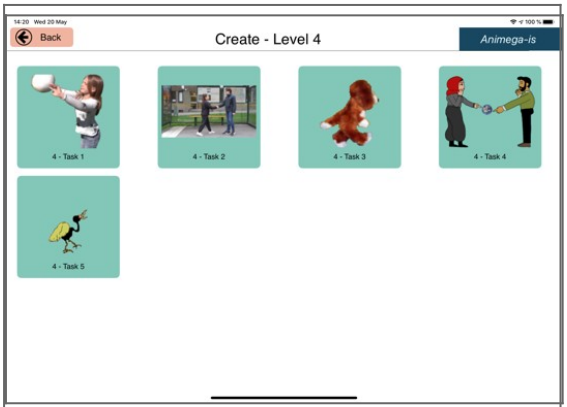


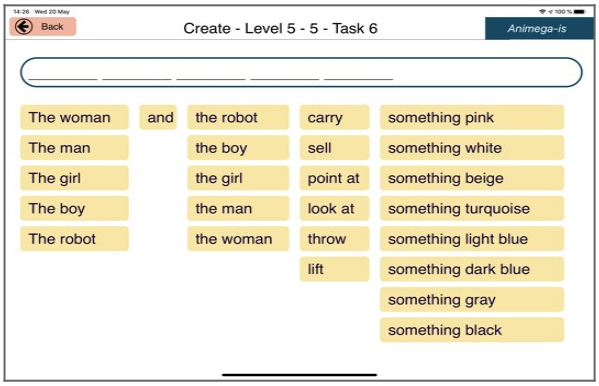

*Figure 18: Tasks to choose at Level 4*


*Figure 19: Task 2, action created: "The woman says hello to the man in the street"*

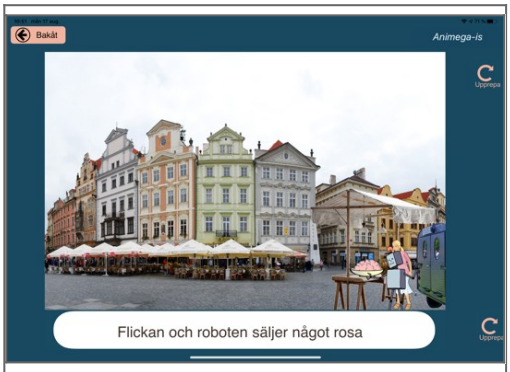
## 3.5 Level 5

The most common prepositions are represented in order for the learner to explore situational positioning (see Figures 20 and 21). Use of the genitive is also practiced in certain lessons as learners explore phrases with a possessive content (such as "the panda's table").

Level 5 includes 6 tasks with the possibility to create 2126 different sentences or actions.




*Figur 20: Task 6 Level 5: Content*




*Figur 21: Task 6, action created: "The girl and the robot sell something pink"*

## 3.6 Level 6

Contains long sentences with added new words. The purpose is reading practice combined with exploring the limits of the learner’s working memory which is important when it comes to reading and comprehending of longer texts. This may also be checked in the testing part if the learner likes this type of challenge.

Level 6 includes 6 tasks with the possibility to create 670 different sentences or actions.

# 4 Test Mode

The test function in *Animega-is* makes it possible to find out how much a learner understands from the linguistic material in any given lesson. The animations are shown initially, and the learner, by selecting text icons, creates a phrase which describes the action. The test can be run in two modes; the Teacher mode and the Student mode. In the teacher mode, the contents are predefined, while in the student mode, tests are generated at random. Furthermore, the teacher mode contains both pre- and posttests for measuring and analyzing the effects on language skills and reading comprehension when the linguistic material has been explored by the learner.

## 4.1 Student Mode tests

In this mode, the learner's ability to express/recreate animated events in text form is challenged in a game like fashion. 10 points are awarded for each test item answered correct. By observing the student's results in these exercises, the teacher can form an opinion about the appropriate level for the learner to work on. But it also gives the learner a direct way to check his or her progress through the score achieved (see Figure: A score of 90 points is achieved).

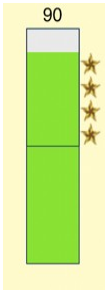



*Figure 22: The score is 90 points*

The Student Mode tests contain linguistic material identical to the Create tasks, and the exercises are chosen randomly from the task the learner is working on, but no test contains more than 10 items. Thus, if a task contains less material than 10 possible events all possible combinations will be used in the test mode. (see Figures 23 and 24 below for examples). If on the other hand the task contains material from which more that 10 test items can be constructed, the random process will pick 10 test items.

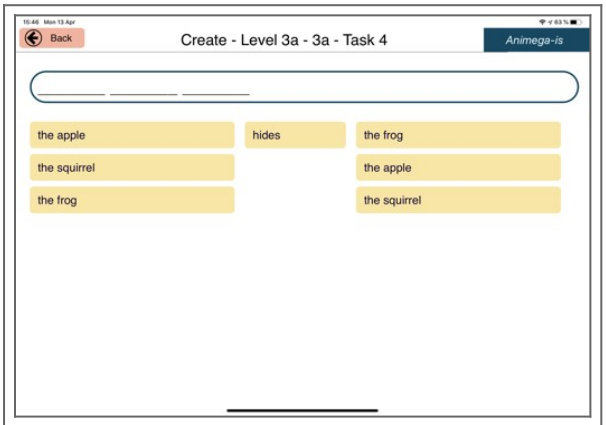



*Figure 23: An example of a task with 9 possible test items (3x1x3). All nine will be used in Test mode*

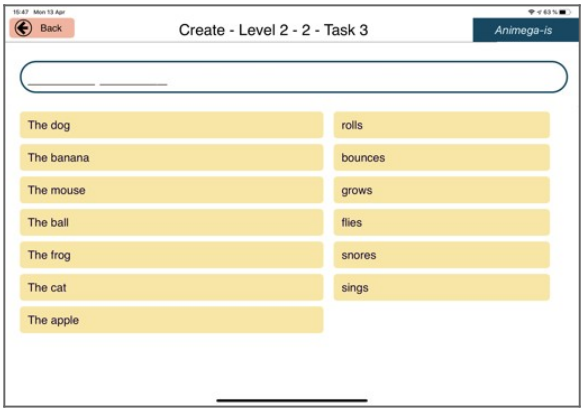



*Figure 24: An example of a task with 42 possible test items (7x6). Ten randomly chosen events will be used in Test mode*

A test chosen early in the learning process gives the possibility to judge how well the task or level suits the learner. If the learner solves no more than 20-30% of the test items, this suggests that the material should be surveyed. This hint comes out of our own experience, but the final decision can only be taken by the teacher/parent who knows the learner, since learners' needs of security and challenge can vary a great deal.

## 4.2 Teacher Mode tests

It is also possible to start a test session from within the Teacher Mode by selecting Teacher Tests. Here the teacher has the option to choose either pre- or post-tests. First select the test type, then select level and task. Pretests are similar to tests chosen in the Student Mode. The main advantage to select a pretest in the Teacher Mode is that the test then is logged as a pre-test which makes it easier to keep track of progress. Posttests on the other hand differ from the tests accessed through student mode by containing distraction words meant to challenge the learner's reading comprehension both semantically (in regard to content, as in car/bus) and phonologically (in regard to that which is heard, as in car/cart).

In order for test scores to be logged correctly a profile must have been entered for the student. This is done in Teacher Mode (see Section 2.2.2 on page 6) by clicking on <current student> and selecting Create New Student from the menu.

## 4.3 Viewing Results

While in Teacher Mode it is also possible to study the learner's progress by selecting Results Summary or Results List.

Results summary gives an overview of the learner's overall performance from the tests s/he has taken (see Figure 25). It is also possible to compare the mean score from the three previous session dates with the score from the last session.

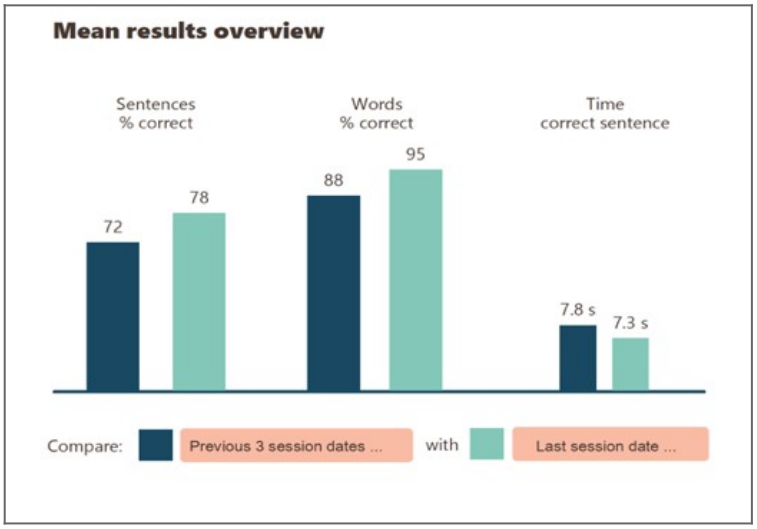



*Figure 25: Results Summary*

A more detailed information is provided by the Results List from which one can choose to see activities from three different modes: Create, Test, and Teacher Test. A detailed log is available for each category. Taking Create as an example, the data gives the dates of the session, start time, level, task, number of sentences created, number of words used and the total session length. By selecting a specific lesson, the exact selection of words can be assessed. The data logged under Create, Test, and Teacher Test can also be exported to be incorporated in Excel or similar program.

The detailed logging under Results Lists (Figure 26) is not something recommended to be used in everyday teaching. It is probably of more use in a research project or in extensive evaluations when the learning process needs to be monitored in detail.

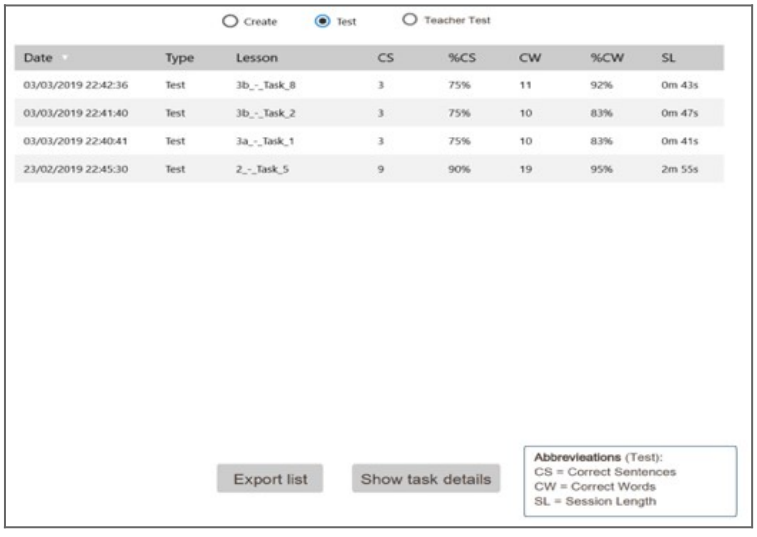



*Figure 26: Results List from Test*

# 5 Educational perspectives: Theories and guidelines relevant to *Animega-is*

The idea behind the *Animega-interactive sentences* app builds on theories and empirical research that actually goes almost four decades back (see the bibliography for a listing of the publications). It stared in the early 1980's……Yes it did but this is not going to be a looong story of how *Animega-is* came to be. We will instead present some brief summaries of our ideas and how to transform those thoughts into a viable strategy to be used in the classroom. What is important to know before presenting the summaries is that *Animega-is* builds on research showing that the software has the potential to be of help for a broad spectrum of children: Children with ASD, ADHD, hearing impairment, down syndrome, dyslexia or just slow to break the alphabetic code. And of course, also typical children on the verge of discovering the written language.

## 5.1 MIR – a summary of our overall strategy

MIR is an acronym that cover a working method that several studies have proven to be the successful:

1. **M =** *multimedia*, a word that sums up the potential and possibilities provided by technology. The app gives the learner the means to create motivating and interesting events on a tablet. Feedback is given through many modalities: written text, spoken words and animation or video clips.

2. **I =** *interaction* emphasizing the importance of an adult conversation partner being present. The goings-on on the screen provide the users with topics for conversation. Topics that the teacher can use to initiate conversations with the learner.

3. **R =** *recasting* and indicates the use of a special conversation strategy that has been proven effectful. In fact, it is a rather uncomplicated strategy: You change the linguistic style without distorting the essence of the learner's statements. Experience shows that there are more advantages to this technique than simply imitating the learner. One will maintain the same focus on the learner's utterances, one adjusts to the learner's pace and level, and the dialogue becomes more varied and genuine. Results from several studies give uniform evidence that a dialogue based upon these principles may have a distinctly positive effect on the development of language skills.

### 5.1.1 Recasting – using the dialogue as a resource

Recasting – using the dialogue as a resource
How can a teacher or parent reduce one's own pace, demands on performance, and tune in to the learner instead? One helpful strategy often used in both research an educational praxis is recasting. It's basically quite simple: The adult, maybe a teacher or parent, changes the language form without altering the core message in what the learner has produced. Studies show that this technique has more advantages than simply imitating the learner. One gets the same focus on what the learner has said, one adjusts to the learner's pace and level, and the dialogue becomes more varied and genuine.

> *"Adult reformulations of child utterances, also known as recasts, have…been shown to relate to the acquisition of linguistic structures in children with language and learning disabilities and children and adults learning a foreign language."*
> (Clarke, Soto & Nelson, 2017; pp 42)

There is unequivocal evidence that a consistent teacher-learner dialogue of this type speeds up the pace of learning. Recasting prolongs the learners' focus on relevant linguistic material and scaffolds working memory processes. But please note that every remark from the learner cannot be recasted; if so, the method is at risk of becoming absurd. So how can it be done? Here's a suggestion:

1. Let's assume that the teacher and the learner are discussing wild animals, watching an Animega-is lesson containing pictures and film clips of different animals and that the learner remarks "I like the big tiger".
2. The teacher must now make good use of the central content of the learner's remark and quickly recast it, giving it a partly different structure without changing the meaning to any large extent. One way of doing so might be saying, "Yes, it's a nice and big tiger" or "I like the tiger, too". An alternative to recasting is helping the learner elaborate by asking, "Why do you like it?"
3. As a final link, it may sometimes be convenient to follow up on the remark in step 2 by trying to direct the learner's attention towards the text shown on the sceen. This can be done by asking something like, "Where's the word?" or by pointing out: "Here's the word! Look: Tiger".

## 5.2 How to support learning – a broader perspective

From today's research-based knowledge in education, psychology, and linguistics, it is possible to compile a number of conditions that strongly affect the normal language development of children. These conditions can be divided into three groups: fundamental, necessary, and facilitating factors. Fundamental factors refer to the embryo of linguistic and communicative development taking place during most of the first 12 to 18 months of life. Some examples being

imitation, turn-taking, eye contact, joint attention, and attachment. Focus here will, however, be on the necessary and facilitating factors that can be directly used to for educational planning. Regarding the necessary factors, they all have to be available for the language to develop normally, while, concerning the facilitating factors, the more of them that are present, the better.

### 5.2.1 Necessary factors for language learning

1. A *competent communication partner*. Sufficient dialogue episodes with one skilled partner is important. (most often an adult with higher lingual competence than the learner).
2. A *sufficient number of episodes*. The learner must be given sufficient opportunities to interact and experience conversations with others whose language is both fluent and varied.
3. *Motivating conversations*. Interactions and conversations that are both motivational and socially interesting to the learner, and where the learner is given the chance to participate according to his or her ability.
4. *Use of intact abilities*. The learner must be given the opportunity to use biologically intact senses. For example, that profoundly deaf children are allowed to communicate through signing.
5. *Challenging conversations*. That the learner now and then experiences a manner of communication that challenges the limits of his or her current linguistic system.

### 5.2.2 Facilitating factors – some examples

1. *Many modalities*. Receiving language input and experience through as many modalities as possible (for instance speech, text and sign language). Simultaneously viewing a text, hearing it and also having it translated into sign language gives the learner more opportunities to understand and analyze relevant language content.
2. *Many challenges*. Conversations that often challenge the learner's language comprehension and level of development create extra opportunities to discover new language structures as well as new ways of maintaining a conversation.
3. *Flexible adjustment*. That the person or persons who talk to the learner use several different means to make concepts or events understandable. This means that the adult modifies the speed as well as the complexity of the spoken language to suit the learner's present motivation, concentration and ability. It also includes the use of different means to make information redundant. This could mean describing the same event in several different ways or using other modes of expression (such as drawing or singing) to increase the learner's ability to understand.

4. *Individual credit*. The language spoken by the important adults surrounding the learner should be modified to suit the learner's personality, way of thinking (cognition) and social style. This is important because it acknowledges the learner as a separate individual with unique interests and needs. Even though much can be gained by studying literature on the subject of talking to children with autism, one must never forget that there is not one predefined way to relate to children diagnosed with autism or children with other neurodevelopmental problems. These children, along with all typical children and all children with disabilities, are different and must be met as unique individuals.

Learning neither occurs exclusively at school nor happens in a situation where learning factors (such as aptitude, memory and attentiveness) can be viewed as disengaged from the social situation (the child's emotional life, interests, self-confidence or previous history).

### 5.2.3 Sometimes learning is a "rare event"

The following section provides a description of a somewhat different way of looking at learning. This is a way, which in our mind, can contribute to new ways of thinking in matters concerning teaching set-up and procedure. The great advantage – in our opinion – with our theoretical take on learning is that this theory focuses not only on the learner's abilities or inabilities, but instead attempts a comprehensive view on learning.

The theory upon which our reasoning is based – the *Rare Event Learning* model (REL) – is geared towards identifying the necessary and facilitating factors described in the previous section that are at work for an individual child or student. These factors are not easily identifiable in the classroom, but an increased awareness about them will hopefully improve chances of creating a learning situation and a classroom climate that maximizes the learners' opportunities to absorb new information. This view may require emphasis to an even greater extent for children with different forms of learning disabilities, since they, in contrast to healthy children, have fewer intact psychological (such as memory, language capability, concept building) and biological (such as sight, hearing, sensory and motor control) systems to employ.

The theory brings up five fundamental aspects that are important to consider when creating a positive learning climate. All of them describe, in different ways, how the learner's learning is guided by his or her ability to think, analyze, emotionally regulate and concentrate. But - and this is important – this theory is more encompassing than this, since it involves more than the usual cognitive conditions by emphasizing the importance of motivation, interest, feelings and the interaction between learner and teacher. Learning always occurs in a larger context. Moreover, within context these multiple learning conditions need to dynamically co-occur and converge--thus sometimes REL is reformulated as a model of *Dynamic*

*Tricky Mixes* (e.g. Clarke, Soto & Nelson, 2017). It is complicated or "tricky" to find the "right" Dynamic Mix that leads to rapid learning for an individual. But when found these individualized learning mixes may lead to highly productive cycles across many learning occasions with increasingly positive engagement and enjoyment by both child and teacher.

In short, the main content of the REL model can be described by using the acronym L.E.A.R.N:

1. **L =** *Launching conditions* that include cognitive factors such as the learner's ability to attend to new and challenging structures that are experienced within a verbal dialogue. It has to do with how prepared the learner is to learn new things, how able he or she is to capture relevant information and how easily those new structures are encoded into the learner's long-term memory. In addition, the teacher may have too high or too low initial expectations of the learner's learning potential and thus create a setting in which the learner feels uncomfortable and/or unmotivated. It is usually difficult to decide what particular levels or zones of challenge are needed to allow optimal processing and learning by a pupil at a particular stage of acquisition in speech and text.
2. **E =** *Enhancing conditions* that might include catalysts such as recasts: The teacher reformulates the children's utterances into new syntactic packages, keeps the central meaning but may add something, as in the following illustration

   Child: "There is a dog."
   Adult: "Yes, there is a dog and it is big, isn't it?"
3. **A =** *Adjustment processes* that include factors such as support from the teacher to the students to overcome frustration and positive reinforcement of the children's self-esteem. This part of the teaching process is particularly important since children with learning disabilities are at high risk for developing associated emotional and adaptive disorders that might contribute to emotional obstacles within the learning process. Poorer self-concepts (general and academic) and lowered expectations have been noted as possible negative outcomes.
4. **R =** *Readiness conditions* are illustrated by the children's level of functioning and their interest, knowledge and motivation for learning. Thus, assessment of various cognitive abilities is needed before the aims of training are decided. This is extremely important for children with autism or other similar disabilities since it has been found that (1) communicative language and (2) cognitive levels are the factors that best predict future progress. In addition, children with disabilities often have problems with self-regulatory strategies that might lead to a lack of checking, planning, and monitoring. They often have difficulties with detecting relevant details and they seldom modify their strategy even after several rounds of negative feedback.

5. **N=** Network representations. When new language material becomes well-rehearsed and well-integrated within existing knowledge, new and efficient representations are formed. As a consequence, allocation of processing energy becomes more sufficient. For example, a good reader must be capable of parallel processing since reading a story requires considerable energy to keep track of all the lexical, syntactic, and discourse information comprising a story. A poor reader usually spends too much time and energy on letter identification which often interferes seriously with higher skills such as comprehension of the text material. Multimedia materials of the type we have used support parallel processing of more than one structural comparison.

In addition to LEARN, there are a number of additional processes to take into account when we aim to understand the factors that helps or hinders the learning process of a child or student we are working together with:

1. *Engagement*. The learner's cognitive system must be engaged in the ongoing learning process. Language learners continuously compare new linguistic forms with the language they already master. We are referring to mainly subconscious cognitive and linguistic processes. When the brain (the cognitive-linguistic system) observes a difference, the discrepancy is examined by these subconscious processes. When the discrepancy has been observed and examined a sufficient number of times, the learner develops a new language skill and is from that moment on able to understand and use the new structure.
2. *Memory*. As new and unknown lingual expressions appear, these are compared to examples already stored in existing memory structures. The memory is, however, not like a tape recorder storing everything without any distinction. The learner primarily observes certain very obvious and easily identifiable examples. It is of uttermost importance to arrange the teaching situation in such way that the learners *working memory* is maximally supported. Something that can be partly achieved by implementing a recasting strategy.
3. *Consolidation*. When the learner possesses full mastery of a new skill, such as being able to use a new language structure without difficulty, the nervous system no longer needs to pay attention to it. In other words, the brain can at this point just let go of this specific linguistic form and instead begin to focus upon new forms that have not yet been completely mastered by the learner. This process is chiefly, if not completely, subconscious. The learner's interest in different matters also, in part, determines what is paid attention to.
4. *Integration*. The brains of children are actively looking for patterns and connections to tie different areas of knowledge together. The recently acquired knowledge is tied together with previous knowledge, and broad patterns of experience are created. This tendency towards integration is present in all human beings and works as an important prop to learning. Of relevance here is also *the Developmental Ease of*

*Language Understanding – model* (D-ELU; Holmer, Heimann & Rudner, 2016) which emphasizes the importance of a good match between language input and preexisting representations for language formation. The better match, the less effort is needed by the learners cognitive-linguistic system in order to form new representations.

# 6 Bibliography

## Scientific publications


Basil, C. & Reyes, S. (2003). Acquisition of literacy skills by children with severe disability. *Child language teaching and therapy*, 19 (1), 27-48.

Clarke, M.T., Soto, G., & Nelson, K. (2017). Language learning, recasts, and interaction involving AAC: background and potential for intervention. *Augmentative an Alternative Communication*, *33*, 42-50.

Fälth, L., Gustafson, S., Tjus, T., Heimann, M., & Svensson, I. (2013). Computer-Assisted Interventions Targeting Reading Skills of Children with Reading Disabilities - A longitudinal study. *Dyslexia*, *19*, 37-53.

Fälth, L., Svensson, I., & Tjus, T. (2011). The effects of two training programs regarding reading development among children with reading disabilities. *Psychology, 2 (3),* 173-180.

Gustafson, S., Fälth, L., Svensson, I., Tjus, T., & Heimann, M. (2011). Effects of Three Interventions on the Reading Skills of Children with Reading Disabilities in Grade 2. *Journal of Learning Disabilities, 44* (2), 123-135.

Heimann, M., Nelson, K.E., Tjus, T., & Gillberg, C. (1995). Increasing Reading and Communication Skills in Children with Autism Through An Interactive Multimedia Computer Program. *Journal of Autism and Developmental Disorders, 25*, 459-480.

Heimann, M., Nelson, K.E., Gillberg, C., & Kärnevik, M. (1993). Facilitating language skills through interactive microcomputer instruction: Observations on seven children with autism. *Scandinavian Journal of Logopedics, Phoniatrics, Vocology 18*, 3-8.

Helland, T., Tjus, T., Hovden, M., Ofte, S., & Heimann, M. (2011). Effects of a bottom-up and a top-down intervention Principle in emergent literacy in children at risk of developmental dyslexia. A longitudinal study. *Journal of Learning Disabilities, 44* (2), 105-122.

Holmer, E., Heimann, M., & Rudner, M. (2016). Imitation, sign language skill and the Developmental Ease of Language Understanding (D-ELU). *Frontiers in Psychology, 7*:107; doi: 10.3389/fpsyg.2016.00107

Holmer, E., Heimann, M., & Rudner, M. (2017). Computerized sign language based literacy training for deaf and hard-of-hearing children. *Journal of Deaf Studies and Deaf Education*. 22 (4), 404-421. https://doi.org/10.1093/deafed/enx023

Nelson, K.E., Barlieb, A., Khan, K., Vance Trup, E.M., Heimann, M., Tjus, T., Rudner, M., & Rönnberg, J. (2012). Working memory, processing speed, and executive memory contributions to computer-assisted second language learning. *Contemporary Educational Technology,* 3 (3), 184-200.

Prinz, P. M., Pemberton, E., & Nelson, K. E. (1985). The ALPHA interactive microcomputer system for teaching reading, writing, and communication skills to hearing-impaired children. *American Annals of the Deaf. 130*, 444 - 461.

Rudner, M., Andin, J., Rönnberg, J., Heimann, M., Hermanson, A., Nelson, K. E., & Tjus, T. (2015). Training literacy skills through sign language. *Deafness & Education International*, 17 (1), 8-17.

Svensson, I., Fälth, L., Tjus, T., Heimann, M., & Gustafson, S. (2019). Two-step tier three interventions for children in grade three with low reading fluency. *Journal of Research in Special Education Needs*, 19 (1), 3-14.

Tjus, T., Heimann, M. & Nelson, K. E. (1998). Gains in literacy through the use of a specially developed multimedia computer strategy: Positive findings from thirteen children with autism. *Autism, 2* (2), 139-156.
Tjus, T., Heimann, M. & Nelson, K. (2001). Interaction patterns between children and their teachers when using a specific multimedia and communication strategy: Observations from children with autism and mixed intellectual disabilities. *Autism*, 5 (2), 175-187.
Tjus, T., Heimann, M. & Nelson, K. E. (2004). Reading acquisition by implementing a multimedia intervention strategy for fifty children with autism or other learning and communication disabilities. *Journal of Cognitive and Behavioral Psychotherapies (2),* 203-221.

## Academic dissertations

Fälth, L. (2013). *The use of interventions for promoting reading development among struggling readers.* Doctoral dissertation, Linnæus University, Sweden.
Tjus, T. (1998). *Language and literacy acquisition in children with developmental and learning disabilities*. Doctoral dissertation, Department of Psychology, University of Gothenburg, Sweden.

## Chapters

Nelson, K.E., Welsh, J.M., Camarata, S. M., Tjus, T. & Heimann, M. (2001). A rare event transactional model of tricky mix conditions contributing to language acquisition and varied communicative delays. In K.E. Nelson, A. Aksu-Koç & C.E. Johnson (Eds.), *Children's Language, Volume 11: Interactional Contributions to Language Development* (pp. 165-195). Mahwah, NJ.: Erlbaum.
Nelson, K. E., Heimann, M., & Tjus, T. (1997). Theoretical and applied in sights from multimedia facilitation of communication skills in children with autism, deaf children, and children with other disabilities. In L. B. Adamson & M. A Romski (Eds.), *Research on communication and language disorders: Contributions to theories of language development* (pp. 299-328). Paul Brookes Publishers.
Nelson, K. E., Craven, P. L., Xuan, Y., & Arkenberg, M. E. (2004). Acquiring art, spoken language, sign language, text, and other symbolic systems: Developmental and evolutionary observations from a dynamic Tricky Mix theoretical perspective. In J. M. Lucariello, J. A. Hudson, R. Fivush & P. J. Bauer (eds.), *The Development of the Mediated Mind: Sociocultural Context and Cognitive Development* (pp. 175-222). Lawrence Erlbaum Associates.
Tjus, T., & Heimann, M. (2000). Language, multimedia and communication for children with autism: Searching for the right combination? In S. Powell (Ed) *Helping children with autism to learn* (pp. 78-93). London, UK.: David Fulton Publishers.

## Conference papers (some examples)

Heimann, M., Nelson, K.E., Tjus, T., & Gillberg, C. (1993). *The impact of an instructional system on language learning for children with autism and multiple handicaps* [summary]. Proceedings of the Second European Conference on the Advancement of Rehabilitation Technology (p 26.3). Stockholm, Sweden: The Swedish Handicap Institute.

Heimann, M., Tjus, T., & Nelson, K.E. (1994). *Delta/Messages: A rewarding, fun and motivating multimedia computer program for teaching reading skills to children with language delays [summary*]. Proceedings of the Sixth Biennial Conference of the International Society for Augmentative and Alternative Communication (pp. 404-407). Hoensbroek, The Netherlands: IRV.

Heimann, M, Tjus, T. & Nelson, K. E. (1995). On the effect of multimedia computer programs: Gains made by children with autism in reading, motivation, and communication skills. *Educational Resources Information Center* (ERIC).

Tjus, T., Heimann, M. & Lundälv, M. (2003, November). *Multimedia enhancement of language and reading skills.* Paper presented at Autisme Europe, Lissabon.

Tjus, T., Heimann, M., & Lundälv, M. (2004, Oct). *Multimedia strategy for facilitation of communication skills*. Paper presented at the 11th Biennial Conference of the International Society for Augmentative and Alternative Communication, Natal, Brazil.