Learn Sign Online!

A proposal for an online platform to learn Dutch Sign Language

This project studies the possibilities of designing an online platform for acquiring Dutch Sign Language (NGT), specifically focused on parents of deaf children. Children need a lot of (diverse) language input to lay a groundwork for their language development and it is thus important that people in their surroundings speak a language the child can interpret. Over the past decades, a lot of different distance learning technology have been developed for second language acquisition. This research will look into NGT and discuss all the grammatical topics which should be explained to people wanting to learn the language. Then, different technologies and will analyse which would suit learning NGT the best. Lastly, the two research topics will be combined and a design for a platform is proposed.

Keywords: NGT; Second Language Acquisition; Computer-Assisted Language Learning; Educational Sciences; Digital learning

List of abbreviations:

ASR	-	Automatic Speech Recognition
BSL	-	British Sign Language
CALL	-	Computer-Assisted Language Learning
LSF	-	French Sign Language
NGT	-	Dutch Sign Language
NmG	-	Dutch with signs
SLA	-	Second Language Acquisition

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Introduction

Deaf children who are born in a hearing family benefit enormously from parents using sign language. The input of language and communication with parents (or caretakers) is shown to have positive effects on academic success and the relationship with one's parents (Hart and Risley 1995; Harris and Mohay 1997). However, only one out of one thousand Dutch people is fluent in Dutch Sign Language (NGT) (van den Bogaerde 2014). So most of the parents of deaf children would benefit from learning NGT to improve communication with their child. There are various courses on NGT, most of them very expensive and not (completely) covered by health insurances (Nederlands Gebarencentrum [date unknown]). Most online resources exist of lexicons, which results in parents using signs as support of the spoken language. As this support does not contains the complete language, it is difficult for a deaf child to follow the conversation.

This project aims to assess the possibilities of a free, digital platform to teach hearing people NGT, mainly focused on grammatical topics to help people shift from Dutch with signs (NmG) to NGT. This platform will be developed online, as it will then be accessible to everyone and will add the possibility of updating and adding more features to it. To ensure this platform is effective, this paper will research different algorithms and platforms for

language acquisition, as well as the most important topics to be covered on such a platform. This platform can provide a more accessible way of learning NGT which can have a positive effect on the further integration of the Deaf in Dutch society.

Research Context

Importance of early language development

In the Netherlands, out of the 170.000 children born each year (CBS 2019), one in 850 is diagnosed hard of hearing or deaf during the neonatal screening (NSDSK [date unknown]). This screening is done a couple weeks after birth at the latest. As this diagnosis is made early on, treatment can be started before the baby is six months of age. This increases, among other things, the (language) development and parent-child interaction (Yoshinaga-Itano et al. 1998). Another benefit of doing the screening in the early stages of development is that parents can start learning the Dutch Sign Language (NGT) early on and thus learn how to communicate better with their child. This communication is found to be very important for the further development of the child: the higher and more diverse the language input is the child receives, the better the child's language acquisition (Nelson 1973). For hearing children, this diverse input of language happens automatically, as spoken language is everywhere: when their parents are having a conversation, on television, in public spaces, et cetera. However, for deaf children, this is way harder because sign languages are not as present as spoken languages in daily life. Especially for children of hearing parents, who are very unlikely to use sign languages.

This early-in-life language development is very important because it is shown to improve cognitive skills and social skills, and it is argued that this variable is the best

predictor for academic success (Hart and Risley 1995). Furthermore, a shared language for child and parent does not only influence language development, it is also shown to increase better parent-child interactions (Harris and Mohay 1997). Thus, it is important for parents of deaf children to learn NGT in the early stages of their child's development, in order to be able to communicate with their child and give them a foundation for further (language) development.

NGT acquisition among parents

It is a common misconception among Dutch people to think that NGT is just a signed version of Dutch (Baker et al. 2016). In contrast, NGT is a completely different language: signs are built from meaningless parts, they are conventional and the connection between sign and its meaning is arbitrarily (Schermer et al. 1991). This misconception causes parents to use signs as support of Dutch, instead of using signs as a separate language (Marschark 2001). This supported Dutch is called Dutch with Signs (NmG) and does not cover the complete Dutch language. However, it is easier to learn, as NmG is not a new language, but just an addition to the language.

Another reason why so few people know NGT is that there are not many possibilities to learn the language. NGT is not included in the primary and high school curricula (except for schools focused on deaf children) and only a few universities offer courses in NGT. Thereby some companies offer courses in NGT, but they all have one thing in common: they are costly. With creating a free platform where anyone can learn NGT, it lowers the threshold for anyone to learn NGT. In that way, the language will become hopefully more well-known and create a better integration of the Deaf in the Dutch society.

Next to the courses, the documentation of NGT is lacking. The only complete overview of the language is dated 1991 (Schermer et al. 1991), but as languages are constantly changing (Fromkin et al. 2014), it is in some ways outdated. There is an online dictionary available, but only a small part is accessible for free (Nederlands Gebarencentrum 2013).

Methodology

This process of this paper is divided into three steps. The first step is to get an overview of the grammar of NGT. As said, there is not much documentation on the language. Before deciding on how a learning platform should look, it is important to decide what should be learned on this platform. The book 'De Nederlandse Gebarentaal' ('The Dutch Sign Language') will be used as a basis of this step, but more recent sources on parts of NGT or sign languages in general will be considered. Furthermore, this chapter will be thoroughly checked by fluent signers and one teacher of the language. For the second step, this paper will dive into the world of digital language learning. Two fields of study will be considered: general digital language learning and digital sign language learning.

Grammar of NGT

This chapter will cover most of the grammatical aspects of NGT. These will be discussed in two ways: as the aspect and its application in NGT, and in comparison to spoken Dutch (after this: Dutch). The comparison will help to make an educated choice in what topics to put on the platform. As the platform is targeted on Dutch speakers, the subjects with the most difference will be of most importance to place on there.

Sentence structure and non-manual markers

For NGT, a different sentence structure applies than for Dutch. Sentence structure of NGT consists of several parts, including the order of signs and non-manual markers[1]. It is different for four types of sentences that can be distinguished, and will therefore be described for declarative, imperative, and negative sentences and questions,.

Declarative sentences

Declarative sentences are sentences that claim something as the truth, thus no question sentences nor sentences with an imperative form (Fromkin et al. 2014). However, this section will not deal with the negative denying sentences, this will be covered later. The order of signs of the declarative sentences within NGT is the structure SOV, subject - object - verb. In Dutch, this is according to the order SVO: subject - verb - object. The sentence structure is not determined by the modality - the American Sign Language (ASL) has the same structure as Dutch: SVO.

[1] A non-manual grammatical marker: ‘Certain grammatical aspects in a signed sentence [which] are not made by the hands, but are expressed through for instance, raising the eyebrows or tilting the head or pushing the chin forward.’ (Nijen Twilhaar and van den Bogaerde 2016, p.131)

Questions

Questions can be divided into two categories, namely closed and open questions (Fromkin et al. 2014). In NGT, both types of questions have the SOV structure (2020 conversation between M Scheffener and author), which is the same structure as the declarative sentences. To stress that the sentence is a question, a non-manual marker is added. Two question markers exist: one is a combination of raised eyebrows and slightly raised head and one a combination of low eyebrows, squeezed eyes and a higher chin. Earlier literature stated that the eyebrows were raised with closed questions and down with open questions (Schermer et al. 1991), but van Gijn (2004) suggests that this separation is not so clear. The current hypothesis is that the raised eyebrows marker is common when a short answer is expected, so for closed questions and some open questions, whereas furrowed eyebrows are more common when a long answer is expected (van Gijn 2004). Regardless of which marker, it is present throughout the question. If a question contains a question word, the sign for that is added as the last element of a question. Even when the question word is the subject, such as in the sentence 'Who is going to the beach?', and thus the structure changes and becomes VOS (2020 conversation between M Scheffener and author).

Imperative sentences

In Dutch we know imperative sentences as sentences without subject with a verb in the form of a commandment. There is only a verb in the imperative form and possibly other phrases (i.e. 'Close the door!'). NGT does not have such an imperative form, instead the sign VERZOEK[2] (request) is used. This sign is the first of the imperative sentence, then optionally followed by a reference to the person who should execute the request to end with the actual request. For example, the sentence ‘Close the door!’ translated to NGT is:

[2] Signs are typed in all capital to make a distinction between words and signs.

‘VERZOEK ($INDEX_2$) DEUR DICHT’ (Request ($INDEX_2$) door close) (2020 conversation between M Scheffener and author)). In the case of a requesting sentence, a non-manual marker could be applied, but this is not necessary. The requesting marker consists of a slightly bent-over position, narrowed eyes and a downward-facing chin (Brunelli 2011).

Negative sentences

Negative sentences are declarative sentences with a negation. This negation can be expressed in two ways. First of all, it is possible to use separate signs for words such as 'nowhere', 'not' or 'never' (Schermer et al. 1991). In addition, it is an option to use a non-manual marker to represent denial, which is formed by shaking the head (Schermer et al. 1991).

Non-manual markers

Four different non-manual markers have now been mentioned: two for questions, one for imperative sentences and one for negative sentences. There is one more marker to add to this: the topicalization marker, used to emphasize a phrase. In Dutch, this is usually done by changing the order of the sentence and putting the main phrase in front. In NGT, the highlighted phrase is added, which consists of raised eyebrows and is often followed by a short pause (Schermer et al. 1991).

The different markers can also be used in combination. For example, a question can also be negative, in which case the negative word marker is added to the question marker. However, the topicalization marker cannot be combined. If a signer wants to apply it in, for example, a negative sentence, the topicalization marker is used for the emphasized phrase and the negative marker for the rest of the sentence (Schermer et al. 1991).

Time

In Dutch, generally two ways are used to express the time in a sentence. On the one hand, adverbial time clauses are used, such as 'yesterday', 'tomorrow', 'in 83 minutes', 'during the previous quarter'. On the other hand, verbs are conjugated to show that something is happening in the past, the present or the future. In NGT such timing clauses are also used, these are called time sign. However, most verbs are not conjugated: it must be determined from context or using the time sign when an event takes place. Thereby, the signing space can be used to express time on different timelines (Baker et al. 2016).

Timelines

NGT has five timelines: left-right, top-bottom, bottom-top and 2 back-front timelines, which are shown in image (Schermer et al. 1991, p. 134). In general, the neutral signing space indicates the present, the space before that the future and the space behind the body the past.

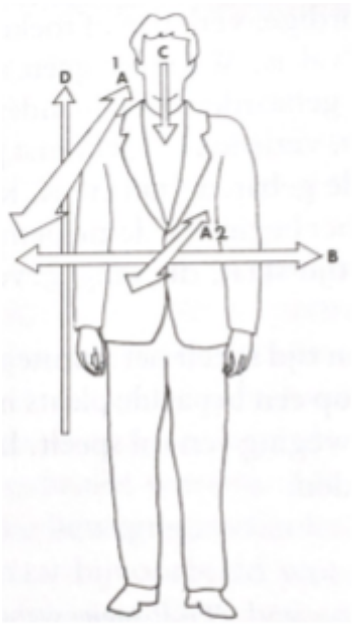

Image 1: Timelines in NGT

The back-front timelines are used to place time signs on. The top line (A_1), at the level of the shoulders, is used for signs such as 'later', 'past', 'future', and the bottom line (A_2), at the level of the abdomen, is used for 'today' and slightly smaller differences with the present such as ‘a little earlier’, ‘a little later’. These signs can be supplemented with a non-manual component such as facial expression and movement, for example to indicate the difference between ‘a long time ago’ and ‘a very long time ago’ (Schermer et al. 1991).

Periods within a year are indicated on the left-right timeline (B). Generally, the year starts with January on the left (seen from the signer) and ends on the right with December. In addition to periods, that is, time clauses with the word 'to' specific dates can be expressed on this line. For example in the sentence: ‘I work from Tuesday to Friday’. For other time markers including days of the week, the up-down timeline located in front of the head is used (C). A kind of agenda is projected, which usually starts with Monday at the top and Sunday at the bottom. The final timeline (D), bottom-top timeline, is to the right of the signer’s neutral signing space. It is mainly used for concepts such as 'growing up' or 'growing', moving over this timeline during the sign (Schermer et al. 1991).

Completed tense (Voltooide tijd)

In Dutch, a completed act is indicated by conjugating a verb to a completed tense. As mentioned earlier, verb tenses are most of the times not conjugated in NGT. For finished actions, therefore, the KLAAR (finished) sign is usually added to indicate that an action is completed (Schermer et al. 1991).

Verbs

Just like in Dutch, verbs in NGT have a form in which the verb appears in the dictionary, the citation form. In Dutch this is the infinitive, for example 'lopen' (to walk) or 'antwoorden' (to answer), but in NGT the citation form is a sign in the neutral signing space (Baker et al. 2016). Verbs are conjugated from that form to add properties to the verb. For example, the subject of the verb or the number of the subject can be indicated by applying certain changes to the sign (Schermer et al. 1991). Not all verbs are conjugated in NGT: verbs can therefore be divided into two groups. The invariant verbs cannot be conjugated, the

variant verbs can (Schermer et al. 1991). The latter group can be divided into four groups, which will be discussed in the following paragraphs.

Invariant verbs

As invariant verbs are not conjugated, it is not immediately clear who or what performs the verb: this must be apparent from context. There is no specific rule as to why a verb is invariant or variant, but it could be related to the iconic aspect of the sign: whether it is possible for a sign to be signed on a different location in the signing space than the place the citation form is signed without losing the meaning (Schermer et al. 1991).

Variant verbs

In Dutch, verbs are conjugated to indicate how many people do something and when (in what time) it is done. In NGT, a conjugation can indicate several things, but not time. To conjugate, one of the parameters (location, orientation, handshape or movement) of the sign is changed (Schermer et al. 1991). The variant verbs can be divided in four groups, which will each be discussed.

First of all, there are directional verbs, for which the change occurs in the direction of the movement (Zwitserlood 2003). A characteristic of the directional verbs is that they have a clear start and end point. By changing these points, the verb is conjugated and it becomes clear to the recipient who or what the subject is and who or what the object is. Within the directional verbs, a distinction can again be made between two classes. One class has verbs where the movement starts with the subject, such as ANTWOORDEN (to answer), where the other class has words that start with the (indirect) object, such as with the word HALEN (to get, to take).

The second class within the variant verbs are the locative verbs. Here, the change occurs in the location of the sign (Brunelli 2011). There are no movements in locative verbs and therefore the sign is made at a point in space, namely the point of the subject. Therefore, it is not immediately clear what the (indirect) object is, that should be extracted from the context.

Thirdly, there are oriental and locative verbs in which two changes occur, both in orientation and in location. An example of this is the verb for ROEPEN (to call). Here, the palm is pointed at the object and the back of the hand at the subject (Schermer et al. 1991). This changes the location of the movement, which is the main difference with directional verbs, where initially the direction changes between two points. Now there are no points distinguished in oriental and locative verbs: there is a movement, but it does not start or stop in a specific place: the orientation of the hand indicates the functions of the two phrases. There are also oriental and locative verbs of which only the finger changes orientation. The rule here is that the fingers point towards the object.

The last group of verbs that are distinguished within the variant verbs are the orientational and directional verbs, where both the orientation and the direction change (Schermer et al. 1991). These are, like the directional, signs that move between two points, often the beginning and end of the verb. The palm orientation, like in the orientational and directional verbs, is used to indicate what the subject is and what the object is. Change in finger orientation is also used here to indicate the object. An example is the verb GOOIEN (to throw), where the movement of the sign begins at the subject (the beginning of the throw so to say) and ends at the direction of the throw (Schermer et al. 1991). For KIEZEN (to choose), the sign starts at the object, (the thing that gets chosen), and ends at the subject (the one choosing it) (2020 conversation between M Scheffener and author)).

Conjugating verbs in NGT follows a whole set of rules, just like most other languages. However, reality shows that these rules are not always followed; often only the quote form is used and in some cases a verb is not conjugated to the subject, but only to the direct or indirect object (2020 conversation between M Scheffener and author)).

Incorporation

Incorporating information in addition to the words actually spoken is done in every language. For example, spoken languages often use intonation and variety in speaking rate to add emotion and speed. In addition, hand gestures and facial expressions are used to emphasize and support the message. For NGT, there are several ways to provide additional information to the recipient, which are discussed in this section.

Number

In Dutch, it is not possible to incorporate the number of a word into the word: when talking about two dogs it is impossible to pronounce the word 'two' and 'dogs' at the same time. Also, there is no facial expression or hand gesture that expresses 'two,' so the words must be spoken separately. This is not the case in NGT: the hand shape of a certain sign can be changed somewhat, to clarify the amount. For example, the week sign, which is normally made with a finger, can also be made with two or three fingers, making it clear how many weeks are involved (Baker et al. 2016).

This may seem obvious for nouns, but it is also possible for verbs. For example, the KIJK (to look) sign, which is normally performed with two fingers, can be performed with five fingers, making it clear that many people are watching (Schermer et al. 1991).

Characteristics

Different characteristics can also be incorporated into signs in NGT: the size or intensity can be added by adjusting the manual or non-manual part, or a combination of both (Zwitserlood 2003). For example, for adverbs to do with intensity, like 'very much', or 'terrible', a combination of manual and non-manual parts is used. The manual part is adjusted by signing larger, faster or multiple times in a row; the non-manual part is adjusted by adding or enlarging a facial expression. In size, for example when indicating a 'big' house, a facial expression is added: one blows their cheeks and makes their eyes bigger.

Classifier

A classifier is a bound morpheme that indicates the semantic class of a word. It is a morpheme because it is the smallest part of a word that carries meaning, and it is bound because it cannot appear freely, or loosely (Zwitserlood 2003). An example of a bound morpheme in Dutch is the letter '-s' in 'appels' (apples): it shows plural, so it has meaning, but cannot occur freely: 's' separately has no meaning (Fromkin et al. 2014). So a classifier is such a bound morpheme, but one that specifically says something about the semantic class. That is not possible in Dutch, but is for example used in Navajo, a language of the Native Americans. In that language, 'a' is added to verbs when it's about something round, and 'ltsooz' when it's about something 'flat and smooth' (Schermer et al. 1991).

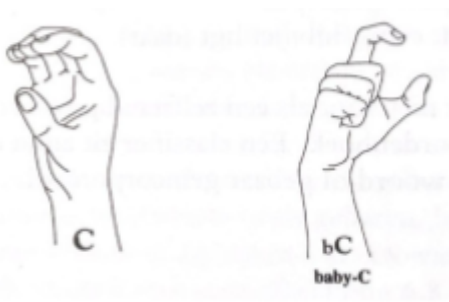

Image 2: C-hand and baby-C-hand

Classifiers within NGT are mainly applied by using a specific hand form in a noun or verb sign. For example, the sign for drinking a glass of beer is performed with a C-hand, but when it comes to drinking a shot, this is

more often a baby C-hand (see image 2) (Schermer et al. 1991, p.128).

Several studies have been conducted into classifiers of NGT (Fortgens et al. 1984; Schermer 1983; Zwitserlood 2003). These show that some classifiers are iconic, that is, the sign makes it clear what they mean (as in the example above). Other classifiers are less obvious, although there is often a reference to the a property of the referent.

Classifiers can have multiple meanings and sometimes it is possible to choose from multiple options. For example, a human is usually referred to with a 1-hand, but when the emphasis is placed on the person's walking, a V-claw hand is used. The signer looks at the most important aspect of the referent; this can be the most important aspect for the signer or the most important aspect of the conversation (Schermer et al. 1991). It is also possible to look at how the signer perceives the object; a beer glass from afar or in comparison with a beer mug can also be indicated with a baby-C hand.

In addition to handshape, the space, hand orientation and movement are more options for applying classifiers within NGT. Space refers to the location of a particular object: it can be static (how two objects are located relative to each other), or dynamic (how two objects are moving relative to each other), or dynamic-static (how an object moves relative to a stationary object) (Schermer et al. 1991). The hand orientation consists of two parts: palm and finger orientation. For example, a car can be signed to be upside down, by making the hand orientation opposite to the normal sign for car. When singing a story about two objects, classifiers can be used to show how the objects interact with each other. When signing about clash of two cars, the location of the hands relative to each other could show on what place the cars hit eachother (Schermer et al. 1991).

Referencing

Referring is something that occurs in almost every language, including NGT. In Dutch, reference words such as 'die', ‘dat’ and ‘daar’ (who, which, where) are used, in NGT, referees are assigned to places in the signing space and referring to those places when talking about that object . The signing space is a semicircle in front of the signer’s body, which runs to the receiver (see image 3). Referencing has also been mentioned in the paragraph on verb conjugation. In this section, ways of referring to personal pronouns and to locations will be further clarified.

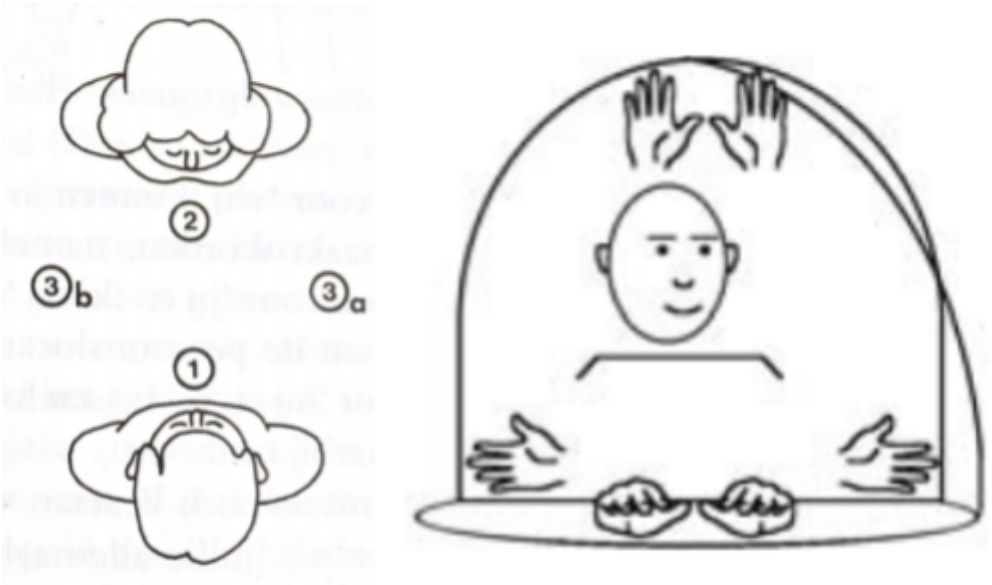

Image 3: referencing space[2] and signing space[3]

Personal pronouns

Personal pronouns are referred to by using pointing signs to 3 specific places or a combination of those (Baker et al. 2016). A pointing sign is called an INDEX, and so an INDEX to location 1 is noted as $INDEX_1$. Location 1 is on the signer itself and means 'I'. Location 2 is in the direction of the receiver and means 'you'. Location 3 is located on the

[3] Source: Schermer et al. 1991, p. 149
[4] Source: van Gijn 2004, p. 16

front right (3a) and on the left front (3b) of the signer and refers to the third person singular: no distinction is made in gender in NGT (see image 3 for the locations). These singular locations can be combined by alternately pointing to two or more places to refer to multiple personal pronouns. In this multiple, a distinction is made between the different combinations of the locations. In Dutch, there is no other word for the 'we' consisting of 'you' and 'I' and the 'we' consisting of 'you', 'I' and 'he' (Schermer et al. 1991). This difference does exist in NGT; after all, it is possible to point to location 1 and location 2 or to locations 1, 2 and 3. There is another distinction that Dutch makes but NGT does not: the function in the sentence. The word 'me' shows that it is not a subject, but the sign $INDEX_1$ does not tell you what function it has in mind. This is done in NGT by the conjugation of verbs, which is discussed previously.

Localization

Localization is referring to things or situations that are not present in the space of the signers (Baker et al. 2016). The situations are signed from the signer's point of view, so the receiver will see the situation in reverse (Schermer et al. 1991). Within the localization, a distinction can be made between iconic and arbitrary localization. For iconic localization, the signer will show the situation exactly as it happened. An example of this is when someone talks about a traffic accident that has happened, where it is important to know where objects or people were in relation to each other.

In arbitrary localization, the locations of the referent are no reflection of the situation in the real world (Nijen Twilhaar and van den Bogaerde 2016). For example, someone can retell a conversation that took place to the right of the person by placing the partners on

INDEX 3a and 3b or tell about a situation that the person did not actually experience, for example a story from history (Schermer et al. 1991).

Ways of localizing

There are different ways to localize (Schermer et al. 1991). For example, the signer can make the sign in neutral signing space, make the citation form, and then point to where the referent is located. In addition, the signer can also choose to sign the sign directly at the point. The signer can also locate by first making the sign in neutral space and then sign the AANWEZIG (present) sign at the reference point. Finally, a localization can also take place by conjugation of a directional verb, as explained in the paragraph on verbs.

Rules of localizing

There are different rules about locating. Firstly, one point can only be used for one reference and can only be reused when the conversation subject changes and the referent becomes redundant. Secondly, the signer does not have to make the sign for the referent again with every referral, but does need to do this occasionally, especially with long stories. Thirdly, as long as the situation remains the same, the referent must be assigned to the same point; this cannot change (Schermer et al. 1991). If a situation does change, for example when a person moves in the signed situation, a sign must be made from the old to the new position to indicate that the referee has moved: from that moment on, the new point is used as the reference point. If the situation changes because the signer’s perspective changes, for example because they are signing from someone else's perspective, they also should indicate that the reference points change.

Role shift

Role shifting is a way of applying perspective to a story. By doing this, a story can be told from the perspective of another person (i.e. not the signer). This applies to direct speech, but also to an experience from someone else's perspective. In written language, direct speech is indicated by quotation marks, such as in the sentence: 'The boy says: "I want to go out" and dashed through the door.' The quotation marks indicate a clear difference between what the boy says and what he does, which is important because there should be no doubt whether the signer himself or anyone else is saying that (Fromkin et al. 2014). Role shifting can be done by altering the facial expression and posture, body shift or INDEX, but most of the times it is a combination of those (2020 conversation between M Scheffener and author)).

Facial expressions and posture

By adopting the facial expressions and/or body position of the other person, the perspective of the conversation can be clarified. Facial expression can denote a certain emotion that the person being quoted has or show what the person looks like, for example a solemn facial expression when signing from the King's perspective (Schermer et al. 1991). The signer would also be able to adjust his body posture by standing upright for the King's perspective. Body posture can also be used in height. For example, when a signer is talking about an adult talking to a child, he could, when quoting the adult, look down as the child is smaller than the adult. This could also be applied in conversations in which one is higher in function than the other (for example employee-employer or minister-citizen) (Schermer et al. 1991).

Bodyshift

Body shift, or turning the body, is also a way of role shifting. The turn of the body moves to one of the INDEXes 3a or 3b, and then takes over the role of respectively 3a or 3b (Schermer et al. 1991). This INDEX must already be localized. A facial expression and body posture of the quoted person can be taken on as well, in addition to the body shift. By alternating between a turn in the direction of an INDEX, the signer can retell a conversation between himself and none other. By alternating between 3a and 3b, a conversation can be retold between two people who are not present.

INDEX

Through indexing, the signer can also tell a story from another perspective. To do this, the signer points to the INDEX where they have located the person and then tells from their perspective (Schermer et al. 1991). INDEX is often used in combination with body shift, facial expression and body posture.

Digital language learning

A lot of research has been done on second language acquisition (SLA) with the help of technology (Akbar 2012; Garrett 2009; Shadiev et al. 2017; Yusof et al. 2012), some of which focused specifically on sign languages (El-Seoud et al. 2013; Mertzani 2011). SLA is often measured on the frame of the four skills: speaking, listening, reading and writing (Blake 2016). The fast development of technology offers new tools for improving, practicing and assessing these skills. However, not all these skills are applicable to sign language. As sign language is only written down for research purpose, there is no need to learn how to write or read NGT. For the other two skills, the terminology is different when talking about sign

language. the terms speaking and listening are not even used, they are referred to as respectively sign production and sign comprehension (2020 conversation between M Scheffener and author). However, the intention of the skills is the same: being able to understand someone else and to express yourself in a conversation. Therefore, some of the research which has been done on general digital SLA can be applied to sign language and will thus be discussed in this chapter. Additionally, the research on the acquisition of sign language, in particular with the help of technology, will be reviewed.

Technology enhanced SLA

Technology enhanced SLA can be both used as addition or support of classes at an educational institution or as a method to independently learn a language. A lot of studies have been conducted for both options. Although the aim of this study is to build a platform for independent study, both subjects of studies can be used to deduce information. The main differences between the two cases are the motivation of the learner and the supervision. Blake (2009) defined what the ideal online learner would be: 'an adult learner who was highly motivated, mature and focused on learning'. There are four aspects in this definition: (1) adulthood, (2) motivation, (3) maturity and (4) focus on learning. As parents are the main target audience of the platform, the adulthood and maturity can be checked. The main motivation of the target audience would be learning NGT to be able to communicate with their child or children. No one would be forcing the parents to learn NGT, so the source of motivation will be because they find it important, essential or enjoyable: intrinsic motivation. This means the motivation is on the right and positive side of the motivation continuum (Ryan et al. 2017), and therefore the learner will be motivated. The last aspect of the ideal

online learner is the focus on learning. This can be met by giving the platform a clear structure, learning goals per page and ensuring the platform is easy to use.

Most of the studies on digital SLA are case studies on a specific type of software or program. Zhuo (1999) researched the effect of hypermedia[5] on grammar learning and instruction. He found a positive effect of hypermedia on the understanding of (German) grammar. Schnackenberg (1997) conducted a research on the addition of the software program Learning English Electronically to a beginners English class at a University. The strength of the software were the additional exercises on grammar, the grammar topics combined with content topics, the self-paced nature of the program and the inclusion of sound. Weaknesses had mostly to do with the use of the computer; the slowness, the use of the mouse and printing possibilities. Different studies have been conducted on one of the most popular language learning apps nowadays: Duolingo. Registration and participation is free and can be done on mobile phones, tablets and computers and the learning can be done completely independent, no classes needed. Nushi and Eqbali (2017), Loewen et al. (2019) and Vesselinov and Grego (2012) both analyzed the effectiveness of Duolingo for independent learners. In both studies, a positive correlation between Duolingo use and language proficiency was found. Strengths of Duolingo were found to be the reminders, the simple use of the app and encouragement of peer-to-peer collaboration through challenging friends. However, this collaboration is limited to see the level of the peers, and not much interaction is possible, even though this is important for SLA (Loewen et al. 2019). Additionally all the learning of language in the application is done by only four types of exercises of translating, listening and speaking which causes the ability to only produce short phrases and Duolingo lacks of explicit explanations on grammatical topics, which may leave

[5] Hypermedia is defined as 'a system that links text to files containing images, sound, or video' (Oxford Advanced American Dictionary accessed 2020)

learners in confusion (Blake 2016). Furthermore, out of these studies it is suggested that there may be more progress studying a language when the starting level is not 0 (Loewen et al. 2019).

Blake (2016) has provided an overview on different computer-assisted language learning (CALL) programs and activities, categorized according to the four skills mentioned above. As only listening and speaking are somewhat applicable to sign language, only those two will be discussed in this paper. For speaking, he mentioned that CALL practices mostly entail the learner recording themself and compare the recording to one provided in the program, or make use of automatic speech recognition (ASR) to let the CALL application give feedback to the student. Those ASR programs are developing fast and they all get more and more functions and applications to different languages. For listening, Blake (2016) mentions the importance of speed control, to slow down the speech rate, or the possibility to turn to transcripts or subtitles when needed.

Technology enhanced sign language acquisition

Only a few studies on digital sign language acquisition have been found during this research. One was done by Mertzani (2011), who looked into CALL applied to a British Sign Language (BSL) class. Students received tasks to be carry out in groups during normal class times, using a computer program called SignLab, which was specifically designed for studying BSL. An activity that was found very useful for the students and their learning outcomes, was recording oneself signing and comparing that to an example in SignLab. The use of SignLab was part of the normal BSL classes for students, thus this is a case of blended learning. Another case of blended learning of sign language with the help of CALL, was a study done by Berrett (2012). Digital videos and photographs of different signs were added to

the online environment of a traditional university course. This imagery included signs from non-regular angles, to give a more complete understanding of a sign. However, the paper concluded that the students who did not have access to the imagery performed as good as the students who did, but thereby added that CALL among sign learners should be studied more, as education is changing, so education of sign language should, too (Berret 2012).

Next to the cases of blended learning, two cases of independent learning were found. One was on an app to learn the Arabic Sign alphabet, with deaf students as the target audience (Ritchings et al. 2012). The app showed the different signs for each letter as pictures and videos. The participants saw the picture and video per sign and completed a 5 question multiple-choice test to recognize the pictures of the signs. For all questions, the average score was above 50%. The participants commented that seeing a picture or video online from only one angle was not beneficial, and more angles should be added. The second case of independent learning was a study on 'Menusigne' (Rayner et al. 2017). This is a 'serious' game designed for French speakers to learn French sign language (LSF), based on the use of an avatar. The game has 3 levels: for the first level, the learner inserts a sentence following a set order which the avatar would then sign in LSF. For the second level, the avatar would sign a sentence and the learner has to choose what the avatar signed. For the third level, the learner would see a video of a real person signing and answer what was signed. The first two levels were received very good and appeared to be good for learning basic signs and sign order. However, the third level turned out to be quite a big step, as every signer alters the signs and will not sign as clear as the avatar is programmed to do.

Design of Digital Platform

This last chapter will combine the previous two chapters to design the ideal platform to learn NGT. The importance of an easy to use program with a clear structure was shown (Blake 2009; Nushi and Eqbali 2017). To ensure such a clear structure, the platform will have an overview page which gives access to all the different subpages which will each explain a grammatical topic on NGT.

Each topic page will have the following components:

- an example of the use in Dutch;
- an example of the use in NGT;
- a short and simple explanation of the rules for the use in NGT;
- a longer and more complex explanation of the rules for the use in NGT;
- one or more exercises to practice with the topic.

The examples of NGT will be shown in video format and include an option to slow down the speed and add subtitles to enhance learning possibilities (Blake 2016). The explanations will be offered at two level to differentiate in levels of learners, as learners can then choose which level explanation they want or need and therefore learn more (Ryan et al. 2017). These components are the basis for each topic page, but may differ slightly from page to page as some topics will require more explanations or examples than others.

The topics for each page are extracted from the chapter on grammar of NGT of this paper, but will use easier wording to ensure a wider accessibility. The topics will have a chosen order, but users are free to go to every page whenever they want so it will not be forced upon them. This creates a certain autonomy, which will increased motivation and

therefore learning outcomes (Ryan et al. 2017). The order is chosen in such a way that it starts with the basics and develops on to harder topics. The topics of the platform will be:

- a sign: what is it?;
- sign order;
- verbs;
- referencing to people and places;
- role shifting;
- indicating time.

Three different type of exercises will be available:

- an avatar game;
- record & compare;
- peer-to-peer.

The avatar game would be the most ideal exercise, as described in the paper of Rayner et al. (2017), where users could input language which the avatar would then sign, or where users should indicate what the avatar signed. As this avatar is currently under development for only some of the grammatical topics in NGT (2020 conversation with dr. F. Roelofsen and author), this is not possible for all the topics the platform will offer.

The record & compare exercises can be done individually. The user is given a couple of sentence which should be signed, for which users can record themselves and them compare their recording to a signed version by a fluent NGT signer (Blake 2016; Mertzani 2011). For this comparison, some guiding questions can be posted to make sure the learner focus on the right topics (Mertzani 2011).

The peer-to-peer learning exercise will be done with two learners. This aspect of learning together was stressed as important for SLA by Loewen et al. (2019). The exercises

for peer-to-peer learning can be comparable to record & compare, but then the learners could come up with their own practice sentences or use some guiding questions to help them achieve the learning goals. For this, the platform should have a function to connect with other learners. This can be achieved by offering a forum page on the platform where users could communicate with each other and find a signing partner to sign with via a video call. This can have two benefits: by partnering up with someone and see them progress, there is more motivation to learn oneself (Nushi and Eqbali 2017) and learning together improves learning outcomes, even if the language level is different. (Loewen et al. 2019).

Lastly, there are three requirements the platform should meet to ensure accessibility. Firstly, the platform should be responsive, such that it adapts to every screen and thus also functions on phones and tablets and not only on computers or laptops. Secondly, it should incorporate other sources of NGT named in the research context of this paper, to make sure all learners can find all the information available. Thirdly, the platform should be free for users, such that everyone can get the chance to learn NGT.

Conclusion

Although 1 out of 850 children are born deaf each year in the Netherlands, not many people are fluent in NGT. This causes a backlog in development for deaf children, as they do not get as much language input as hearing children. This paper aimed to make NGT more accessible to Dutch speakers, by proposing a design for a platform on which NGT can be learned by Dutch speakers. To do so, different studies and resources on language of NGT have been consulted to write down a complete overview of the language, as no current synopsis is available.

Next to NGT, digital language learning is studied. Multiple apps and platforms, most developed for teaching spoken languages, have been analyzed by other scholars and this study gave an overview of these studies to conclude which requirements a learning platform should meet. As a last chapter, a proposal for an online platform is given. This is a combination of the other two chapters, such that the knowledge on digital language learning is applied to NGT.

As this paper only gave a proposal for the platform, a next step would be to create this program to ensure the implications of this study. The aim of the author is to build the platform in the upcoming months, with the help of the supervisor. The avatar exercises discussed before will also be implemented, as they are currently under development. To improve the platform, future research can be done in the effectivity of the platform and how it can be improved and further developing of the avatar exercises, as they will not be available for every topic just yet.

Further research on NGT is also needed, as there are some grammatical aspects for which scholars do not agree, such as the non-manual markers for questions. For other topics within NGT, documentation is lacking, such as an exact list of which verbs are variant and which are not, while most signers of NGT will be able to tell you this. To conclude, this paper is a good start of making NGT accessible to Dutch speakers, more research on the language of NGT can be done to improve the accessibility.

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