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EXPERIMENTAL EYETRACKING GLOTTODIDACTICS

ABSTRACT

A growing access to advanced research tools makes it possible to conduct equipment-based research also in the scientific areas that have not used it yet (for example, glottodidactics). Nowadays even there the most advanced equipment, as an eyetracker, can be used. The aim of the article is to shortly describe eyetracking as a research method in glottodidactics and to present the *experimental eyetracking glottodidatics* name for that type of glottodidactic research.

KEYWORDS: glottodidactics, eyetracker, experimental eyetracking glottodidactics, learner, textbook

STRESZCZENIE

Coraz większa dostępność zaawansowanych narzędzi badawczych pozwala na prowadzenie badań wspieranych aparaturowo także w dyscyplinach, które nie wykorzystywały takich narzędzi (np. glottodydaktyka). Obecnie również one mogą sięgać po narzędzia bardzo zaawansowane, jak np. okulograf. Celem artykułu jest przedstawienie okulografii jako metody badawczej w glottodydaktyce i przedstawienie pojęcia *eksperymentalna glottodydaktyka okulograficzna* dla tego rodzaju badań glottodydaktycznych.

SŁOWA KLUCZOWE: glottodydaktyka, okulograf, eksperymentalna glottodydaktyka okulograficzna, uczący się, podręcznik

INTRODUCTION

Language as a subject of teaching differs from other subjects of teaching (Zabrocki 1979) that is why the language material for teaching purposes should be treated in a different way than the teaching materials related to other subjects. Since the end of 19th century, when talking about teaching and learning foreign languages the name *glottodidactics* has been used, especially on the Polish ground. Not so long ago was glottodidactics located somewhere close to linguistics, psychology and general didactics (Komorowska 1982) but nowadays it is an independent scientific discipline and the number of its academic achievements is constantly growing.

Glottodidactics (language teaching; from Greek *glotta* = language, *didascein* = to teach) is related to the practice of foreign language teaching as well as to the analysis and research of language acquisition (Pfeiffer 2001, Grucza F. 1979, Dakowska 2010). The very beginnings of glottodidactics as a practice of foreign language teaching are parallel to the moment a human being started speaking the languages (Grucza F. 1979).

As it has already been said, the subject of glottodidactic research and interest is language acquisition (Grucza F. 1978b: 31) consisting in the development and/or specification of innate language composition of a human being (Sadownik 2000: 372). The goal of glottodidactics is an analysis and description of the glottodidactic chain (Polish *układ glottodydaktyczny*) together with all the processes and actions that can be observed in the chain, followed by the explanation of them (Grucza F. 1978b: 32). Glottodidactic research is, among others, devoted to the acquisition of the first (i.e. native) and second (foreign) languages in natural conditions, as well as in school conditions (see Sadownik 2000).

Glottodidactics is interested not only in methodology of foreign language teaching, but also in all the aspects related to the foreign language teaching and learning, preparation of teachers, foreign language teaching materials, technical tools connected with it etc. (Grucza F. 1978b: 31).

Glottodidactics can be divided into general glottodidactics and detailed one, and each of them can be further divided into pure one and applied one (Pfeiffer 2001: 14–15). Pure glottodidactics describes and explains the glottodidactic chain, all the processes in it and glottodidactic activities. Whereas applied glottodidactics is related to the changes of the glottodidactic chain, the processes and activities in it that are aimed at realizing all the planned results. Applied glottodidactics prepares the base for glottodidactic "devices" (i.e. foreign language teaching and learning materials, didactic methods etc.) (Grucza F. 1979).

The object of the glottodidactic research are particul people / particular person (Grucza F. 2007) who teach and/or learn the foreign languages. They are interesting for glottodidactics from the point of view of their characteristics but also of their knowledge that is the base of their proper skills (Grucza F. 2007).

All the glottodidactic processes, i.e. foreign language acquisition and teaching the language, are started by the human being and they happen in the human being in a specific communications chain (Polish *układ komunikacyjny*) (Grucza F. 1979, por. Grucza F. 1978a) called the glottodidactic chain. The development of the Polish glottodidactic thoughts is reflected in the appearance and then evolution of the idea of the glottodidactic chain. The chain reflects the concepts, basic areas and tasks of glottodidactics (Gębal 2013, see Jaroszewska 2014).

The glottodidactic chain is a kind of the communication chain but in the glottodidactic situation. As such, it consists of three basic elements, i.e. an information receiver (a learner), information channel (with the help of it the information is delivered to the learner) and the information sender and information source (in

some cases the information sender and the source can be the same element of the chain). The most important part of the chain is the learner.

ANTHROPOCENTRIC IMPLICATIONS IN GLOTTODIDACTICS

In the 50s and 60s of 20th century glottodidactics was oriented on a teacher (so called *teacher oriented instruction*) and the relation between a method as a starting point and the teaching results as the consequences of the method applied. In the 70s a learner occurred in the center of glottdidactic attention (so called *learner oriented instruction*).

From the point of view of the following paper anthropocentric implications in glottodidactics are very important. As it was mentioned before, the very first areas of glottodidactic interests were related to preparation and assessment of the language texts (used during the process of foreign language teaching and learning) on the basis of language knowledge. Then, however, the attention went to the problem of characteristics of learners in the process of foreign language acquisition. Finally, though, it was changed and, as a consequence, a human being as a teacher or learner became the most important object of glottodidactic research (Wąsik and Wąsik 2008). Such a concept of the language oriented towards the human being is strictly related to the anthropocentric theory of human languages (Polish *antropocentryczna teoria języków ludzkich*).

The starting point of the anthropocentric theory of human languages by Franciszek Grucza was an assumption that a language in general cannot be directly observed as such and that is why it is only possible to observe people speaking the language and communicating with each other in such a way (a human being as an object of any research). Language is a characteristics of human mind which can be seen in a form of language rules and communication skills internalized in one's consciousness. Speakers and hearers who use these subjective rules and skills, develop their competence and communicate by means of language expressions (Wąsik and Wąsik 2008: 138–139).

In the process of language acquisition, on the basis of an observation of the incoming language products, i.e. texts, a learner reconstructs the language, then stores and processes the reconstructions (Grucza F. 1978b: 39). So, generally speaking, it can be said that a process of language acquisition (that occurs in the glottodidatic chain), together with all elements that have an influence on it, is a specific subject of glottodidactic studies (Grucza F. 1978b: 40–41). Similarly, in linguistics the interest is put on particular people because of their particular language skills (Grucza S. 2008: 129, see Grucza F. 1983, Grucza S. 2010) – the main interest of linguistics is directed at particular speakers-hearers

and language properties located in their brains as well as linguistic processes in their brains.

As a consequence of the above, the aim of foreign language learning is to support the development of knowledge being a base for the ability of completing language expressions, receiving, recognizing and understanding language expressions of other people and for the ability of considering contexts and situations in the process of creating and understanding language expressions (Grucza F. 2005, Olpińska 2009). Applied linguistics in the field of foreign language teaching should, however, study people from the point of view of their linguistic and communication skills. This would help to answer the question of what should be done to prevent the people learning the languages from making mistakes and to make them increase and develop their verbal competence (Wąsik and Wąsik 2008: 139).

An anthropocentric approach in glottodidatics is seen in the orientation on a learner (see Józefiak 2013). Traditional didactics of foreign languages was mainly related to the aspects of external control of directing the didactic process (preparing new, more and more effective methods of teaching, individual characteristics of a learner, i.e. motivation, attention, attitude, interests). According to foreign language teaching methods (grammar translation method, audio-lingual method etc.) and theories of that time learners can, should or just have to quickly and without mistakes learn the language material given on the lesson. It was believed a didactic activity of a teacher is the most important for the learner's language acquisition processes. Such an approach was reflected in textbooks and attitude of teachers (Sadownik 2000: 373). Whereas for contemporary glottodidactics a human being is a proper subject of the research and studies. The language learning is not the function of a teacher anymore and the teaching methods no more are the base to understand the core of language acquisition process (Sadownik 2000: 374). Now it is a learner who decides about and influences the way and results of learning. The learning process has become autonomous and is run by a learner themselves – there is only a slight influence on it from outside (Chudak 2011). In such a situation the glottodidatic materials used by a learner should stimulate his/her development, should influence in a positive way his/her desire to learn the language and should increase the efficiency of learning. A teacher is now a kind of guide who should lead a learner through the complicated process of learning and help him/her overcome unavoidable obstacles that occur during the process of learning a system of a foreign language (Arabski 1998: 5, see also Grucza F. 2007).

All the problems related to contemporary foreign language textbooks (especially English textbooks that are of my special scientific interest) comply with the anthropocentric context of modern glottodidactics. It is so because in the studies of textbooks in the centre of research attention there is a particular student (group of particular students) and his/her (their) individual features.

RESEARCH TOOLS IN GLOTTODIDACTICS

In recent years in linguistic research new tools are more and more often used and owing to this linguistic research becomes equipment-based. Some linguistic research was, is and can be conducted with the help of (i) acoustic filters, sound scanners (sonographs), spectrometers, (ii) kymography, laryngoscopy, roentgenography, kinoroentgenography, palatography, labiography, (iii) neuroimaging, electroencephalography (EEC), magnetoencephalography (MEG), positron emission tomography (PET), functional magnetic resonance imagining (fMRI), (iv) eye-tracking (Grucza S. 2011, Grucza S. 2013). In glottodidactics, however, the research is usually conducted by means of language tests and different questionnaires (Wysocka 2000), interviews and observations. Although owing to these methods it is possible to collect important data, they are not free from the risk of a mistake. The risk is connected with the limitations out of the researcher control, as, for example, unreliable answers of participants, changing composition of the group under the research (during the lessons' observation the composition of the same class group may vary because not always the same students are present; very often the researcher is not able to control and prevent it) etc. It can also be caused by bad preparation of the research itself (imperfect questions in the questionnaire, not all the variables taken into consideration etc.). However, the latter may occur in case of any kind of research, irrespective of the assumptions, the equipment and tools used.

In recent years the technological progress has been very fast but its results, i.e. the newest technological devices, are mainly used in the research from the field of chemistry, physics or medicine. However, for some time the most advanced equipment that is widely used in scientific research has also been used in academic one. An example of such a device is an eye tracker that has been recently used by both psychologists (Eye Tracking Research Center of SWPS University; Faculty of Psychology, University of Warsaw; Laboratory HD, Faculty of Social Sciences, The John Paul II Catholic University of Lublin) and linguists (Faculty of Applied Linguistics, University of Warsaw: Eye-Tracking Experimental Linguistics Laboratory (LELO) – research in the field of experimental eye-tracking linguistics, especially translation studies-oriented experimental research – see for example M. Płużyczka 2011, 2012, 2013a, 2013b, 2013c, 2015, A. Bonek 2016, as well as experimental glottodidactic research (the author's research; there are also some other studies conducted by the Polish researchers and related to eyetracking in the context of, for example, reading and dyslexia – see J. Ober 2000 (as well as other papers by this author – J. Ober et al. 2000a, 2000b, 2002, 2009); morphosyntactic processing in foreign language learning – see M. Szupica-Pyrzanowska 2016; bilinguals/multilinguals and reading – see D. Titone et al. 2016; glottodidactic web platforms – see M. Zając 2015); Audiovisual Translation Research

Lab (AVT Lab); Faculty of English, Adam Mickiewicz University in Poznan – linguistic and translation research). The evidence for the growing interest in the use of eye trackers in linguistic research are new regular scientific conferences devoted to eye tracking. One of the two most important events of that type is the Polish Eyetracking Conference that has been held annually since 2012. Its first edition was titled *Eyetracking in social and humanistic research. Theory – method – application* (Polish *Eyetracking w badaniach społecznych i humanistycznych. Teoria – metoda – aplikacja*) and the title clearly emphasises the use of eyetracking methods in the fields that were not equipment-based. The second one is the International Conference on Eyetracking and Applied Linguistics (ICEAL) that was held for the first time in 2014. It is worth mentioning that the name of the conference puts together applied linguistics and eyetracking tools.

EYE TRACKER

An eye tracker (also *oculograph*) is a device that allows to observe and analyse the way the person looks at the object, so it may be possible to see in details what is at the central direction of gaze as well as to follow along the path of the visual attention of the observer (Duchowski 2007: 23). Modern video-based eye trackers register eyeballs movement with the help of the camera directed at the eyes and the measuring system integrated with the computer and it allows to identify the areas which are brought to the participant's attention (Grucza S. 2011, Holmqvist et al. 2011, Duchowski 2007).

The first written information about eye movements date back at the end of 16th century. In 18th century the first research of binocular vision was conducted as well as experimental studies of eye movements (Wade 2007). In 1823 Jan Evangelista Purkyne published his paper describing the physiology of the eye and listing his most important ophthalmological observations (Grzybowski and Pietrzak 2013). In 1823, too, Charles Bell showed the results of his studies on, among others, passive and active reactions of eyeballs on visual stimulus. In 1826 Johannes Müller published his two works on visual behavior (Wade and Tatler 2005; Wade 2007; Soluch and Tarnowski 2013).

At the end of 19th century there was a growth of the interest in the eye and eye movements. The first attempts to register eye movements date back at the end of 19th century. The 20s of 20th century is the beginning of the film and cinema – as a consequence it became possible to film (in a non-invasive way) both, i.e. horizontal and vertical, eye movements, however, the quality of it was not good enough. That is also the beginning of electrooculography which is based on measuring the corneo-retinal standing potential that exists between the front and the back of the human eye. Photooculography (videooculography) that is the most

popular nowadays uses pupil tracking and/or corneal reflection tracking during the movement of an eyeball – a (video)camera is directed at the eyes and records specific parts of the eyeball in motion (Soluch and Tarnowski 2013; see more in Duchowski 2007, Grucza S. 2011). Because of many situations where eye trackers might be used, they are constantly adjusted to the conditions and that is why there are stationary eye trackers (perfect for laboratory research) and mobile ones for dynamic research.

Eye trackers are used in many different areas of human interest and activity, for example: neuroscience, sociology and psychology (visual perception and brain, reading, visual scene perception, visual perception and information processing etc.), medicine (eye movement tests in the treatment of neurological, psychiatric, and ophthalmic diseases; assessment of the effects of behavioral or pharmacological therapy, as well as effects of eye operations; assessment of oculomotor speed reaction and the stability of eye fixation etc.), industrial engineering, human factors (aviation, driving etc.), sport, marketing and advertising (copy testing, print advertising, ad placement, product label design, consumer behavior etc.), computer science (human-computer interaction etc.), ergonomics and usability (of web pages, computer programmes, computer games etc.) (http://www.neurodevice.pl/pl/uslugi/eye-tracking, see Duchowski 2007, Opach 2011).

EXPERIMENTAL EYETRACKING GLOTTODIDACTICS

The studies of textbooks that were initiated by me and described in a few articles (Andrychowicz-Trojanowska 2015a, 2015b, 2016a, 2016b, 2016c, 2016d) use and are based on the above-mentioned technologically advanced device, i.e. eye tracker. Because of the fact that so far there are no glottodidactic studies in Poland using that type of equipment it seems necessary and useful to name this new area of academic research that has just been opened as *experimental eyetracking glottodidactics* (Polish *eksperymentalna glottodydaktyka okulograficzna*). At the same time it should be emphasized that the first one to use the name *eyetracking glottodidactics* (Polish *glottodydaktyka okulograficzna*) was S. Grucza (2016, for example).

Experimental eyetracking glottodidactics combines all the previous and present achievements of glottodidactics with the newest and most advanced technological possibilities that an eye tracker gives. As for now it is still an experimental approach because the eyetracking papers on linguistics that has already been published mainly deal with reading processes, cognitive load during reading, translation processes (sight translation, audio description), but not glottodidactic problems.

This non-invasive method of analysing eye movements that is used by me makes it possible to collect a lot of data on the cognitive processes related to

perception, memory and notion. A human being pays his/her visual attention to the parts of the observed objects that are important from the point of view of information gathering, so eye movements reflect active, (intentionally) oriented activities that are directed by the upper processes. That means eyetracking research results are an important and valuable source of information about the quality of all the cognitive processes and their courses that happen during visual perception (Borkowska and Francuz 2013: 46).

A starting point for experimental eyetracking glottodidactics is a particular student, and, as a consequence, the question if it is possible to come to know in a scientific way all the capabilities of the glottodidactic chain by means of eyetracking research. Communicative approach that locates a student, and not a teacher (as it was earlier), in a center of attention and makes the teaching concentrate on a student led to the idea of autonomy in teaching and learning foreign languages (i.e. glottodidactics). In the teaching process oriented on a student it is a student (not a teacher anymore) who becomes responsible for the course and efficiency of a didactic process and that is called a student's autonomy (Gabryś 1998). The student's autonomy is then the responsibility of a student for the learning process the student participates in, irrespective of a place (classroom or not). The autonomy is related to the awareness of the process (why am I learning?) and the ability of self-learning and self-monitoring of the progress (Gabryś 1998: 20). The student's autonomy also leads to contesting the role and power of a teacher (who used to be the most important) and to the emancipation of the student. The emancipation is an obvious consequence of becoming an active participant of a didactic process and of taking a responsibility for learning a foreign language. The student's autonomy also means that is a student who chooses the topics or ways of teaching, who can make use of self-learning and self-monitoring of the results (Dakowska 2014: 38). From the point of view of student's autonomy it is also important to remember about individual differences between students, because the differences influence the processes of language acquisition and its efficiency. The student's autonomy requires more attention to be paid on learning strategies that are related to the learning efficiency of, among others, foreign languages (Zybert 2000). Because of that a foreign language teacher (but also any other teacher) is obliged to use techniques (accepted by methodology, linguistics, psychology) that are proper and adjusted to the needs of a particular student (related to, for example, an individual learning style that is a result of an individual cognitive functions; individual characteristics, experience, knowledge) as to make it possible to fully realize the individual approach in teaching (Jaworska-Biskup 2007). In such an anthropocentric context of a student's role in the glottodidactic chain it is not possible to forget about the problem of glottodidactic materials which should support his/her autonomy.

Still one of the most often used glottodidactic materials is a traditional printed textbook. Such a textbook is chosen by a teacher for every group of students,

although no group is homogeneous. Textbooks are very attractive from the visual point of view and that is related to their role – a format of a textbook is also a tool helping to direct and control the students' attention (graphic elements are used to emphasize some information, to draw the students' involuntary attention and concentrate the attention on the presented material) (Dakowska 2001). And that is the layout of a textbook and its influence on the glottodidactic process as well as its efficiency which are the main and most important aspect of the research conducted by me in the field of experimental eyetracking glottodidactics.

LIMITATIONS AND CHANCES OF EXPERIMENTAL EYETRACKING GLOTTODIDACTICS

Although experimental eyetracking glottodidactis is connected with many chances, it also suffers from some limitations. Both aspects will be shortly characterized below, starting from the limitations.

The first limitation is the high price of an eye tracker which influences the limited access to the equipment and lower number of (hypothetical) studies of that type. An eye tracker and all the related equipment are technologically advanced and that is why they are expensive. As a consequence, from the financial point of view it might be impossible to equip the laboratory with a few eye trackers. The more eye trackers, the shorter time needed to conduct and complete an experiment, since it is not possible to check a big group of participants in an efficient way with only one device. What is more, the longer time of experiment, the higher probability of consulting its course by the participants. That may influence the reliability of the results.

Secondly, the equipment must meet particular technical requirements because the data is big and needs a lot of computer data memory. This is another aspect influencing the cost of conducting such experiments.

Thirdly, an eyetracking laboratory should be designed in a proper way (it is important in case of stationary eye trackers). The lab should be soundproofed and lit in a way that doesn't disturb an eye tracker (it shouldn't influence anyhow the cameras). In a perfect lab, a researcher and his/her equipment are placed in a separate room, as not to disturb a participant and the experiment course (see Holmqvist et al. 2011, Duchowski 2007). The above-mentioned lab requirements are not important in case of traditional glottodidactic research.

Fourthly, nowadays an experiment can be conducted only when the written consent of a participant (including some particular information) is given. Because of the fact the glottodidactic studies are very often related to (pre)school students, these are the parents who should give a written consent for the participation of their minor children in the experiment. On the basis of my own experience I know

that asking a parent for such a consent can be a difficult, tedious and sometimes unsuccessful task and it influences the number of participants.

Fifthly, conducting an experiment not in a natural situation (for example school) but in a lab may have an influence on the results (that was one of the reasons why my second and third studies on secondary school students were conducted in their schools and not in the lab, as it was in case of my first one; the change of place made the experiment situation more similar to the students' everyday one).

When talking about the chances it needs to be said that the basic and undeniable advantage of experimental eyetracking glottodidactics is its chance of verifying the results of previous studies (very often theoretical ones) and researcher's own ideas, hypothesis and expectations by means of numerical data. The eye movements recordings make it possibile to collect reliable numerical data to be further analysed. After the analysis it is possible to draw reliable conclusions based on numbers.

What is more, owing to the specialized software it is possible to analyse the recorded eyetracking data in many different ways and many useful combinations (for example, the data can be prepared for one particular participant only, for a few chosen participants, as well as for the whole group; it is possible to set a particular moment of the experiment to be analysed; it is possible to change the areas of interests (i.e. the parts of the material the researcher is especially interested in) during the analysis of the data; except for recording the eye movements, sound and vision can be recorded too). The recorded data can be visualized in many different ways – in a form of numerical data, heat maps (in colour and black-and-white), scan paths, diagrams, transition matrices etc.

The researcher can just adjust the equipment and the way of analysing the data to his/her particular experiment.

FUTURE OF EXPERIMENTAL EYETRACKING GLOTTODIDACTICS

As it is only the beginning of eyetracking-based studies in the field of glottodidactics many research areas of experimental eyetracking glottodidacitcs can be named. It seems that almost all the glottodidactic aspects can be analysed with the help of eye trackers. Depending on the available eyetracking equipment experiments can be conducted in various places and in various ways – stationary eye trackers can be used in static experiments, where the material is presented on a computer screen (for example, my eyetracking studies of textbooks or the studies on reading, cognitive load etc. during the process of learning the language); head-mounted eye trackers (equipped with a head-tracker) can be used for dynamic experiments outside a lab. So many different technical options given by the equipment make it possible to broaden the scope of glottodidactic studies, as well as of any other branch of science using an eye tracker.

CONCLUSIONS

So far, research in the field of glottodidactics has been limited to conceptual deliberation and its verification in glottodidactic practice. Now it became possible to complement that with experimental research – conducting such research has become possible thanks to eye trackers.

Experimental eyetracking glottodidactics goes beyond the scope of traditional glottodidactics because of the tool, i.e. eye tracker, that it uses. Eye trackers, that are now one of the most advanced devices for measuring eye movements, can be (and sometimes they already are) successfully used in the academic research, not only linguistic, but also glottodidactic one. The opening of eyetracking methods on glottodidatics lets the researchers look at the previous and nowadays problems from the new perspective. The new eyetracking perspective verifies and makes the previous results of traditional experiments reliable. It also broadens the scope of glottodidactic research and opens new innovative cognitive possibilities for glottodidactics (and entire applied linguistics). Such an equipment-based experimental research carried out within the confines of glottodidactic studies is, from the scientific point of view, relevant as it contributes to the creation of new or verification of previously acquired scientific knowledge, as much as it contributes to the scientific cognition (Grucza S. 2013) of the object of glottodidactic studies.

Because of the fact the eye movements directly reflect the processes of language processing (Soluch and Tarnowski 2013), experimental eyetracking glottodidactics brings a new light into the new research possibilities and lets us concentrate our scientific attention on the very basic and central element of the glottodidactic chain, i.e. a learner.

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