Zinnig zoeken: een cognitieve benadering van woordenboekdidactiek Grieks

Bartelds, D.C.E.

Deel 2

Het succesvolle gebruik van het woordenboek

De opzet van het tweede deel van dit proefschrift komt voort uit de uitkomsten van het vorige deel. We bevinden ons nog altijd in de onderzoeksfase *Analysis & Exploration* (McKenney & Reeves, 2019), waarbij we hebben geconstateerd dat de eerste onderzoekscyclus (Deel 1) nog onvoldoende duidelijkheid heeft geboden over welke ontwerpkenmerken we als uitgangspunt kunnen nemen voor het ontwikkelen van woordenboekdidactiek. Wel schatten we in dat de *feedback loop*, een onderdeel van het *dictionary use model* van Bogaards (1993), een veelbelovend concept zou kunnen zijn om succesvol woordenboekgebruik bij klassieken te beschrijven.

We hebben twee studies opgezet die meer inzicht moeten bieden in de succesfactoren van woordenboekgebruik. Om dat te onderzoeken hebben we ervoor gekozen om zogenaamde 'expertleerlingen', leerlingen die goede resultaten behalen bij vertaaltaken, te observeren. We beoogden daarbij zoveel mogelijk relevant woordenboekgedrag te verzamelen. Daarom hebben we het woordenboekgebruik van de expertleerlingen zowel bij de vertaaltaak als geheel als specifiek tijdens het navigeren door een lemma bestudeerd. We waren daarbij op zoek naar gedrag dat duidt op succesfactoren: hoe vermijden deze leerlingen de fouten die in Hoofdstuk 1 staan beschreven? Daarbij leverde de probleemanalyse met *Cognitive Load Theory* nog een extra aandachtspunt op: hoe gebruiken deze leerlingen hun woordenboek terwijl ze cognitieve overbelasting voorkomen?

In Hoofdstuk 3 doen we verslag van een hardopdenkonderzoek waarbij we het woordenboekgedrag van expertleerlingen tijdens een proefvertaling hebben onderzocht. De hardopdenkprotocollen zijn door ons gecodeerd en geanalyseerd met behulp van het concept van de *feedback loop*.

In Hoofdstuk 4 staat het eye-trackingonderzoek centraal, waarin we het navigatiegedrag van expertleerlingen hebben bestudeerd. Deze leerlingen hebben in een eye-tracking lab zes korte vertaaltaken gemaakt, waarbij hun oogbewegingen werden geregistreerd. Deze oogbewegingen hebben we achteraf in een video met de deelnemers bekeken en hen gevraagd om aan de hand van de beelden hun denkstappen expliciet te maken. De verslagen van deze gesprekken hebben we geanalyseerd met behulp van het concept *affordances*. We vroegen ons daarbij in het bijzonder af in hoeverre deze

leerlingen een zogenaamde (impliciete) cognitieve kosten-batenanalyse maken tijdens het navigeerproces.

De uitkomsten van deze twee empirische studies geven ons een beter beeld van de inhoud van succesvol woordenboekgedrag. De hardopdenkstudie levert een gedetailleerde beschrijving op van het zoekproces en succesfactoren voor het hanteren van de *feedback loop*. De eye-trackingstudie laat zien hoe leerlingen op een efficiënte manier informatie uit een lemma gebruiken.

Een andere uitkomst van deze studies betreft het cognitieve verklaringsmodel dat we tijdens dit onderzoek ontwikkelden. We kwamen erachter dat *Cognitive Load Theory* ons helpt te beschrijven wat er misgaat bij woordenboekfouten, maar minder vruchtbaar is om *succesvol* gedrag te verklaren. Hoe expertleerlingen hun cognitieve belasting beheersbaar houden kan goed verklaard worden vanuit *situated cognition*. Bepaald gedrag van de participanten, zoals het slim gebruiken van pennen, woordenboeklint, vingers, wees ons in deze richting. Het concept van affordances, een onderdeel van *situated cognition*, bleek bovendien zeer zinvol als analyseinstrument. Deze verschuiving in ons verklaringsmodel heeft een cruciale rol gespeeld bij de keuze voor een didactische leidraad (zie Deel 3).

Hoofdstuk 3

How to stay in the loop

A think-aloud study on dictionary use by excellent secondary-school students of Ancient Greek

Hoofdstuk 3 is eerder als artikel gepubliceerd:

Bartelds, D. (2021). How to stay in the loop. A think-aloud study on dictionary use by excellent secondary-school students of Ancient Greek. *International Journal of Lexicography*, *34*(4), 453–471. https://doi.org/10.1093/ijl/ecab001

1. Introduction

This article deals with dictionary skills in the context of secondary-school classics education in the Netherlands. Translation into Dutch is part of the classics curriculum, and using a dictionary (Ancient Greek – Dutch and Latin – Dutch) plays an important role in the translation process. Various studies have been conducted on how learners of modern languages should use dictionaries (e.g. Scholfield 1982, 1999; Bogaards 1993; Nesi 1999; Lew & Galas 2008, Nation 2013), but not so for Greek and Latin. What is clear, however, is that the way secondary-school students of Greek and Latin use their dictionary is problematic. A number of translation studies, in which students' dictionary consultation was an incidental concern, report that it was an important factor in students' mechanical approach to translation, which typically produces awkward and incoherent translations (Eikeboom, 1967; Van Krieken, 1981; Florian, 2017; Luger, 2018). On the basis of these reports, Bartelds (2018) distinguishes the following five common dictionary mistakes in classics:

(1) *excessive use*: students look up almost every word in a sentence, from left to right, without prioritising;

(2) *not arriving at the right lemma*: students do not perform a morphological analysis and are not aware of dictionary conventions of lemmatising;

(3) *navigating with semantic tunnel vision*: within a lemma, students direct their attention solely to semantic information (i.e. direct options for translation), ignoring other information. A specific type of tunnel vision occurs when one of the translation options matches a preconceived translation;

(4) *wrongly sticking to a choice*: students do not consult the dictionary again, not even when they have difficulties formulating a coherent translation as a result of a wrong translation choice;

(5) *creating a 'bridge-language'*: as a first step in their translation process, students replace all Greek or Latin words in a sentence, one by one, with their respective translations from the dictionary. This garbled

> collection of words in the target language, rather than the (morpho)syntactic features of the classical source language, forms the new groundwork from which students build up their translation.

In spite of these evident problems, dictionary use is hardly taught in the classics school curriculum. A first step to reverse this situation is to investigate which dictionary behaviours can help students to avoid these five dictionary mistakes. To this end, a think-aloud study was conducted with Dutch secondary-school students who are highly skilled in translating Ancient Greek into Dutch. The research question was: which activities in these expert students' dictionary behaviour can we identify as leading to success, or, in other words: how did these expert students avoid making the mistakes mentioned above?

Before addressing the empirical part of the study, the next section will be devoted to establishing a model for dictionary consultation in classics education. Using the model by Bogaards (1993) as a basis, we will first argue that the concept of a feedback loop is an effective general model for successful dictionary use, which we will then further elaborate with insights from a number of other research disciplines.

2. A dictionary use model for classics

2.1 Classics versus modern languages

The most important observation about the five mistakes is that the dictionary is poorly integrated in the translation process. Students only use the dictionary at a preliminary stage to form a bridge-language and there is no sustained interaction between text and dictionary. This points to a general difference between classical and modern languages in the Dutch curriculum regarding dictionary behaviour. When learning English, German or French, a Dutch secondary-school student will have a good grasp of the meaning of most of the words and can relatively easily 'read' the syntax. This means that, when confronted with an unknown word, a student 'only' has to find the right lexical value of the word, the verification of which will often occur implicitly.

This process would probably fit the description of dictionary use such as that of Nation (2013). His last two steps, for example, are: 'Adapting the meaning found in the dictionary to the context of the word in the text. In many cases: not a big change' and 'Evaluating success of the search, that is, does the meaning found fit nicely with the message of the text?'. These steps suggest that 'meaning' is the sole object of the search, and that a thorough understanding on sentence-level has already been achieved, so that a user can evaluate a decision on the basis of the text as a whole.

In order to grasp the meaning of a Latin or Greek text, however, students need to solve lexical, morphological, syntactic and semantic problems at the same time. This calls for an active engagement of all types of information in the dictionary throughout the translation process as a whole, in which students frequently have to move back and forth between text and dictionary to come to an understanding.

2.2 Bogaards' model

The model that best describes such dictionary use is the one proposed by Bogaards (1993) for the modern languages. Combining a number of models, he presents a flow chart of the whole search process, divided into a number of steps (Figure 3.1). Crucial for the context of classics is the way Bogaards connects the three central steps of the model ('select entry', 'select relevant information', and 'adapt to context'). Contrary to other models, he argues that these steps should not be successive, but iterative, interacting intimately both with each other and with the context.

2.3 The feedback loop as a model for classics

The concept of iteration in Bogaards' model is essentially a feedback loop, and will form the basis of our dictionary model for classics education. In Bogaards' model, the feedback loop is limited to the central steps, but for classics it should encompass the lookup process as a whole. Already the early stage of finding the right lemma forms a morphological puzzle that many classics students fail to solve. In order to avoid this mistake, students need to 'loop' between text and dictionary, engaging in a continuous verification process. In

other words, Bogaards' step 'success?' has to be made several times, not only as a final step. Furthermore, Greek and Latin students do not engage in just *one* search at a time. Often multiple words are unknown and closely connected, resulting in several parallel searches: the decision-making process for one word is often embedded in the decision-making processes for other words.

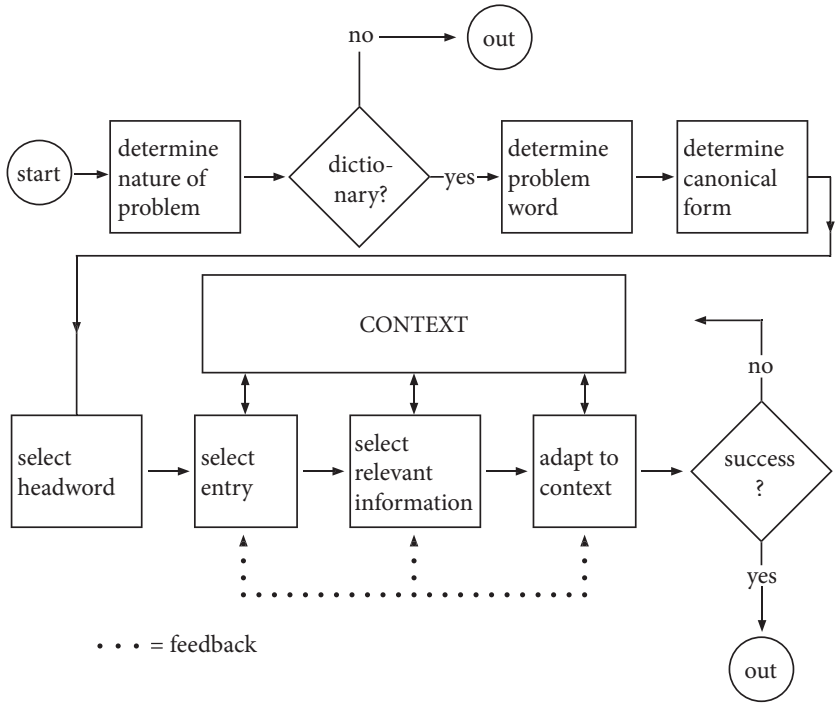

Figure 3.1. Dictionary use model by Bogaards (1993).

2.4 Hermeneutics and preconceptions

The concept of the feedback loop bears a strong resemblance to the hermeneutic circle, identified by Schleiermacher and further explored most notably by Dilthey, Heidegger, and Gadamer (Mantzavinos, 2020): interpreting the whole through its parts, and the parts through the whole. According to Gadamer, an interpreter's preconceptions play a crucial role in this process, leading to an initial understanding 'which is constantly revised in terms of what emerges as he penetrates into the meaning' (Gadamer, 2003, p. 267). For dictionary use, this means that it is crucial that students form an idea

about the semantic, morphological and syntactic value of a word before looking it up.

2.5 Tunnel vision and balancing two systems of thinking

Preconceptions, however, can also cause one of the common dictionary mistakes in classics: tunnel vision. This mistake is an example of confirmation bias, which occurs when one favours information that confirms one's preconceptions over information that does not. This could be explained by the urge to reduce cognitive dissonance (Festinger, 1957).

In this respect, the theory of Kahneman (2011) is relevant, which proposes two modes of thinking: 'System 1' is fast, unconscious and intuitive, 'System 2' is slow, deliberate and logical. According to Kahneman, System 1 enables us to effortlessly deal with numerous cognitive operations on a daily basis, but it is also the cause of cognitive biases such as confirmation bias. In order to avoid confirmation bias, students should know when to activate the slower System 2 and engage in a process of careful and critical verification.

2.6 Cognitive load reduction and schemata

Using System 2, however, entails serious demands on the working memory of students. This is by nature a limited resource and already under great pressure when translating Latin and Greek. This observation is supported by Cognitive Load Theory (CLT), which holds that understanding a new language involves a high intrinsic cognitive load (Sweller et al. 1998, p. 260). The pressure on the working memory can explain the occurrence of the common mistake of making a 'bridge-language'. Students try to cope with the high intrinsic cognitive load by switching to their own, well-known language. However, this move is made too soon.

A more successful strategy to unburden the limited working memory, according to CLT, would be to make use of *schemata*, stored in the unlimited long-term memory. Schemata contain abstract meaningful categories of information, which allow one to reduce a multitude of elements to a single element. Successfully learning and mastering a task, according to CLT, is the formation and, ultimately, automation of schemata, minimising the cognitive

strain involved in performing the task. Frequent activation of schemata, even those in formation (but not yet fully automated), benefits task performance. In terms of Kahneman, schemata can help balancing between Systems 1 and 2. For classics, activating both semantic and (morpho)syntactic schemata is necessary to reduce cognitive load.

2.7 Progressive deepening

The heuristic processes involved in successfully dealing with a cognitively demanding task are also investigated by studies on the decision-making process of chess players. Reduction of cognitive load can be seen as one of the main findings of De Groot's (1965) seminal work on chess grandmasters. The heuristic behaviour of chess grandmasters showed that they did not systematically consider all possible moves, but quickly focussed their attention on a small subset of promising moves.

De Groot observed that his participants engaged in what he called *progressive deepening*, the activity of iteratively trying out the same promising branches of the search tree. Further research on this behaviour indicated that chess experts deepen their search activity when finding positive results (this is classified by Newell & Simon (1965, 1972) as a 'win-stay' strategy), and only broaden their search in the case of negative results ('lose-shift').

De Groot himself argued that progressive deepening is not restricted to the game of chess but could also be used to characterise other heuristic activities (De Groot, 1969). For our model it can serve as another strategy, in addition to activating schemata, to balance between System 1 (quickly and intuitively selecting a promising translation) and System 2 (extensively and critically testing it).[61]

2.8 Avoiding the five mistakes: staying in the loop

To conclude the theoretical part of this paper, we have argued that the feedback loop is a fitting model for successful dictionary use in classics. A feedback loop

[61] It is, however, important to note that De Groot's subjects were absolute experts at chess, whereas the participants of this study are mere expert students.

helps students to integrate word meanings and context, but is, at the same time, highly challenging given the cognitive load involved. It means managing a fragile balance between two modes of thinking: too much of the slow System 2 causes a cognitive overload; too much of the fast System 1 causes uncritical thinking and cognitive biases. Preconceptions, schemata and progressive deepening are heuristic instruments that can assist students to 'stay in the loop'.

Revisiting the five common dictionary mistakes in classics, we can firstly observe that two of them, *excessive use* and *creating a bridge-language*, pertain to the translation process as a whole and are symptoms of not engaging in a feedback loop at all. Students who make these mistakes treat the text as a mere collection of isolated words and have the strategy to look up every individual word, without paying attention to the way they are connected within the context of the sentence or text.

The other three mistakes refer to different moments in the lookup process and indicate that a student prematurely leaves the feedback loop by taking a wrong turn. *Not arriving at the right lemma* occurs at the initial stage of starting up the loop; *navigating with semantic tunnel vision* occurs at the middle stage of moving back and forth; *wrongly sticking to a choice* occurs at the final stage of closing or re-opening the loop.

To answer our question which dictionary activities are successful within this model, we can use the three different stages as anchor points to further inspect what our participants do to avoid the corresponding mistakes.

3. Method

An explorative, qualitative think-aloud study was conducted among students with excellent translation results. Think-alouds, or verbal reports, offer a possibility to examine the thought processes of participants: they are asked to verbalise what is going through their minds when confronted with a task. This method is the most adequate for our purpose, as we examine which activities students engage in while using the dictionary for a translation task. To minimise concerns related to thinking aloud, viz. veridicality and reactivity (Mackey & Gass, 2012, p. 149), we arranged for maximal participants' comfort

during the experiment. The concurrent verbal reports were complemented with a stimulated recall, producing a rich data set of the translation process and the role of the dictionary in particular.

3.1 Materials

Two translation tasks were designed for this experiment, both examples of a so-called 'unseen translation': a common type of school test in the Netherlands in which students need to translate into Dutch an original Ancient Greek text which they have not previously studied. One was used in the selection process and the other in the think-aloud study itself. Following a number of selection criteria (ensuring that the participants had not come across the text at school, and, at the same time, that they were accustomed to the text's genre and Greek dialect) we chose two passages of Plato (*Laches* 179c2-d5 for the selection and *Gorgias* 523a3-b3 for the experiment). Another reason for choosing Plato was that his texts are relatively difficult, which was needed to guarantee selective pressure. The Dutch national examination authority was consulted to validate the tests' design, score model and level of difficulty.[62]

The dictionary that the participants were allowed to use throughout the translation task was the bilingual Ancient Greek – Dutch school dictionary, which also holds a grammar summary as an appendix. All participants were familiar with this dictionary. As a warm-up task to accustom the participants to thinking aloud, we selected five Greek word forms to look up in the dictionary. These word forms (*houtôs, tois theois, eluon, sophôteron, moi*) are relatively easy to find, but they are all inflected forms, so a morphological analysis needs to be made to locate them. By designing a dictionary-specific warm-up, we hoped to serve veridicality, as we expected that this would also encourage participants to verbalise dictionary-related processes in the experiment itself (without informing them about the true nature of the study).

[62] Board of Tests and Examinations (*College voor Toetsen en Examens*, or *CvTE*), https://www.cvte.nl/about-cvte.

3.2 Recruitment and selection process

Teachers of students from the penultimate (fifth) or final (sixth) year of six Gymnasia were asked to recruit candidates with excellent translation skills. The candidates were informed that the study would examine their translation behaviour in general but not that it was directed specifically at their dictionary behaviour. Furthermore, it was explained that first a selection round would be held, after which a number of participants were to be admitted to a follow-up study consisting of a think-aloud and eye tracking experiment.[63]

A total of 48 respondents completed the selection task, of whom we selected 14 participants with the highest scores (i.e. all candidates with a score of 8 or higher on a scale of 1 to 10).[64] We expected that this number of participants would yield enough data to reach saturation. The number is comparable to the number of participants in other studies on translation habits in classics (e.g. Eikeboom 1967; Van Krieken 1981; Florian 2017).

As part of this experiment a small number of talented university students participated who were in the first year of the bachelor's programme Greek and Latin Language and Culture. Their results were nonetheless excluded from this study because their behaviour was not representative for the school context. They were already trained to use more advanced dictionaries and considered the school dictionary used in the experiment a somewhat 'forbidden tool'. Most importantly, the translation skills of these students were too advanced to be representative for secondary-school students.

3.3 Experiment procedure and data collection

Each experiment started with a brief instruction about procedure, after which participants performed the warm-up task. Subsequently, the participants were given the translation task and asked to finish it in 50 minutes. The researcher asked participants to treat it as a regular school translation test, which means

[63] The results of the eye tracking experiment will be reported in a separate paper (in progress).
[64] One exception is S6, who scored 7, but was nonetheless strongly recommended by the teacher.

they were free to consult the dictionary and/or grammar summary at any desired moment. The researcher would interfere only if participants fell silent and would then use phrases such as 'Keep trying to speak' or 'What is going through your mind now?' to encourage the participant to think aloud again. The participants were filmed during the experiments in an otherwise empty classroom, while the researcher observed and took notes.

Following the translation task, a stimulated recall interview was conducted in which the participant was shown certain video fragments of the recorded data. The researcher asked the participant to clarify passages of interest, or fill gaps in the stream of thought.

Transcripts were made by the researcher of all the words spoken during the think-aloud experiment and the subsequent stimulated recall. Other relevant behaviour of the participants in the video, such as opening the dictionary, or using their finger to indicate a word in the text, was recorded in the transcripts in italics within square brackets.

4. Analysis

The goal of the empirical part of this study is to describe the dictionary activities of expert students, with the concept of a feedback loop as a framework. To do so, data analysis was performed in two rounds: (1) systematically coding all dictionary activities and (2) using the three stages of the feedback loop as a framework (see 2.8), analysing in further detail typical successful behaviour within these stages.

4.1 Coding

The coding process was limited to all verbalizations pertaining to dictionary reference (*units of analysis*). All other parts of the transcripts, which were concerned with the more general translation process, were not coded.

We started coding the first transcripts before all of the experiments were conducted. This allowed the researcher to direct his questions more precisely in the stimulated recall of later interviews. For instance, when codes started to

emerge pertaining to participants' motor behaviour (use of fingers), the researcher became more aware of this in later interviews.

During the coding process we took consistency and inter-rater reliability into account. The researcher started by assigning a preliminary set of codes to the first transcripts, after which a research assistant was given the same transcripts to test whether (1) he would use the codes in a similar way and (2) additional codes were needed to cover all activities. Following this check, some codes were redefined, and new codes were added. This routine was repeated for additional protocols and, at this time, two additional supervisors joined the process. After ca. 8 protocols the team agreed that the codes had reached a sufficient level of saturation.

A total number of 45 were formulated and were given a self-explanatory example from the data (see Appendix 5). In preparation for the second round of analysis, the codes were further classified according to the moment the respective activities occurred in the lookup process, using the stages 'initial', 'middle', and 'final'. Below we see examples of codes from each of these stages.

stage	**code**	**example**
initial	Performing a syntactically informed search	So, I just need to look up the meaning of the verb and the object.
middle	Choosing possible translation based on context	Yes, it's the adverb of *adikos* so 'unlawful', so that is the opposite of the other one.
final	Looking up again	Hmm, well, I'm going to look up *nomos* again to see if there's a translation that works better for me.

In addition, we found a small number of activities that were not bound to one of the three stages, but occurred throughout the lookup process: (1) motor activities (eg. holding a finger near a word) and (2) metacognitive activities (eg. activities that denote monitoring one's progress or evaluating results).

4.2 Episodes of staying in the loop

In the second round, to explore what dictionary activities could be responsible for avoiding the mistakes discussed earlier, we further analysed each of the different stages of the lookup process. In describing the 'loop behaviour' of our participants, we found that the codes of round 1 became meaningful especially when we followed sequences of codes instead of investigating them individually. Therefore, we proceeded to focus on *episodes* of successful behaviour. We selected episodes when students 'stayed in the loop' and did *not* make a mistake (see also 2.8). Of particular interest were 'near misses': when students were about to make a mistake but managed to correct it in time. These episodes were analysed and compared to the elements and concepts pertaining to the feedback loop model.

5. Results

In this section, we will give a detailed description of a number of episodes with successful dictionary activities. That does not mean that our participants' work was flawless; most of the five dictionary mistakes also occurred from time to time, with the exception of creating a bridge-language. Perhaps the most interesting examples are the near misses (e.g. example 11).

The examples below follow stages of the look-up process and are divided into three sections: an initial stage of preparation, the middle stage of moving back and forth between text and dictionary, and the final stage of closing or re-opening the loop.

5.1 Initial stage

As addressed in section 2.4, an important feature of the feedback loop is to verify one's preconceptions. We noticed that students were successful when they performed so-called 'informed searches', inferring meaningful information regarding the word in question, in anticipation of the dictionary's feedback. The richness of this informed search determines the ease of processing the information in the dictionary and making the right choice. Below, we will discuss examples of three different types of informed searches.

Furthermore, particular attention will be given to the mistake associated with preconceptions: confirmation bias.

5.1.1 Morphologically informed searching

Student number 43 (S43) is confronted with the inflected verb form *dielthonta*, the lemma of which is stored under the form *dierkhomai* ('pass through'). When consulting the dictionary, she starts to analyse the form by removing the prefix *dia-* and then first looks up *elthonta*, to find out to which verb this belongs. From the referral lemma *elthein* she concludes that *elthonta* is a form of *erkhomai*, after which she adds the prefix *dia-* again and finds the right lemma.

> (1)[65] S43 *dielthonta* … [*opens dictionary*] let's see … I'm looking at *dia*… but I suppose I need to know first what verb *elthonta* is from … shall I go to the e first … I'm already at the kappa … but I need to go to the labda … *elthonta* … let's see … a bit further, I think … *elthein* … is from *erkhomai* 'to go', so that makes it *dierkhomai,* I think … if it starts with *di-*, I think it just means 'continue/go on' [*opens dictionary*] but, or, 'go through', but I'm not sure, so I'll check that.

Here we see that the morphological analysis facilitates the search for the right lemma. We also see that this participant uses the conventions of lemmatising to receive useful feedback. She knows that the form *dielthonta* is stored under a different stem, but she does not know which one. She does know, however, that those forms are best found in the dictionary under their base form, without a prefix.

[65] The examples were translated from Dutch into English for the purpose of this article by Susannah Herman, a bilingual teacher of Classics in Voorburg (Dutch and English). I would like to thank her for her cooperation.

5.1.2 Semantically informed searching

S13 performs a semantically informed search. He has already inferred the meaning of the verb from the rest of the sentence, before actually looking it up. When he does, the feedback in the lemma confirms his assumption: he had the right translation in mind.

(2) S13 *ienai* … oh yes … *ienai*, that is, I've really translated that already. But it's going to mean 'to go', yes, it has to [*opens dictionary*] iota … iota where is it, let's see, we're almost there, *ienai* from *eimi* 'to go', yes, OK.

In this type of situation, however, confirmation bias may occur, and we have also found this in the behaviour of our expert learners. This seems to happen when students have a certain fixed translation of words in mind. As soon as they see this translation anywhere in the lemma, they stop reading, missing out on the correct translation.

The following example shows that S31 has such a strong assumption that the word *arkhê* means 'beginning', that he immediately chooses this translation. The fact that the resulting sentence is nonsense, which he himself admits, does not change his mind. The correct translation of *arkhê*, in this context, is 'reign' or 'power', listed as the third possibility in the lemma of *arkhê*.

(3) S31 I suppose that it's something with 'beginning' or so, but I'm just going to check [*opens dictionary*] *arhkê* yes, it's 'beginning'. 'Zeus and Poseidon shared the beginning' … oh, I see now it's 'Zeus and Poseidon and Pluto', so 'Zeus, Poseidon and Pluto shared the beginning'. I don't really understand the context, but I wouldn't know exactly what else it could be.

In the stimulated recall (example 4), S31's description of the episode clearly indicates that it was an example of confirmation bias. Critical is his statement

that he 'did not look at the other meanings': the confirmation of his assumption blinds him to other possibilities.

> (4) S31 You just suppose something, and you think: it's probably 'beginning'. And yes, then I didn't really look at the other meanings.

To conclude, making assumptions about the meaning of words can lead to success, but feedback must be digested critically (see section 5.4). Moreover, it seems that a confirmation bias is more likely to occur when a preconception is made on the basis of vocabulary knowledge per se, and not on text comprehension as a whole.

5.1.3 Syntactically informed searching

Another way to start a dictionary search in an informed manner is to first perform an analysis regarding the syntax of either the sentence as a whole, or parts of it.

> (5) S6 And then this is the subject 'Zeus and Poseidon and Pluto' [*marks the text by circling the subject*] in the nominative and it has to have a verb and then *tên arkhên* is the object. So, I just need to look up the meaning of the verb and the object.

Here we see that S6 first identifies the predicate, the subject and object of the sentence. Then he states that he 'just' has to look up the meaning of the verb and the object. By doing this, in CLT terms, he seems to activate a syntax schema before consulting the dictionary. This strategy can help in the decision-making process, as this participant not only realises that the two words relate to each other, but also in which way.

Syntactically informed searching was not only observed at the sentence level, but also at the level of the word group, when participants were translating the noun phrase *eis to tês tiseôs te kai dikês desmôtêrion* ('to the prison of both punishment and justice'). In this phrase, the definite article *to* belongs to *desmôtêrion* ('prison') which is the head of the noun phrase. The word group

tês tiseôs te kai dikês ('of both punishment and justice') is the attribute and is placed in between in the genitive case.

The examples below show that these participants first look up the word *desmôtêrion*, thus acknowledging the hierarchy, or in the words of S24: *desmôtêrion* is 'the thing that keeps it all together'. Further, they identify the value of the clause *tês tiseôs te kai dikês* and perform a preliminary translation in which this word group is not (fully) translated yet, but which recognizes the use of the genitive for an attribute ('of'). They either keep the Greek words ('to the prison of *tiseôs* and *dikês*') or make use of a dummy placeholder ('of such-and-such and so-and-so').

This approach indicates the use of a syntax schema, in which certain slots have certain syntactic roles. By first performing this syntactic analysis, the consultation of the dictionary is fully integrated in the translation process.

(6) S24 'to the *tês tiseôs*' … *to* … wait, this is *to desmôtêrion*, so we're going to look up *desmôtêrion*, because that is the thing that keeps it all together [*opens dictionary*] *desmôtêrion* is 'prison' … 'to a prison' and this is all genitive, so 'of such-and-such and so-and-so', *te kai* is 'and' …

S31 'to' … 'the' … let's see … 'to the *desmôtêrion*' … [*opens dictionary*] we're just going to look up *desmôtêrion* … *desmôtêrion*: 'to the prison' … 'they go to', so *eis*, 'to the prison of … *tiseôs* and *dikês*'

S0 so 'he goes to *to tês tiseôs te kai dikês desmôtêrion*', first I'm just going to look up *desmôtêrion* [*opens dictionary*] because the rest, it seems to belong with it, but as an attribute, *desmôtêrion*, *desp-*, *desmo-* … 'prison' and that is neuter and that is correct if you look at the article '*to*', [*writes it down*] 'prison' … *tês tiseôs* we're going to look that up [*opens dictionary*] *tiseôs*, *tis-* … *tisô*, I was looking for *tiseôs* … *tis* … *tisis, -eôs* 'retribution, fine, punishment', [*writes it down*] and it is feminine so *tês* goes with that and *dikês* goes with that, so 'a prison of punishment and *dikês*' …

5.2 Middle stage

In this phase we will investigate examples of participants moving back and forth, first only involving one lemma, and then multiple lemmata at the same time. This procedure can be connected with De Groot's (1965) progressive deepening, a heuristic strategy of tightening and widening the search scope observed in the behaviour of chess experts (see section 2.7).

5.2.1 Single lemma loops

The following is an example of a feedback loop involving one lemma. S6 looks up the word *arkhê* and has to choose between 'beginning' and 'power' as translations. She then turns back to the text, or in this case: the Dutch introduction above the text, which also has the phrase 'to seize power'. From this she draws the conclusion that 'power' is the right usage. This is an example of using the context, either from the Greek text itself or the Dutch introduction, as a basis of feedback. It is common for introductions in this type of task to help students along by introducing Dutch concepts of some of the Greek words in the text, as is the case with 'power'.

(7) S6 And then I'm just going to look up that word *tên arkhên* [*opens dictionary*] … *hê arkhê* means 'beginning, power', OK, and the topic here is power, or, anyway, it says 'seize power' over there, so it will probably mean 'power' here.

In the next example, we can see that S33 is reading the lemma of the word *dierkhomai*, 'to go through', and at first seems to find it hard to make a choice, so she writes a preliminary translation above the Greek word in the text. Then she sees the word *bion* ('life') in the text and jumps back to the lemma, where one of the possibilities reads 'life' in italics as additional information for the translation 'pass through', which offers the verification she needs.

(8) S33 *dierkhomai* is 'to go through something' … so: 'he who goes through' … 'to pass through' … [*writes 'passes through' above the word in the text*] oh 'spends his life' and it says *bion,* that is 'the life', so 'he who spends his life' …

5.2.2 Using a finger to facilitate loop

Apart from cognitive activities regarding moving back and forth between dictionary and text, we also observed the motor activity of holding a finger near the word that the participant is looking up. This both facilitates and stimulates the feedback movement, of which S29 is an example. He is using the dictionary to find out whether the words *kai aei kai nun* is a fixed combination and keeps his finger in the text while doing so.

(9) S29 *kai* … *kai* … let's just see if it's in the list of expressions… *kai aei kai nun* … [*uses finger to indicate point in the text*]

5.2.3 Multiple lemma loop

So far, we have seen examples of feedback loops involving only one lemma, but often more than one lemma is active at the same time. We observed this particularly when participants encountered difficulties.

In the next example, S29 is looking up the aorist subjunctive *teleutêsêi* and first thinks incorrectly that it is a noun in the dative case, but then comes to the conclusion that there is no corresponding lemma *teleutêsê* and rejects this hypothesis. He then arrives at the correct verb lemma of *teleutaô* ('end life, die'), assumes *teleutêsêi* is a future tense and returns to the text: 'let's see what that produces'. Next, he looks up the word *epeidan* ('when'), the lemma of which not only gives the translation, but also says '+ coni.', which means that the conjunction will be followed by a subjunctive. Upon learning this, S29 says it is of great help ('OK, that explains a lot') and returns to the lemma of *teleutaô*, to further investigate its morphology. In the morphological information of the lemma he cannot find the subjunctive form but he does see that the aorist of the verb is *eteleutêsa* and then infers the aorist stem *teleutês-*. With this information he consults the grammar summary located at the end of the dictionary and finds confirmation that *teleutêsêi* is in fact the subjunctive suggested by the lemma of *epeidan*. This is an example of a student moving back and forth between text and dictionary, using lemma information of one word in the decision-making process of another. It is also an example of a

student making a preliminary decision ('let's see what that [assuming a future tense] brings me') and keeping an open mind to come back to it afterwards.

(10) S29 *epeidan teleutêsêi* … *teleutê* … has something to do with the 'end' … I'm going to look it up at *teleu* … I hope I can find it starting with *teleu* … [*opens dictionary*] *teleutaios* … *teleutaô* … *teleutê* … *teleutêsêi* [*underlines tês in the text*] it's a dative so probably something from *epeidan teleutêsêi* … uhm … I should really find *teleutêsê*, but … [*goes back to the dictionary*] *teleutaios* … yes, or it's from the verb *teleutaô*. Then it's future tense … *teleutêsêi* and then it's *ô*, *eis*, *ei*. Yes, let's see what that brings me.

epeidan let's just look that up [*opens dictionary*] or have I already had that, I don't think so … *epeidan* and *an*: 'when, as soon as plus subjunctive', OK, that explains a lot.

OK then *teleutêsêi* probably is a subjunctive … let's see how that verb form works. *teleutaô*, then we go back [*opens dictionary*] aorist, future … OK. It doesn't have a separate subjunctive, but let's just have a look … *teleutaô* … is this … the aorist stem is *eteleutêsa*, so the stem is aorist … *teleutês-* … *teleutêsêi* … *epeidan teleutêsêi* … I'm just going to look up the declension of *luô* [*checks the grammar summary in the back of the dictionary*] for the *êi*-form … subjunctive … yes, so then that has to be … *luêi* … *lusêi* actually, so that makes it third person singular [*writes* '3rd sg' *above the form in the text*] and then it's, yes.

We now move to an example of a participant making wrong assumptions. S37 corrects his mistake by moving back and forth between the text and the two lemmata involved. He first wrongly traces back the word *di-eneimanto* (which comes from *dianemô* – 'divide'), to the lemma *dianoeomai* ('have in mind to'). Secondly, like S31 did in the confirmation bias example, he assumes that the word *arkhê* means 'beginning'. He then attempts to translate the sentence but cannot find an infinitive to construct 'have in mind to' with. Upon

this feedback, he returns to the dictionary, looks up *dieneimanto* again and now finds the right lemma *dianemô*. He then starts to translate the sentence again but is not satisfied with the outcome 'dividing the beginning' and opens the lemma *arkhê* again, now finding the correct translation: 'power'. Immediately after this discovery, S37 returns again to the lemma of *dianemô*, 'to see if there's a better translation' and adds 'among each other', which indeed correctly renders the middle voice of the form *dieneimanto*.

(11) S37 I'm just going to *di-e* … [*opens the dictionary*] delta … *dia* … *neimanto* … uh … I can't find the *nu* … oh then it's from *dianoeomai*, that means 'to plan', so then it means 'Zeus, Poseidon and Pluto were planning to' …

and *arkhên* … let's look up what *arkhên* means … [*opens the dictionary*] *arkhos* … *arkhê*: 'begin' … so: 'as … were planning the beginning' … but I don't see an infinitive … so probably it's from … uh let's check … check *die-* [*opens the dictionary*] *di*, *di*, *di* … *die* … OK, *dieneima* is from … is the aorist of *dianemô*. So, then this probably is the middle voice of *nemô* … *dianemô* … so then I'm going to look over there. *dia* … *nemô* … OK, and that means 'to distribute. So: 'as Zeus, Poseidon and Pluto … the beg…' [*looks in the lemma of arkhê*] 'the kingdom… the power, distributed the power'. OK.

[*writes down as translation:*] 'Zeus and Poseidon and Pluto distributed uh the power'. Let's just see if there is a better translation of *dianemô* … they shared among each other, [*writes down as translation*:] 'shared the power among each other'.

When confronted with this fragment in the stimulated recall, S37 uses the expression 'sweeping clean' to describe his method of correcting. His description bears resemblance to the concept of progressive deepening observed in chess literature (De Groot, 1965). First, he selects an initial translation from a lemma, then tests it in the wider context of the sentence,

after which he returns to the lemma either to correct an unsatisfactory translation (lose-shift) or fine-tune a satisfactory translation (win-stay).

(12) S37 I OK, so you go back there again too, you're fixing it there? How do you do that here?

S That's right. It seemed a bit useless to me to say, 'shared the beginning', so I started to look for … a kind of … so first, I write down a kind of alternative, just the first thing I think of. And next is a kind of sweeping clean, like: what … uh … looking at the small pieces, so which other meanings can be, are better in this context … (…)

[*listens to fragment*: *shared … uh … Zeus and Poseidon and Pluto distributed uh the power. Let's just see if there is a better translation of dianemô …]*

I Is this what you mean with 'sweeping clean'? Or not?

S Yes.

[*listens to fragment*: *… they shared, shared the power between each other*]

I And how did you get to 'among each other'?

S It seemed … uh … for how the translation is, it seemed better, because they already gave the names, and I know the three brothers shared the power, so 'among each other' seemed like a better translation to me.

5.2.4 Using fingers or ribbon marker to facilitate loop

Furthermore, observing S37 moving back and forth between the text and two lemmata, we noticed that he placed a finger between the pages at each lemma. When he was confronted with this behaviour in the stimulated recall, he commented that he does this 'so he does not have to look up the words again and again'. Other participants (for example S32) used the ribbon marker to mark certain lemmata that they thought they would need to return to at a later stage.

(13) S37 S Oh yes, that I do it like this … [*holds fingers between pages of the dictionary*] yes, I think that's quite handy, because …
I You're spreading your fingers now.
S Hm hm, and then I keep them at the words I'm using like this, and I keep the pages open like this, so I don't have to keep looking.
I Yes, exactly, and so you can go back easily too?
S Yes.

(14) S32 *epi* with a genitive says … it says 'in the time of…' or 'of location' or 'of time', but I think it's of time; it seems to make more sense in this context [*marks with the ribbon of the dictionary*] but I can come back to that later.

5.3 Final stage

The final stage of a dictionary search is concerned with the students' decision to close the loop and integrate their findings in a translation, or to re-open a closed loop in revision.

5.3.1 Integrating into a translation

At the end of the feedback loop, when a word has to be integrated into a translation, it is critical that students bear in mind its original morphology in the text, after having 'decomposed' it in order to find its canonical form in the dictionary. A correctly chosen meaning in the lemma can still lead to an incorrect translation. This especially occurs with verbal forms. We observed participants making morphological comments at this stage, as if to remind themselves of the correct form.

Below we see that S33, after she has found the right usage of the verbal form *dielthonta*, first incorrectly renders it as 'he who spends his life', but then reminds herself that 'it is the aorist' and corrects her translation to 'he who spent his life'.

(15) S33 so 'he who spends his life' … *êlthon* is an aorist … so then … 'he who spent his life'

5.3.2 Revision

Chronologically the last successful activity of these expert learners is that, after having translated the text, they return to certain words or phrases with which they were not yet satisfied and use the dictionary to re-evaluate their choices.

S13 comes back to his translation of the phrase *ho dê Tartaron kalousin* ('which they call the Tartarus'), that he had translated to 'also the so-called Tartarus'. He starts his revision by looking up the verb *kalousin* again. Here he had previously chosen for the usage 'the so-called', but now seems to reject this, while (correctly) recognising *ho* as a relative pronoun, instead of a definite article. At this point, he has the right translation in mind, but thinks that *ho* is a nominative, where he (correctly) expects an accusative. He then uses the grammar summary at the end of the dictionary to locate the declension to which *ho* belongs. He finds the declension of the article, and then realises that this was the mistake he had made before. Because he does not know the grammatical term for the word class of *ho*, he has some difficulties to locate the declension, but just browses through the pages until he finds the right form ('I want that paradigm of *hos*'). Upon finding it, he sees that *ho* is in fact the neuter form, which can be both nominative and accusative, which gives him the confirmation he needed for his translation 'which they call the Tartarus'.

(16) S13 and then the text is basically finished, but I'm going to check if everything is still correct in the sentence construction.
(…)
'also the so-called Tartaros' … *kalousin* … yes yes. [*opens dictionary*] *kalousin* … oh … it's connected to *ho* … if it had said *hon* there, it would have made more sense, because I could have translated 'which they call the Tartaros', but it says *ho* and that is a nominative. So I think that's a bit strange. Let's just look [*checks the grammar summary*] it's not here, that's earlier in the book … *ho* … look, nominative singular, it has to be. But that's the article of course. Yes. I need … what do you call a little word like that, [*browses through the grammar summary*] comparative … superlative

> … personal pronoun, yes, this is where I need to be … *ho* … I want that declension of *hos* … oh here it is. Neuter and it can be accusative too. That is good. Yes, [*writes down as translation*] 'which they' and then we're talking about a general 'they', 'which they call the Tartaros'.

5.4 Metacognition and metalanguage

Two other crucial ingredients in the feedback loop at all stages are metacognitive skills and the use of a metalanguage. Because of the slow process of the feedback loop in classics, it is important that students actively monitor their progress. These skills are closely connected to successful attitudes, especially having a critical and open mind (see, for instance, examples 11 and 15). As expected on the basis of their expert learner status, we observed the participants engaging in cues of monitoring positive or negative progress (see examples below).

> (17) S29 OK, that explains a lot.

> (18) S44 Hmm … I don't really understand that.

Furthermore, the ability to reflect on the text using an appropriate linguistic metalanguage made their dictionary use more successful. Students need to be able to readily use the linguistic terminology involved in the morphology and syntax (see, for instance, example 6). This will both stimulate activating the relevant schemata and will enable the dictionary to facilitate this process because students can find references to this linguistic terminology in its lemmata.

6. Discussion

The strength of the research design followed for this study is that, first, ecological validity was served relatively well: we managed to conduct the experiment in the student's own classroom, on a very familiar task. It was remarkable how quickly the participants seemed to forget the presence of the researcher and research instruments. Further, by making use of the stimulated

recall interview, triangulation was obtained. The choice to include video data proved to be helpful, both for facilitating the recall process of students and for noticing non-verbal activities during data analysis.

An important limitation in the research design concerns metacognitive activities. Although we believe to have found evidence of metacognitive reasoning in the think-aloud protocols, it can be argued that the task of thinking aloud itself induces metacognitive thinking, which can therefore not be established independently. Furthermore, it must be noted that we conducted highly explorative, qualitative research with a relatively small group of students translating only one text. We think our results offer an instructive first examination of successful dictionary use in Ancient Greek, but much more research needs to be done to validate these results and further formulate the activities connected to the feedback loop.

With respect to the transferability of the findings of this study, we think that the concept of the feedback loop applies both to translating Ancient Greek and Latin, because Latin has the same kind of distinctive syntax and morphology. More research needs to be done on dictionary consultation in the context of translating a Latin text to shed light on possible differences. The concept of the feedback loop, however, should not be restricted to these classical languages only: it can be applied to dictionary use involved in translating any language with a complex and rich morphology and syntax (compared to the mother language).

Another topic for further research may be how dictionary design for classics and similar languages could be optimised in terms of cognitive load reduction. Besides the advice to include ribbon markers, an important implication of the results of this study is that school dictionaries for these languages should not be (over)simplified. This may seem counterintuitive: why burden students with multileveled lemmata with various (morpho)syntactic information when they are already at their cognitive limits? The answer is that simplifying lemmata only offers an apparent reduction, as a result of which classics students build a bridge-language and do not confront the complexity of the language. The challenge is to design a dictionary that provides just enough anchor points for students to activate schemata, without

overwhelming them with information. The design of the dictionary can thus help to equip students to engage in the feedback loop.

The most important factor in achieving this, however, is training. It is worth reminding that dictionary use is currently not part of the classics teaching practice. Our participants were never explicitly taught their successful dictionary activities. This points to an important first step in improving dictionary instruction in classics education: raising dictionary awareness. Students must become aware that using a dictionary in the context of translating an Ancient Greek text requires a different approach and skillset than looking up a word in their mother tongue or one of the modern languages taught at school. Moreover, their teachers need to be made aware of this. Classics teachers themselves, too, were never actively trained in using a dictionary. This means that they too need to be aware of the cognitive processes involved in dictionary consultation. Furthermore, the question arises how we teach less talented students the behaviour of the 'expert learners' of this study. The latter have more unused working memory, which means they have more cognitive space for using the slow System 2 thinking than students with a lower proficiency in the language (see section 2). It is important to start with feedback loop training at an early stage, when students still use vocabulary lists instead of a dictionary, so students become accustomed to the process of verification. Upon the introduction of the dictionary, mostly in the fourth year, a first step can be to stimulate forming semantic, morphological and syntactic expectations.

7. Conclusion

Translating Latin or Greek is an inherently complex task involving high cognitive strain. Successful dictionary use in this context means engaging in a slow feedback loop in a process of constant verification. The challenge is to ensure that dictionary consultation helps to reduce the cognitive load, instead of increasing it. In our experiment, we have seen examples of behaviours that facilitate moving back and forth between text and dictionary. Students reduced cognitive load by activating morphological, semantic, and syntactic schemata. The activities involved occur on a cognitive level (informed searches), motor

level (using their fingers or the ribbon bookmark), and metacognitive level (monitoring the process and using a metalinguistic apparatus). Future research is needed to validate these activities and to design educational material to train them in the classroom practice.

Acknowledgements

This study was funded by DUDOC-ALFA (DA2-2017-01). I would like to thank all students and their teachers for participating in the study. I am also grateful to Caspar Sundholm, who acted as a co-coder of the think-aloud protocols, and Susannah Herman, who translated them into English. Lastly, I would like to thank the two anonymous reviewers for their helpful comments.