A cognitive offloading perspective on the modality effect in note-taking

Chudi Gong

Jennifer M. Rodd

Division of Psychology and Language Sciences

University College London

Correspondence:

Jennifer Rodd, Department of Experimental Psychology, Division of Psychology and
Language Sciences, University College London, London, WC1H 0AP. Email: j.rodd@ucl.ac.uk

Abstract

The present study compared the effectiveness of typing on laptops to longhand writing when second language English learners took notes to help learn new vocabulary. The results showed that the benefit for longhand writing over typing was significantly modulated by participants' expectations about the future availability of their notes: when participants were explicitly told that their notes would *not* be available to them in the future, there was a significant benefit for handwriting over typing. In contrast, in a 'cognitive offloading' condition, in which all participants expected to have *full* access to their notes in the future, no modality effect was observed. We explain this interaction by suggesting that participants in the typing conditions tended to offload due to strong pre-existing expectations about the pervasive accessibility of information typed into a laptop, and that this tendency to offload reduced future memory performance.

Keywords: Memory; Note-taking; Longhand Writing; Typing; Cognitive Offloading

1. Introduction

1.1 Why Take Notes?

Surveys have shown that almost all students (91%-99.6%) report taking notes to help their learning (Bjork, Dunlosky, & Kornell, 2013; Morehead, Dunlosky, Rawson, Blasiman, & Hollis, 2019), and share the belief that taking notes improves academic performance (Van Meter et al., 1994). The opportunity to take notes has shown to improve later memory and comprehension of the target material regardless of the modality and content of presentation (e.g. Di Vesta & Gray, 1972; Bohay, Blakely, Tamplin, & Radvansky, 2011; see Kiewra, 1985 and Peverly & Wolf, 2019 for reviews).

Two explanations can potentially account for a benefit of note-taking. First, the external storage view attributes the value of note-taking to the opportunity to later review the notes. In a review paper by Kiewra (1985), among 32 studies reported, 24 have reported better performance when students had the chance to review their notes before tests. In addition, the encoding hypothesis (Kiewra, 1989) suggests that a benefit of note-taking can arise from the additional activity of recording materials (at the time of learning), which leads to deeper processing of that information. This view is supported by studies which found that note-takers recalled significantly more target materials than non-note-takers when listening to a lecture (Einstein et al., 1985) and also when reading a passage on paper (Bretzing & Kulhavy, 1981), in the absence of the opportunity to review their notes.

Advances in technology have introduced major changes into classrooms: the practical convenience of light-weight laptops and tablets and their potential unlimited storage capacity mean that these devices are commonly observed in educational settings. Over half (53.4%) of the students (N=435) reported taking notes on a computer at least sometimes according to

Peverly and Wolf (2019), and 46% of the students (N=577) identified laptops as their note-taking medium in another recent survey (Morehead, Dunlosky, Rawson, et al., 2019). It is therefore of interest to investigate whether the benefits of notetaking differs according to whether students choose to take note by typing on a device or writing on paper.

Some studies have criticized the use of laptops in classrooms, with the most prominent reason being that laptops serve as a source of significant distraction (e.g. Yamamoto, 2007). A study has shown that students were not using laptops for task purpose such as taking notes for nearly two-thirds of the time during an in-class observation, and were instead engaged in off-task activities such as social media and instant messaging etc. (Ragan et al., 2014). Results from correlational studies have also shown that laptop use is negatively related with exam performance (Glass & Kang, 2018) and students' satisfaction (Wurst et al., 2008).

Nonetheless, those correlations do not reveal the direct impact of typing notes on learning in comparison to traditional longhand writing. Would the use of laptops become beneficial if distractions are controlled? There are different reasons as to why laptop might be efficient for learning. The characteristics of modern laptops – expanded storage and light-weight – provide efficient and accessible storage. In addition, since most students can type faster than they can write: laboratory studies have shown that laptop users recorded more notes, in terms of both amount of words and idea units (Luo et al., 2018) than pen and paper users. It is therefore expected that expanded records on laptops will benefit note-takers from both encoding and review perspectives.

To date, two studies have provided evidence in favour of typed notes. Bui, Myerson, and Hale (2013) found that the group of participants who typed notes while listening to a non-fiction text performed better on both free recall and short-answer tests, immediately after studying

(without a chance to review their notes), compared with participants who had used pen and paper. This benefit for typed note taking was particularly strong for those groups of participants in the ‘transcribe’ condition who had been told to record as much of the lecture as possible. Similarly, in study by Fiorella and Mayer (2017), participants studied 10 slides of information about the human respiratory system. They were then given 3 minutes to review their notes before being asked to (i) directly recall the learned information, and (ii) transfer this information to answer more novel questions on the topic. Performance on both tests was best if notes had been taken on laptops, compared with whiteboards or paper.

In contrast, in three studies Mueller and Oppenheimer (2014) found that typing resulted in significantly *poorer* performance than writing on later memory tests. This effect was observed regardless of whether participants were allowed to review their notes before test. They attributed the negative impacts of laptop note-taking to higher level of verbatim overlap in typed notes, i.e. participants tend to transcribe/copy-and-paste contents when typing and thus shallower level of processing. This is in contrast with findings from Bui et al. (2013) that transcribing style of note-taking leads to best recall. However, Morehead, Dunlosky and Rawson (2019) conducted a direct replication of the Mueller and Oppenheimer (2014) study, and although some trends suggested longhand superiority, performance did not consistently differ between the groups. The authors conclude that conclusion about which note-taking method is superior is premature.

One possible explanation for the inconsistencies in the literature is that studies vary in important factors that influence learning. For example, Luo et al. (2018) report a complex pattern of results where the difference between different forms of note taking depends on whether review of notes was allowed and on the type of learning material. Here we focus on a third important variable that might explain the inconsistencies: participants expectations about the

function of their notes. In the study by Morehead, Dunlosky and Rawson (2019), participants were told that their notes will be taken away immediately after writing, whereas in other studies participants were either told that they would have opportunity to review their notes (Fiorella & Mayer, 2017) or information about the access of notes in the future was not clear (Bui et al., 2013; Mueller & Oppenheimer, 2014; Luo et al., 2018). When viewed from a cognitive offloading perspective, these differences may have important consequences on subsequent memory performance.

1.2 Cognitive offloading and note-taking

The term cognitive offloading refers to the practice of using physical aids to reduce the cognitive demand for tasks. For example, one may rotate their head when reading tilted text (offload onto the body) or writing down post-it notes of information that needs to be remembered (offload into the world) (Risko & Gilbert, 2016).

Note-taking can be considered as a form of cognitive offloading in the sense that people offload the materials that need to be remembered onto their notes so to reduce the capacity they take in memory, which potentially can lead to weaker memory, as the individual no longer has the expectation that the information needs to be retained internally. The relationship between note-taking and cognitive offloading has been demonstrated by Eskritt and Eskritt (2014). They used a Concentration memory card game, which required participants to remember the identity and location of each card pair. The results showed that taking notes during the task not only impaired later recall about location, but also reduced the likelihood of proactive inference from similar information, which was referred as ‘intentional forgetting of note-taking’. This showed that the encoding benefits of note-taking on learning could be affected or even replaced by the

possibility of cognitive offloading, conflicting with previous findings of better performance following taking notes (Kiewra, 1985). According to this view, the potential encoding benefit of taking notes would be modulated by the learner's expectation about whether (or not) they will be able to access those notes in the future. Sparrow et al. (2011) found that among two groups who had typed a set of trivia statements on computers, participants who had believed their typed contents will be erased afterwards performed better on later recall test than participants who had believed them to be kept. Their findings reflect that when recorded information is expected to be accessible in the future, it is less likely to be as well remembered as when it is not expected to be accessible.

Importantly, the extent to which participants tend to offload to-be-learned material onto external notes, may vary according to the note-taking medium. The portability of laptops as well as 'Cloud' technologies make typed notes on laptops much more accessible compared with traditional written notes on paper/notebooks, which will not always be so easily accessible across different locations and are not securely backed up. It is therefore possible that the improved accessibility of typed notes reduces the likelihood of the contents being deeply encoded by individuals because of an increased tendency to cognitively offload. On the other hand, the longhand notes on paper or notebooks are less portable compared with laptops, which might lead the note-takers to hold the expectation that those notes are less accessible compared with typed notes, influencing the encoding process. As a result, this difference in expectations about the accessibility between written notes and typed notes might contribute to differences in performance following laptop note-taking and longhand note-taking.

1.3 The Current Study

The current study has two aims. Firstly, we aim to replicate the finding that longhand writing leads to better performance for delayed recall in the absence of review (Mueller & Oppenheimer, 2014). Additionally, we will explore the effects of participants' expectations of the purpose of their notes on these different note-taking modalities, by explicitly varying the instructions given to participants as to whether they should expect these notes to be accessible to assist them in a follow-up study. We predict a main effect of expectation, such that participants who expect their notes to be available will show poorer memory performance due to cognitive offloading. Of key interest is the possibility of an interaction, whereby the effect of these expectations may differ depending on the note-taking modality.

A novel approach is taken to measuring participants' performance after taking notes. In contrast to all the earlier studies which gave all participants the same memory test, regardless of the contents of their notes, we produce bespoke memory tests for each participant that only measures their memory for the specific information that they have chosen to include in their notes. We focus on L2 language learners' ability to learn novel vocabulary. This learning paradigm is ideally suited to this research question: not only is this an important learning domain from a practical perspective, but it allow us to assess the memory for multiple, relatively distinct pieces of learned information where individual participants can easily indicate which words were previously unfamiliar to them.

2. Method

2.1 Participants and design

68 second language learners (aged 18-40 years) were recruited via UCL SONA system. Participants were required to speak fluent English as registration criteria and no severe difficulties in English communication were present with any participant during the experimental procedure. (See Results for additional demographic information.) 3 participants were given course credit and the remaining 65 were paid for their time. Five participants failed to pass the comprehension test, two did not follow the instructions during learning stage and five did not return for the second part of the experiment. The final analyses included data from 56 participants.

A 2 (modality: writing vs. typing) x 2 (access: access vs. no access) between-subjects design was used. Participants were pseudorandomly allocated into 4 groups: writing access (N=15); writing no access (N=13); typing access (N=15); typing no access (N=13). Note taking modality (i.e. writing vs. typing), was manipulated by giving participants either pen and paper or a laptop to take notes. The access manipulation was achieved through altering instructions given to participants during learning stage: participants were either told that the notes they produced would be accessible for them during the next testing stage (access group) or that they would *not* be able to access their notes (no access group).

2.2 Materials

2.2.1 Learning materials

The passage was taken from *Nightwood* by Djuna Barnes (Barnes, 1936). A novel notable for its intense, gothic prose style. The selected passage (Chapter 1, pg 11-16; 1267

words) was chosen to be suitable for reading in the time available and as it contains a reasonable number of low frequency words likely to be unfamiliar to the L2 participants.

2.2.2 Test materials

The experimenter identified 83 low-frequency words in the passage that were likely to be unknown by L2 participants. The definitions for each word were then taken from Lexico (<https://www.lexico.com/>), the online Oxford dictionary. They were then randomly mixed with two incorrect answers to make up the three options for each multiple choice question. The multiple choice questions was designed to test participants' knowledge of meaning for each word they selected during learning stage (see SuppInfo 1.1.). For example:

What does 'reproach' mean?

- a. accuse someone of
- b. make something continue indefinitely
- c. tremble or shake with a slight rapid motion

2.2.3 Vocabulary test

A novel vocabulary test was devised to measure participants' English lexical knowledge. It consisted of 40 target words that included a range of word frequencies and included both unambiguous and ambiguous words. Participants were required to select the option that best matched the target word in meaning from among four options. (See SuppInfo 1.2. for list of items).

2.3 Procedure

2.3.1 Overview

This experiment involved two parts, learning and testing, with one-week interval. The first part lasted around 30 mins and the second part took around 15 mins to complete. Informed consent was obtained at the beginning of the study. Both parts of experiment were conducted in experimental cubicles within the Division of Psychology and Language Sciences, UCL.

2.3.2 Learning stage

During the learning stage, participants were asked to carefully read a paper copy of a selected passage from *Night Wood* (see materials section for details). They were instructed to then circle any words they did not understand, including words they have seen before but did not understand in the context of the given passage. They were instructed to look up definitions using the Oxford online dictionary, Lexico, (<https://www.lexico.com/>) on the computer provided. Instructions about using the dictionary were provided.

Depending to their experimental condition, participants were provided with either a piece of plain A4 paper and a pen to write with, or with a laptop (Apple MacBook Pro 2018, 13-inch retina display) to make notes about the new words. The typing group was given an open blank Microsoft Word document. All features of Microsoft Word were available to participants, but the laptop was disconnected from internet and notifications to ensure there were no distractions. There was no specific requirements about the contents or format of notes, and participants were instructed to include any information that would help them to learn the word meanings. Participants were required to make notes in English.

Before the experiment, they were told that they would be asked to return after one week to read another chapter from the same book, which would require the vocabulary knowledge they

have gained from this part. This instruction was included to ensure that participants would expect their vocabulary knowledge from this stage to be useful in the follow-up experiment, increasing their motivation for learning those words. According to their experimental condition, participants were either told that they would have access to their notes from first week (access group), or they won't be able to view their notes (no access group). All participants were encouraged to learn the meanings for the new words.

The total time given for participants to read was 20 minutes and they were told to stop exactly at that time regardless of whether they had finished the whole passage. All participants then completed a comprehension test about the passage, in order to exclude any participants who did not read the passage carefully or have insufficient language skills to complete current study. Qualified participants were asked to come back a week later.

2.3.3 Testing stage

The testing stage took place one week after learning and involved three elements that were all administered via the online experiment platform, Gorilla Experiment Builder (www.gorilla.sc), (Anwyl-Irvine et al., 2020). Participants did *not* read a second chapter as expected, instead they completed a multiple-choice word meaning test to measure their memory for the words they had looked up during the learning stage. No participants had access to their notes from the learning stage.

The test included words that each participant had chosen to look up during the learning stage, and therefore differed across individuals. The test was specifically tailored for each participant to include 20 items/questions. This comprised a subset of the questions listed in SuppInfo 1. (see Materials for details). In cases where participants looked up more than 20

words, the test items were randomly selected from those words. In cases where participants looked up fewer than 20 words, the vocabulary memory test consisted of all words they looked up and other randomly selected filler words from the passage. The latter words were not included in the analysis.

A vocabulary test then assessed their vocabulary skills. Finally, a demographic questionnaire collected information such as age started speaking English, self-reported English proficiency and note-taking habits etc. (See SuppInfo.3).

3. Results

Table two below presents the descriptive statistics for the demographic variables collected by questionnaire. There are no significant differences between the four groups with respect to any demographic variables collected or the score on the lexical knowledge test (See SuppInfo.4 for details).

Table2. Descriptive Statistics for Demographic Variables. (See SuppInfo.4 for details of individual measures.)

	Age Speaking English	Number of Language	English Frequency (scale 0-10)	Typing Frequency (scale 0-10)	Writing Frequency (scale 0-10)	Notetaking usefulness (scale 0-10)	Notetaking Frequency (scale 0-10)	English Proficiency (scale 0-10)
Mean	5.286	3.179	8.929	5.786	8.018	8.375	7.786	7.643
Std. Error	0.368	0.167	0.169	0.349	0.220	0.179	0.272	0.168

Appendix A provides a summary of all the words that were circled by participants and their frequency of being selected. Each participant's vocabulary memory score for these words was calculated as the proportion of trials on which they selected the correct answer (excluding filler items). Importantly, this measure only included items for which an individual participant had circled the word during learning.

Of the demographic variables, only self-reported English proficiency ($p=.003$) and English usage frequency ($p=.047$) are significantly correlated with the performance in the vocabulary memory test (Table 3). However, these two demographic variables are significantly correlated with each other ($p<.001$), and a linear regression analysis reveals that while English proficiency significantly predicts vocabulary memory score ($p=.031$), adding English frequency does not significantly improve the model ($p=.867$). Therefore, only English proficiency was included as a covariate into the main ANCOVA analysis.

Table 3. Correlation between key demographic variables and vocabulary memory score (* denotes significant correlation).

		Vocabulary Memory Score	English Frequency	English Proficiency	Number of Languages Spoken	Age Speaking English	Notetaking Frequency	Typing Frequency	Writing Frequency	Lexical Knowledge Score
Vocabulary Memory Score	Pearson's r	—								
	p-value	—								
English Usage	Pearson's r	0.267	—							
	p-value	0.047*	—							
English Proficiency	Pearson's r	0.386	0.648	—						
	p-value	0.003*	< .001*	—						
Number of Languages	Pearson's r	0.069	0.077	0.122	—					
	p-value	0.616	0.572	0.370	—					
Age Started English	Pearson's r	0.057	0.131	0.062	-0.094	—				
	p-value	0.676	0.334	0.652	0.490	—				
Notetaking habit	Pearson's r	0.221	0.058	0.105	0.058	-0.096	—			
	p-value	0.101	0.673	0.443	0.670	0.482	—			
Typing Frequency	Pearson's r	0.191	0.078	0.015	-0.044	0.241	0.114	—		
	p-value	0.158	0.568	0.912	0.749	0.073	0.401	—		
Writing Frequency	Pearson's r	0.180	0.123	0.038	-0.063	-0.025	0.333	-0.270	—	
	p-value	0.185	0.366	0.779	0.643	0.854	0.012	0.044	—	
Lexical Knowledge Score	Pearson's r	0.075	0.081	0.309	0.496*	-0.009	0.173	0.063	-0.397*	—
	p-value	0.741	0.694	0.125	0.010	0.965	0.399	0.759	0.045	—

* $p < .05$, ** $p < .01$, *** $p < .001$

A 2x2 ANCOVA (writing vs. typing; access vs. no access; Fig.1) indicated a statistically significant main effect of modality ($F(1,51)=4.833$, $p=.032$, $\eta^2_p=0.087$) which was due to better overall performance by the writing group ($M=.794$, $SD=.139$) than the typing group ($M=.705$, $SD=.122$). There was also a significant main effect of access ($F(1,51)=4.324$, $p=0.043$, $\eta^2_p=0.078$), which was due to a better overall performance when access is not expected (i.e. no access group) ($M=.787$, $SD=.152$) compared to when access is expected (i.e. access group) ($M=.717$, $SD=.115$). Importantly, there was a significant interaction between modality and access ($F(1,51)=6.437$, $p=0.014$, $\eta^2_p=0.112$). The interaction was followed up by separate independent samples post-hoc t -Tests with between-subjects factor modality which showed a significant effect of modality in the no access group ($t(24)=3.064$, $p=.005$) but not in the access group ($t(28)=.694$, $p=.494$).

Fig.1.Effects of modality and access on vocabulary memory performance. Error bars represent the standard error of the mean.

4. Discussion

The current study investigated the effect of modality on note taking in an experiment in which second language learners read a short fiction text and took notes on the meanings of any unfamiliar words. We also manipulated participants' expectations about whether their notes would be made available to them after learning to explore the role of cognitive offloading on the two modalities. Participants were given bespoke memory tests, which only tested their retention of those items that they had chosen to include in their notes during learning. Participants were not restricted on how many words they are allowed to or supposed to learn.

The results showed a significant interaction between these two factors. When participants had no expectation that their notes would be available to them in the future, performance on the subsequent memory test was significantly better when the notes were taken using pen and paper (longhand) compared with then they were typed into a laptop. This suggests that longhand note taking supported stronger encoding of the new information. In contrast, when participants expected to be able to have access to their notes in the subsequent testing session, this modality effect was eliminated such that performance in the long-hand condition was reduced to the level of performance seen in the other conditions.

This interaction suggests that the extent to which participants engage in cognitive offloading depends on the modality of their note taking. It seems that for the longhand group, the effort that participants devoted to learning the new material was significantly influenced by their expectations – they encoded the material better when they expected that they would have to rely on their internal memory to perform well in the follow up experiment. Interestingly, this effect of cognitive offloading was *not* observed in the typing condition. There are several possible explanations for why this might be.

One explanation for the absence of an offloading effect for the typing conditions is that *all* participants in the typing conditions offloaded regardless of the instructions that they received: even when participants were told they would *not* be able to look at their notes (no access group), they still underwent the process of cognitive offloading despite the need of retaining information in their cognitive system. This is consistent with the overall pattern of means: performance in both typing conditions was similar to that seen in the longhand group who had received the offloading instructions. This tendency towards cognitive offloading while typing on laptops might occur because individuals hold a strong expectation that typed notes on laptops are usually highly accessible, and therefore automatically offloaded the material to be learned despite the instructions. According to this account, the offloading manipulation was ineffective for the typing group because of their strong pre-existing expectations about the likely accessibility of information typed into a laptop.

An alternative explanation is that some characteristic of typing has prevented these participants from gaining the boost in the no-access condition that is seen for the long-hand condition. Under this view, the act of typing engenders a relatively superficial processing style that prevents the additional encoding seen in the longhand no-access group. For example, participants' likely increased practice in typing (compared with long-hand writing) may tend to take notes without deep semantic engagement in understanding the material. This is consistent with evidence for higher levels of verbatim overlap in typed notes (Mueller and Oppenheimer; 2014).

These two accounts of the interaction are closely related. They both assume that the cognitive offloading manipulation is more effective in the handwriting condition, but they differ in that they attribute the failure to benefit from *not* offloading in the typed condition to (i)

implicit expectations about future access or (ii) the relatively superficial thinking style used during typing.

Integrating these results with the previous literature is difficult. While some studies have found benefits for longhand writing over typing (Mueller and Oppenheimer, 2014), other studies have found either no reliable effects of modality (Morehead, Dunlosky, & Rawson, 2019) or a benefit for typing (Bui et al., 2013; Fiorella & Mayer, 2017; Luo et al., 2018). As previously discussed, participants' likely expectations about their future access to their notes was not always clear. In addition, in contrast to the current study, these studies tended to use immediate tests of memory making it difficult to know whether the newly learned information was strongly encoded in long-term memory. Future studies are needed to explore the extent to which these inconsistencies in the literature can be fully explained by accounting for the extent to which participants have engaged in cognitive offloading.

Unfortunately, this study suggests that there is no simple answer to the question of whether typed note taking differs from longhand. The current study shows that participants' expectations about the availability of their notes can modulate the strength of the memory traces in these different modalities. In addition, the inconsistencies in other previous studies (Bui et al., 2013; Mueller and Oppenheimer, 2014; Fiorella & Mayer, 2017; Luo et al., 2018; Morehead et al., 2019) suggest that other factors such as the nature of the information to be remembered and the delay before testing may also have an interactive effect on any modality effect. In contrast to most real-life learning, participants in this study were not rewarded for good performances and had little motivation to put maximum effort into learning. This is in direct contrast to educational settings where better performance is in the students' self-interest. To answer practical questions

about how students should optimise their note-taking behaviour, future studies should therefore take better account of participants' motivation and their reasons for taking notes.

In summary, the results from current study, together with the existing literature, therefore suggest that using laptops to take notes in classrooms may sometimes be less effective than writing by hand, but this modality effect can be strongly modulated by situational factors, such as participants' expectations about the future accessibility of their notes.

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Appendix

Appendix A: Frequency with which words were circled by participants

Word	Frequency	Word	Frequency	Word	Frequency
valance	44	handkerchief	9	vigilance	2
bifurcated	38	remorseless	9	fist	2
dandy	38	recoil	9	damned	2
rotund	35	spine	8	mould	2
obstetric	35	timid	7	bind	2
genuflection	32	impermissible	7	racial	2
haughtily	30	repercussion	7	shook	2
crimson	28	tassel	7	waistcoat	2
encominums	28	satin	6	rope	1
canopied	27	reproach	6	longing	1
coverlet	26	stride	6	noble	1
wrought	26	suspicion	5	abandon	1
tarnished	23	buttonhole	5	attain	1
perpetuate	22	prominence	5	decay	1
clatter	21	exquisite	5	preoccupation	1
gourmet	21	unjust	5	outcast	1
cardinals	19	impending	5	constituent	1
conspicuously	17	futile	5	gentile	1
quiver	17	fling	5	condensed	1
jut	16	reprimand	5	predicament	1
sanction	15	creaking	5	soldier	1
tinge	15	salute	4	Baron	1
progenitor	15	hysterical	4	stalk	1
protrude	14	lethargic	4	imposing	1
blasphemed	14	sinister	4	abandon	1
advisability	13	staccato	4	gross	1
clenched	13	pitch	4	incautious	1
impaied	13	pretence	4	degradation	1
heraldic	13	ribbon	4	incautious	1
splendour	12	thread	3	gowned	1
thrust	12	ecstasy	3	participation	1
homage	12	tormented	3	faint	1
bosom	12	manoeuvre	3	bind	1
sentry	12	heady	3	linen	1
wane	12	apprehension	3	gross	1
ordonnance	11	slope	3	military	1
populace	11	arc	2	beauty	1
forgo	11	comic	2	childless	1
florid	11	bearing	2	goose-step	1
succumb	10	tactical	2	called	1
burgundy	9	predicament	2		

Appendix B: Sample of learning material

(Night Wood Chapter 1, Page 11)

Early in 1880, in spite of a well-founded suspicion as to the advisability of perpetuating that race which has the sanction of the Lord and the disapproval of the people, Hedvig Volkbein, a Viennese woman of great strength and military beauty, lying upon a canopied bed of a rich spectacular crimson, the valance stamped with the bifurcated wings of the House of Hapsburg, the feather coverlet an envelope of satin on which, in massive and tarnished gold threads, stood the Volkbein arms—gave birth, at the age of forty-five, to an only child, a son, seven days after her physician predicted that she would be taken.