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VIRTUAL LEARNING AND MEMORY DISSONANCE

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Abstract

This study aimed to find out declarative memory recalls during online classes. Using a qualitative approach, the instruments used were simple and difficult word-sets. The data were collected through Zoom and WhatsApp platforms and later analyzed using interactive analysis. The results revealed two dissonances encountered: Informational Loss and Built-Up Dissonance. Initially, in the simple-word set, the majority of the students encountered Informational Loss 74 times (after 30 seconds) increasing to 97 times (after 30 minutes). In difficult word sets, it occurred 144 times, increasing to 154 times within identical spans. Regarding Built-Up Dissonance, it occurred 19 times (after 30 seconds), decreasing to 13 times (after 30 minutes) in simple word sets, and 27 times (after 30 seconds), increasing to 30 times (after 30 minutes) in difficult word sets. Surprisingly, it was found that in the recall test, linguistic buffering was generally employed instead of visual buffering. This finding helps teachers understand that virtual learning prompts need to be accompanied by activities involving procedural memory to minimize dissonances.

Keywords: *Virtual Learning; Declarative Memory; Procedural Memory; Memory Dissonance.*

A. Introduction

The COVID-19 pandemic has brought a huge change in the teaching-learning process worldwide. The need for social distancing and lockdown to prevent the virus transmission has consequently caused many educational institutions to shift their pedagogical and learning mode from the conventional mode to the virtual mode as the only relevant solution during the pandemic (Moorhouse, 2020). The use of virtual learning is familiar in the world of education. It was born in the late eighties and nineties when Computer-Based Training was first introduced (Hubackova, 2015).

Ever since it has undergone much development until it transforms into the virtual learning system we use today. However, it has only been exclusively utilized all around the globe once the COVID-19 outbreak started. In other words, it has become a necessity now rather than just an option. Even though it appears as a panacea during the crisis, the sudden transformation to digital mode is unfortunately not without consequences. It has led to confusion and chaos all around the world. Several educational institutions have been reported to feel reluctant and unprepared for this shift, but no other options are available at the time (Dhawan, 2020; Giray et al., 2022).

Especially during the pandemic, "virtual learning" is often used interchangeably with online, online, e-learning, distance, internet-based, technology-enhanced, and many more. It refers to learning experiences assisted by digital technologies and internet networks (Dhull & Shaksi, 2017). In this learning atmosphere, the teachers and students are physically distant. Instead, they are connected by internet-based platforms or applications to facilitate learning. The number of educational institutions that adopt virtual learning continues to grow for plenty of benefits that it offers. First, it allows teachers and students to access materials or extra information freely and quickly on the Internet (Xhaferi & Xhaferi, 2020). Whenever they have doubts or need clarification about certain things with no one around to ask, they can browse some online references directly on the internet.

Second, it is cost-effective because users do not need to spend money traveling to the learning place as normally happens in a *classroom*-delivered

course (Appana, 2008). Besides, it gives users flexibility, particularly among those who work and cannot attend courses with strict schedules (Arkorful & Abaidoo, 2014). Another major advantage of virtual learning is that anyone can participate in online courses equally, regardless of geographical background, sex, and age (Jaligama & Liarokapis, 2011). The application of virtual learning is also deemed favorable because it is easy to review for exams (Zboun & Farah, 2021).

Despite the benefits it provides, there are also some drawbacks reported on virtual learning. One of them is that it leads to anxiety and reduced concentration of students and teachers, as Dhawan (2020) reported. Reduced concentration suggests a reduced amount of information to be absorbed well and retrievable comprehension in learners' memory. Lack of motivation is also among the critical issues associated with virtual learning (Mese & Sevilen, 2021), indicating that the learners need to pay more attention to understanding the course and remembering the acquired information. Unexpected distractions within the online learning environment are also inevitably present, such as noises in the background, interrupting learners' focus and minimizing their mental capacity to alter the currently learned information into long-term memory traces (Sweller et al., 1998). Virtual learning also reduces learners' capacity for information acquisition and retention because it lacks context cues rich in a real class setting (Cherney, 2008).

A major problem teachers and students face in virtual learning is that they need to meet physically. This means that there are no physical materials, no physical assignments, and, most importantly, no physical experiences. When a learner has physical experiences in the physical dimension, peripheral visualization is induced into his/ her working memory. The more physical it becomes, the stronger the memory impulses leading to long-term storage. This long-term term-storage is hierarchical to Declarative Memory (Riedel & Blokland, 2015). It consists of Semantic memory, a memory of factual information about the world, and Episodic Memory, the database of specific experiences or past events in the human mind. When a learner consciously observes and learns from their physical surroundings, the concept-based knowledge they

acquire will usually be retained longer in their semantic memory. Likewise, their episodic memory lasts longer when they perceive their physical learning experiences as impressive. This durable memory is useful when dealing with complex tasks such as analyzing and problem-solving (Klemm, 2007). Unfortunately, such goals are not achievable in virtual learning. The hierarchy of human memory is provided in Figure 1 below.

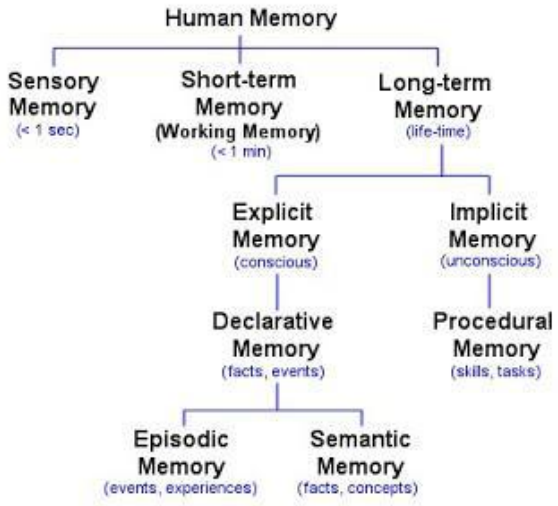

Figure 1. Human memory (Craik & Lockhart, 1972)

The human brain has around 100 billion neurons with 100 trillion connections that play a great role in receiving and storing information (Namaziandost & Ziafar, 2020). The information then becomes a memory, which serves as the database and the basis of any natural intelligence (Wang et al., 2003). According to Craik & Lockhart (1972), human memory includes Sensory, short, and Long-Term Memory. Long-term memory is permanent, consisting of Explicit Memory (Conscious) and Implicit Memory (Unconscious). Explicit memory, in particular, is a collection of information occurring at the humans' conscious level and explicitly kept in the brain. It is also called Declarative Memory, which consists of Semantic Memory and Episodic Memory. Semantic memory is retrieving concepts, beliefs, and factual information about the world (Yee et al., 2017). When children are introduced to a bicycle

for the first time, for instance, they will typically learn the concept of "a bicycle", its characteristics, function, and how to ride it. Later, when prompted with the word "bicycle", they will recall its shape, size, purpose, how to operate it, and other relevant things about the object. This remembrance indicates that their semantic memory has been established with specific information on a bicycle retained in it. Episodic memory, in contrast, refers to the retrieval process of particular life episodes or past experiences (Gillund, 2012). For example, when a person physically experiences certain life moments (e.g., first day of school, first vacation, graduation day) that he or she deems memorable, the information about those moments will consciously be retained in memory. Later in life, when he or she recollects and is mentally able to re-experience those moments, it indicates that his or her episodic memory of those bygone events has been solidly established and kept for a long term.

Rodriguez Strange (2014) states that people seek cognitive consistency regarding memory dissonance. However, some information may need to be included or found during the moment recollection process. As a result, people need help filling in the gap with information they believe is true. They assume what has happened based on their expectations, resulting in a memory error (Hirt, 1990). In other words, the effort to be consistent has led to the creation of a false or distorted memory that, as a matter of fact, is conflicting with the real action/ event/ attitude in the past. This paradigm is called memory dissonance. Memory dissonance can also occur when a person gains new knowledge that contradicts his or her existing schema. When the two pieces of information are out of sync, the person tends to 1) not be aware of the difference, 2) neglect it, 3) elaborate it, 4) adopt the two contradicting concepts, or 5) question the new information, to minimize the dissonance (McComas, 2014).

In learning, memory dissonance is also likely to happen. A learner would experience less dissonance when the recalled information is consistent with the retained one. On the other hand, a learner would feel much cognitive discomfort when there is informational loss. Some learners may consequently create false memories in an attempt to achieve

consistency. In virtual learning, where many learners have been reported to feel demotivated, suffer from headaches or migraines, lose focus, and lose interest due to the absence of physical learning experiences, memory dissonance can potentially occur as a result of the difficulty in remembering the previously acquired information, particularly the pieces of information that are deemed challenging (Widarti et al., 2022).

Previous research has also pointed out various drawbacks of virtual learning for both learners and teachers. A study by Cherney (2008) has shown that a virtual learning environment lacks real context cues that can be experienced by the learners, which affects information retrieval. Another study by Muthuprasad et al. (2020) revealed that virtual learning leads to headaches and migraines due to harmful radiation from devices used for online classes, making it difficult to concentrate and absorb information. Yuzulia (2021) reported that virtual learning has resulted in a number of problems for students, such as poor internet connection, lack of motivation, and stress, which they rarely experienced beforehand in a traditional *Classroom*.

Bali & Liu (2018) found that students' satisfaction is lower in virtual reality classrooms than in face-to-face classrooms because of the absence of social engagement. In a study carried out by Nambiar (2020), a vast majority of teachers (86.9%) expressed that they would rather have a classroom-delivered teaching than the online version because of many limitations it poses within the online environments, such as lack of interactivity, difficulty in controlling the students, and technical issues that impact the virtual learning pace and flow.

In Indonesia, the problems are relatively similar. Virtual learning has been reported to lower teachers' enthusiasm; however, the teachers only have options to show that they are passionate enough because if not, their students' learning motivation will be affected accordingly (Rasmitadilla et al., 2020). A study by Rahmat (2021) discovered that slow and disconnected internet connection is perceived to be the most significant problem faced by Indonesian teachers and students in Kuningan regency, followed by ignorance of Information and Technology (IT) and the unavailability of supporting facilities, such as gadgets.

Purwadi et al. (2021) found that students associate virtual learning with unpleasantness because of the absence of detailed explanations that teachers usually provide in conventional classrooms, inadequate internet support, financial issues preventing them from buying internet data or gadgets, lack of social interaction leading to depression, and difficulty in concentration. Efriana (2021) found that unpreparedness for the shift and lack of Information and Communication Technology (ICT) skills among teachers hinder them from using applications needed for online learning, such as *WhatsApp*, *Zoom Meeting*, *Google Meet*, *Google Classroom*, and many more.

Many studies focus on students' or teachers' perceptions of virtual learning. However, little is known about the impacts of virtual learning on the learners' declarative memory, especially on college students. Therefore, This study intends to fill the existing gap in such a statement by setting the scope only for two major categories: a simple and a difficult word set. This study traces the memory dissonance experienced by a group of college students who are, as a matter of fact, familiar with academic instructions. A research question is highlighted in the following:

"What memory dissonance(s) is experienced by college students in remembering simple-word set and difficult-word set after 30 seconds and 30 minutes?" .

B. Method

This study employs a qualitative research design in nature. It analyzes the dissonance cases in students' working memory during online classes. Cropley (2021) states that researchers should use a systematic language-centered analysis technique to make sense of different types of qualitative data rather than statistical analysis to make sense of numerical data. Research instrument in this approach should have a large range of possible responses, and it is supposed to have no-to-little constraints. Many different topics can have data collected on them very flexibly and open-ended. The intricacy of participants' inner thoughts and interpretations, as well as their impressions of the variables that may have impacted them to think or react in various ways, can be further explored by researchers using

this qualitative method (Creswell, 2013). Qualitative research and analysis are ideal for studying particular themes or learning models about the diversity in participants' opinions without being confined by a statistician's focus on central tendencies in the data.

There were 22 final-year college students involved in this study. They were the subjects of this study. The objects were their memory recalls examined in two phases: 30 seconds and 30 minutes. The Instrument used was a word set consisting of two categories (simple words and difficult words). The word sets are as seen in Table 1 below.

Table 1. Word sets for instrument

No.	Simple Wordset		Difficult Wordset	
	Code	Lexeme	Code	Lexeme
1	Simp1	Dark	Diff1	Identical
2	Simp2	Bird	Diff2	Toxin
3	Simp3	Fish	Diff3	Exposure
4	Simp4	Flower	Diff4	Juvenile
5	Simp5	Land	Diff5	Deficient
6	Simp6	Power	Diff6	Flower
7	Simp7	Good	Diff7	Inventive
8	Simp8	Moon	Diff8	Persistent
9	Simp9	Man	Diff9	Autodidactic
10	Simp10	Toxin	Diff10	Compassion

The data collection was carried out through *Zoom* and *WhatsApp* platforms. Two sequential time-sets were applied to compare their memory retainment (30 seconds and 30 minutes after the display). The procedure of data collection was as follows. First, the screen-sharing was made, and the simple words were displayed. The students were given 60 seconds to see the words. Later, the display was set off. The students were asked to do a distracting activity: reading a short text. After 30 seconds, the students were required to send the words they can still remember to the researcher's *WhatsApp*. The sending process was given 15 seconds only to exterminate the possibility of cheating or other potential biases. After that, the students were again asked to read 4 short texts as the distracting activity. Then, after

30 minutes, the students were again required to send the words they still remembered through the *Zoom* chat box. The time given was also 15 seconds. The second round continued. A similar procedure was carried out in the second round for difficult word-set. Both procedures are concisely provided in Figure 2 below.

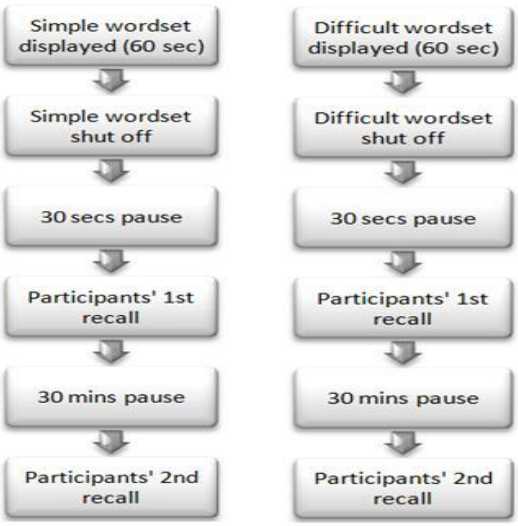

Figure 2. Data collection procedure

The data were later analyzed using interactive analysis. The processes in this analysis include data reduction, which involves eliminating all extraneous data collected during the study; data display, which involves presenting the data as tables and graphs; and data verification, which involves deriving conclusions from the data and verifying them (Miles et al., 2014).

C. Result and Discussion

1. Result

Table 1 below shows the results obtained from data analysis. The initial R1, R2, etc. stands for Respondent-1, 2, etc. The "Informational Loss" row provides lexemes that were forgotten after 30 seconds and 30-minute spans, and the "Built-up" row provides lexemes that emerged

from their dissonance; these lexemes do not appear in the actual word set. Table 2 below provides the results of a simple word set.

Table 2. Result of simple word-set

Respcode	Dissonant tokens after 30 seconds		Dissonant tokens after 30 minutes	
	Informational Loss	Built-up	Informational Loss	Built-up
R1	Simp2, Simp6, Simp9	Talk	Simp2, Simp6, Simp7, Simp9, Simp10	-
R2	Simp1, Simp5, Simp6, Simp7, Simp10	Park, toxic	Simp1, Simp3, Simp4. Simp5, Simp6, goon, Simp9, Simp10	-
R3	Simp3, Simp5, Simp6, Simp7, Simp10	Push Talk	Simp1, Simp2, Simp3, Simp4, Simp6, Simp8, Simp10	-
R4	Simp5, Simp7, Simp8, Simp10	-	Simp5, Simp7, Simp8, Simp10	Cool
R5	Simp8, Simp9	-	Simp2, Simp5, Simp6, Simp9, Simp10	-
R6	Simp5, Simp6, Simp8	Toxic	Simp5, Simp6, Simp8, Simp10	-
R7	Simp3, Simp6, Simp10	Flash	Simp6, Simp7, Simp8	-
R8	Simp3, Simp4, Simp5, Simp6, Simp8	Toxic, flush	Simp4, Simp5, Simp6, Simp8, Simp10	-
R9	Simp6, Simp10	-	Simp6, Simp10	-
R10	Simp6, Simp7, Simp8, Simp9	-	Simp6, Simp7, Simp8, Simp9	-
R11	Simp1, Simp2, Simp3, Simp4, Simp5, Simp6, Simp8	Fine, Brid, Monn, Toxit	Simp3, Simp4, Simp5	-
R12	Simp5, Simp10	-	Simp3, Simp5, Simp6, Simp10	-
R13	Simp6	-	Simp6, Simp7, Simp10	Food
R14	Simp5, Simp6, Simp10	Food	Simp1, Simp2, Simp4, Simp5, Simp6, Simp10	-
R15	Simp1, Simp3, Simp5, Simp6	Big toxin	Simp1, Simp3, Simp5, Simp6, Simp8, Simp10	Mood
R16	Simp1, Simp3, Simp5, Simp6	Toxic	Simp1, Simp5, Simp6, Simp8, Simp10	-
R17	Simp6, Simp7, Simp10	Plank	Simp1, Simp6, Simp7, Simp10	-
R18	Simp6	-	Simp6, Simp7	-
R19	Simp5, Simp6, Simp10	-	Simp5, Simp6, Simp9, Simp10	-
R20	Simp5, Simp6, Simp7, Simp9	-	Simp3, Simp6, Simp7, Simp9, Simp10	-
R21	Simp6, Simp7, Simp8,	Fin	Simp6, Simp7, Simp8, Simp10	-

Respcode	Dissonant tokens after 30 seconds		Dissonant tokens after 30 minutes	
	Informational Loss	**Built-up**	**Informational Loss**	**Built-up**
R22	Simp10 Simp6, Simp10	-	Simp5, Simp6, Simp7, Simp10	-
Total	74 times	19 times	97 times	3 times

The table above shows that the most forgotten lexeme is "power", as it is noted 18 times in the Informational Loss row. This means that after 30 seconds, 18 respondents out of 22 students needed to remember this lexeme. However, a similar lexeme containing a morpheme similar to "power", "flower", was only forgotten by 2 respondents after 30 seconds. Then, the lexemes "land" and "toxin" were also forgotten at high occurrence—11 respondents forgot both after 30 seconds.

Next, the lexeme 'toxin' is forgotten by 11 respondents after 30 seconds. However, because this lexeme has quite a few words, the built-up versions vary more, as Table 1 shows—"toxic" for 4 times, "toxin" for 1 time, and "toxit" for 1 time. Then, the lexeme "fish", "good", and "moon" were forgotten by 7 respondents after 30 seconds. The lexeme "fish" was dissonantly recalled as "push" by R3, "flash" by R7, "flush" by R8, and "fin" by R21. The dissonance of "push", "flash", and "flush" is caused by the phoneme /ʃ/, as also found in "fish". This dissonance can majorly be categorized into morphological dissonance. The lexeme "dark" is forgotten by 5 respondents and built up into 'talk' and "park" because of the clustering morpheme of final /k/. Other lexemes, such as "man" (3 respondents) and "bird" (1 respondent), are forgotten in minor occurrences.

Then, in the 30-minute phase, more words were forgotten, and only 3 built-ups appeared: "cool" by R3, "food" by R13, and "mood" by R15. The phoneme /u morphologically orients these built-up dissonances :/. The comparison between the two-time spans can be seen in Figure 3 below.

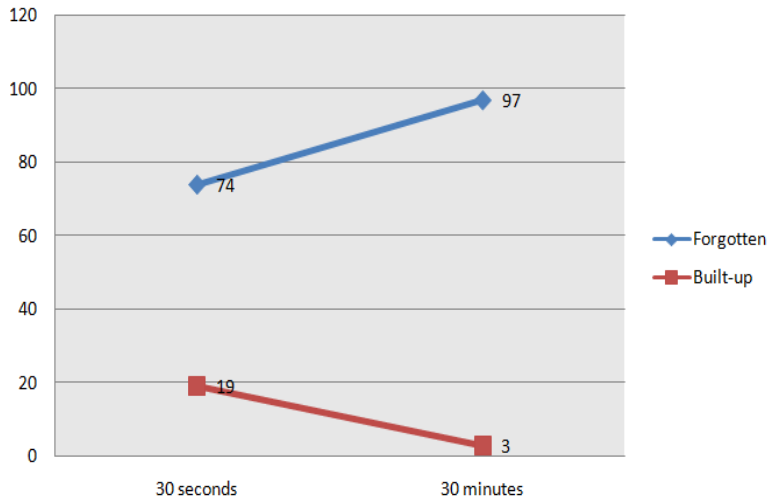

Figure 3. Dissonance trend in simple word set

The figure above demonstrates that, in simple words, 74 forgotten lexemes occurred after 30 seconds, and it inclined to 97 forgotten lexemes after 30 minutes. This means that even simple words and lexemes fade out after a very short time when the information is provided on the digital display. On the contrary, the built-up dissonance decreased after 30 minutes. Built-up dissonance functions by reconstructing information maintained from the latest visual displays. It implies that visual displays on digital screens can lead to cognitive overload and decrease the ability to reconstruct information. In a nutshell, it is learned that when motoric engagements involving procedural memory are left alone, digital displays decrease both memory and reconstruction ability.

The result of the difficult words is later provided in Table 3 below.

Table 3. Result of difficult word-set

Resp. code	Dissonant token after 30 seconds		Dissonant token after 30 minutes	
	Informational Loss	Built-up	Informational Loss	Built-up
R1	Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Toxins	Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Toxins

Resp. code	Dissonant token after 30 seconds		Dissonant token after 30 minutes	
	Informational Loss	**Built-up**	**Informational Loss**	**Built-up**
R2	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff1, Diff2, Diff3, Diff4 Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R3	Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Toxins	Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R4	Diff3, Diff4, Diff5, Diff6, Diff8	Autodidac toxic inventif deficien	Diff3, Diff4, Diff6, Diff7, Diff8, Diff10	Toksin, autodidac, deficien
R5	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R6	Diff4, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff4, Diff6, Diff7, Diff8, Diff9, Diff10	-
R7	Diff4, Diff6, Diff7, Diff8, Diff9, Diff10	Deficien	Diff3, Diff4, Diff6, Diff7, Diff8, Diff9, Diff10	Deficiency
R8	Diff6, Diff8, Diff9, Diff10	Toxic, compositi on	Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Toxic eficient
R9	Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Auntentive, toxins	Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	auntentiv, toxic invention
R10	Diff1, Diff6, Diff7, Diff8	Toxins, tree, persistence	Diff5, Diff6, Diff7	Persistance tocins
R11	Diff3, Diff4, Diff7, Diff9, Diff10	Toxins persistence	Diff4, Diff6, Diff7, Diff8, Diff9, Diff10	Toxins exposition
R12	Diff4, Diff5, Diff9, Diff10	Persistence	Diff4, Diff5, Diff6, Diff9, Diff10	Expoosure toxins persistence
R13	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R14	Diff3, Diff4, Diff6,	Idential	Diff3, Diff4, Diff6,	Idential

Resp. code	Dissonant token after 30 seconds		Dissonant token after 30 minutes	
	Informational Loss	Built-up	Informational Loss	Built-up
R15	Diff8, Diff10 Diff6, Diff7, Diff9, Diff10	toxins Adentical exposur persistence	Diff8, Diff10 Diff2, Diff6, Diff7, Diff8, Diff9, Diff10	Exposur profesion
R16	Diff4, Diff8, Diff9, Diff10	Inventife,	Diff2, Diff4, Diff6, Diff8, Diff9, Diff10	Inventife, defisent differensial
R17	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R18	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R19	Diff1, Diff4, Diff5, Diff8, Diff10	-	Diff1, Diff4, Diff5, Diff8, Diff10	-
R20	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-	Diff1, Diff2, Diff3, Diff4, Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	-
R21	Diff1, Diff5, Diff6, Diff7, Diff10	Juvenill, presistance	Diff5, Diff6, Diff7, Diff10	Juvenill presistance, compass
R22	Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Toksins, juventive, exsposure	Diff5, Diff6, Diff7, Diff8, Diff9, Diff10	Toksic juvenil eksposure
Total	144 times	27 times	154 times	30 times

The table above shows more forgotten lexemes and words for difficult word categories. After 30 seconds, there are 144 words forgotten. The most forgotten word is "compassion"; 19 out of 22 respondents forgot this word after 30 seconds. This is the last word in the set, and since the form is not the basic lexeme form, forgetting this word is highly likely to occur. R8 is the only one who built this word into "composition". We can learn that this built-up is on the morphological basis as there are similar morphemes such as /k/, /o/, /m/, /p/, /s/, and /n/.

Different from the result of a simple word set, regarding built-up dissonance, there is more lexical dissonance found in this word set—the dissonance is more lexical-based or spelling variations. For example, the word "persistent" turned out to be "persistence" and "persistant"; the word "juvenile" turned out to be "juvenill" and "juventive", the word "exposure" turned out to be "exposur" and "eksposure", and the word "toxin" turned out to be "toxic", "toxins", and "toksins".

Meanwhile, for the memory recall after 30 minutes, the forgotten words increased to 154. This is similar to what is found in simple word sets. The outcome, however, rises from 27 to 30 times over 30 minutes, in contrast to the simple word set. More precise information can be seen in Figure 4 below.

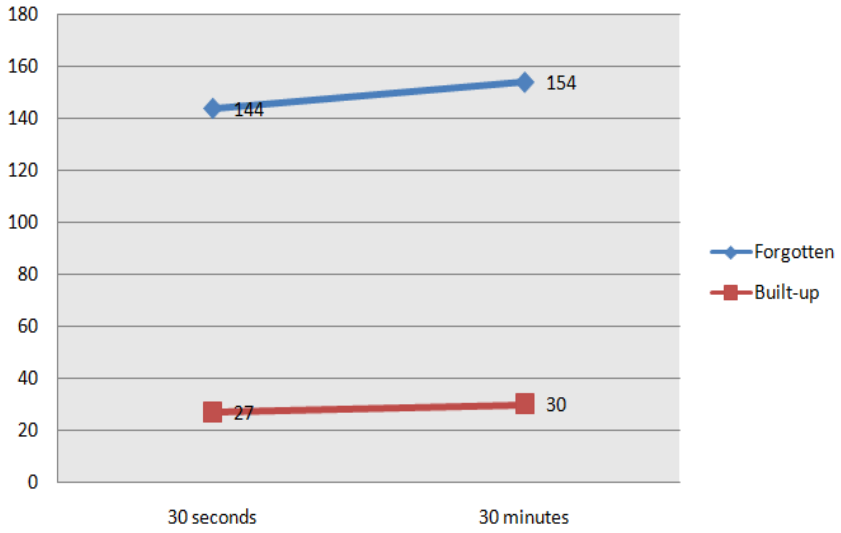

Figure 4. Dissonance trend in difficult word set

To sum up the results, Figure 5 below provides the comparison results between simple and difficult word set recall.

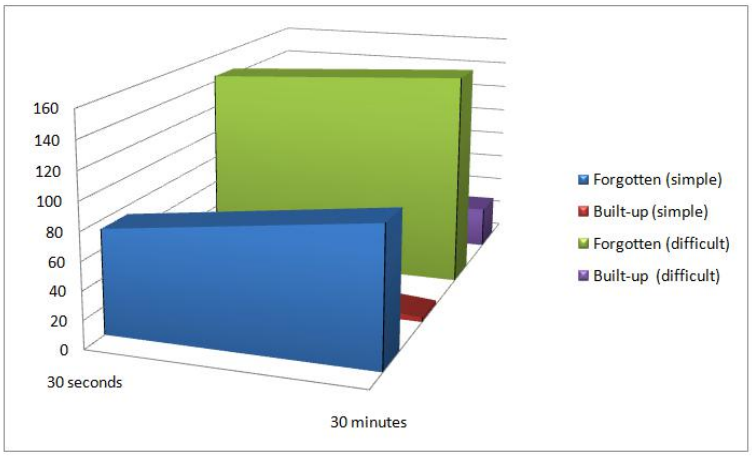

Figure 5: Comparison between simple and difficult word set recall

From the graph above, we can learn that difficult word sets were majorly forgotten compared to simple ones. It is assumed that the difficult word set is less relatable to the students' memory because the words are not daily words they use. They presumably rarely-to-never use these words after all. However, regarding the built-up dissonance, a difficult word set is built up more than its counterpart, but not in a significant difference.

2. Discussion

Referring to the research question once more, it has been initially addressed that this study sought the answer to this research question: *"What memory college students experience dissonance(s) in remembering simple word sets and difficult word sets after 30 seconds and 30 minutes?"*. The result of this study is certainly important since even if we are currently in the post-pandemic phase where classroom-based learning has resumed, there are still several benefits to studying online, and distant learning still plays a role in various educational settings, especially for this Industrial Age 4.0. To attain the desired learning outcomes, lecturers and teachers alike must ensure that their students are learning the materials and skills they deliver at the best possible.

In terms of procedures, as already elaborated in the earlier section, this study involves 22 students who were in their final year. The subjects'

memory recalls were tested twice, for 30 seconds and 30 minutes, respectively. They were first shown the simple word set through *Zoom* screen-sharing; after 60 seconds, the screen-sharing was stopped, and they were distracted with an intervening activity for 30 seconds in which they had to submit the words they could recall by sending the word list to *WhatsApp*. Then, the procedure repeated after 30-minute time span. Similar steps were taken in the second round for the difficult word set.

The results demonstrate two trends: first, the trend in simple word sets, and second, the trend in difficult word sets. To begin with, in a simple word set, the lexeme "power" is the most forgotten one. Eighteen out of 22 respondents needed to remember this lexeme after only 30 seconds. This lexeme is the most forgotten because of its morphology, similar to "flower", but "flower" appears earlier than "power", where "flower" was only forgotten by 2 respondents. This shows that if two or more similar information appear together, the first one will be easier to recall. Then, the lexemes "land" and "toxin" were also forgotten at a frequent rate, with 11 respondents needing to remember both words within 30 seconds. "Land" was forgotten as it is in the 5 order in the word set. Information that appeared in the latter order is the easiest to forget. R17 even built up this lexeme into "plank". This is quite predictive because the morphemes in the lexeme "land" are similar to those in "plank", e.g.,/l/, /æ/, and /n/. Thus, memory dissonance can lead /lænd/ to become /plæŋk/. The least forgotten lexemes are "man" and "bird". After 30 minutes, more lexemes were forgotten, and fewer built-up lexemes occurred.

In line with Peterson & Peterson (1959), the information was already lost when subjects were instructed to recall a list of three-letter strings before being allowed to instantly complete a distracting task (counting backward by threes). Another similar result was also found by Sperling (1960). In his research, the participants were shown a display of letters in rows for only about 50 milliseconds; then, during a memory test, the participants were required to list all the letters that came to mind. Only roughly a quarter of the letters they had seen, on average, could be remembered by the participants.

Afterward, in a difficult word set, there are more forgotten lexemes and words in the category in this set. The most forgotten lexeme is "compassion"; there were 19 respondents who needed to remember this lexeme. This lexeme was even built into "composition" due to similar morphemes such as /k/, /o/, /m/, /p/, /s/, and /n/. Words are recognized by the brain not as their orthography or meaning but as images and sounds, as supported by Hillen et al. (2013) and Seghier et al. (2014). Humans commonly connect the image of a certain word to a certain meaning; thence, it becomes a meaningful word. A similar case was demonstrated in the difficult word set dissonance.

Similarly, Steffens et al. (2015) found that memory is often easier to recall if it is associated with an action or activity. This is known as kinesthetic memory or *muscle memory*. When performing an action or activity, our brain creates a neural pathway that connects the sensory information we receive from our muscles and joints with the memory of the action itself. This creates a strong association between the action and the memory, making it easier to recall when we perform the action again. Meanwhile, little to no kinesthetic memory is utilized when students learn through digital platforms (in this study, *Zoom*).

Moreover, this eventually makes the memory-recalling process harder to achieve. Let us put, as an example, R8, who turned the word "compassion" into "composition". As R8 saw the difficult word set for the first time, he understood that most words are unfamiliar, so it was impossible to remember the word set by employing their meaning. Consequently, he remembered the orthographic forms of the words, the word portrayal as symbols, and the phoneme arrangements. Since this word set is not connected to any meaning in his memory, the phoneme might have been stored jumbled, remembering only the key—and most resemblant—phonemes. This word recognition is already made at the linguistic level because it is more complicated by involving phoneme recognizance.

Rodriguez Strange (2014) support that human consistently struggles to fill the void with knowledge they perceive to be accurate.

Unfortunately, these efforts have perpetually resulted in the formation of a false or distorted memory. However, information needing recall had better be stored through procedural memory, e.g., writing it out, acting it out, etc., so that it is a lot easier to retrieve and can even lead to more productive stages such as the increase in attention, comprehension, and memorization (Ismail & Fata, 2021).

D. Conclusion

This study set out to figure out memory dissonances experienced by college students in remembering simple word sets and difficult words after 30 seconds and 30 minutes of forgetting and built-up dissonance. It has been identified that forgetting happened at a higher rate, 74 times after 30 seconds, 97 times after 30 minutes in a simple word set, 144 times after 30 seconds, and 154 times after 30 minutes in a difficult word set. This is why major compared to built-up dissonance—19 times after 30 seconds and 13 times after 30 minutes in simple word set and 27 times after 30 seconds and 30 times after 30 minutes in difficult word set. Additionally, in both words set in the recall test, linguistic level of buffering was employed as it was found that morphology was used in the lexeme buffering.

On the one hand, the data collected for this study were rigorously controlled by the supply of two distinct word sets: simple and difficult, as it is accredited that different difficulty levels employ different buffering strategies during recall tests. This is considered as a compelling element of this study. On the other hand, this study has certain limitations because the memory test did not include various knowledge types. Providing a picture test, audio test, or other relevant information to be recalled may make up more satisfying findings. Further work is still required to establish the viability of this issue for future researchers.

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