

MNEMONICS - MEMORY METHODS FOR MORE EFFECTIVE LEARNING

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ABSTRACT

Mnemonics is the science that deals with memory training and describes memory methods and information processing strategies. In the theoretical part, we describe in more detail the different methods of mnemonics. In the empirical part, on an ad hoc sample of 230 students of the First High School (Gymnasium) in Celje, Slovenia we determine the knowledge and use of different mnemonics, according to gender and year of schooling. We found that, despite their knowledge of mnemonics, high school students under-use these highly effective mental aids. It would be worth considering integrating mnemonics more often into the school system, as they can help to make learning more effective.

Keywords: Mnemonics, Mnemonic Methods, High School Students, Learning.

1. INTRODUCTION

In the days before printing, a trained memory was essential. Today, in an age of many technological aids, it seems that memory is not so important anymore. While technology allows us to store and have access to large amounts of information, memory is closely linked to cognitive processes that allow us to make autonomous and critical judgements about this information (Ackerman, & Thompson, 2014). Memory enables learning, creative integration of learned knowledge and social interaction based on a person's identity and acquired experiences, and the preservation of culture (Schank, & Abelson, 1995). For these reasons, we were interested in the knowledge and use of mnemonics; by high school students (16-19 years) at the First high school in Celje (I. Gimnazija v Celju).

1.1 Definition of mnemonics

The art of memory, like many other arts, was invented by the Greeks and then spread across Europe by the Romans (Yates, 2019). Cicero (2016) tells the story of the "invention of memory" in his work *On the Speaker*.

"At the feast of the Thessalian nobleman Scopas, the poet Simonides of Keos sang a song in honour of his host, but also included a section in the ode in praise of Castor and Pollux. Scopas therefore told the poet, in a distressed tone, that he would only pay him half the agreed amount for the hymn, since he had dedicated half of the poem to the twin gods, and that he should get the difference from them. A little later a message was brought to Simonides that two young men were waiting outside to see him, but when he got up and went out, he found no one outside. While he was gone, the roof of the banqueting hall collapsed, burying everyone in the palace. The bodies were so mangled that even relatives could not identify them. But Simonides remembered the places where they had been sitting at the table, so he could show the dead to their relatives. The unseen visitors, Castor, and

Pollux paid their share in the hymn by luring the singers from the banquet just before the collapse.”

When he noticed that he could identify the deceased through his memory of where the guests were sitting, he realised that an orderly classification was essential for a good memory. This experience demonstrated to the poet the principles of the art of remembering.

The word mnemotechnics is derived from the Greek word "mneme" (Hilton, 1997), after the ancient Greek goddess Mnemosyne, who was worshipped in ancient Greece as the goddess of memory and remembering (Laketić, 2010). According to Buzan (1996), the skilful speakers of Ancient Greece used mnemonics to captivate their audiences with their astonishing memory skills, while at the same time, the inhabitants of the time, while admiring them, occasionally considered them as tricks. With the development of neuroscience (Hang et al., 2018), memory methods based on the brain's natural ability to enable the mind to remember material more easily, quickly and for longer periods of time, have proven to be effective. Mnemonics is thus the science that deals with memory training, but the word also refers to methods of memory training (Hilton, 1997), or memory aids (Bambeck and Wolters, 1995).

Through mnemonics, we consciously create mental connections between our prior knowledge and our perceptions (Hilton, 1997). Yates (2019) further specifies them as methods of remembering by imprinting 'places' and 'images'. Griffith (1979) defines mnemonics as (cryptic) information-processing strategies used to organise and/or group material into larger units, which are particularly useful for remembering information that is not meaningfully related. They introduce meaning and organisation into meaningless information, thereby making it more memorable.

Mnemonics facilitate memorisation by a) incorporating intentional learning, which requires effort; b) the learner's attention to the material during the use and/or creation of the mnemonic, thereby supporting the transfer of information into long-term memory; and c) the association of knowledge with already established mental schemas in long-term memory (McCabe, 2010). Many mnemonic devices require the integration of two or more information codes (e.g., verbal, and visual), which, by providing multiple links to retrieval, enhances memory. Researchers recommend interactive, dynamic, varied and even bizarre mental representations and spending at least 6 seconds of time on each visual association (ibid.).

1.2. Organisational and coding mnemonics

Mnemonics fall into two broad categories: a) organisational mnemonics and b) coding mnemonics. Both categories are based on mental keys. Organisational mnemonics organise the representations in memory by linking new information to a set of pre-generated mental keys that have been memorised as (visual) part of a memory treasure trove. With encoding mnemonics, on the other hand, we create more easily memorable representations that must be semantically and/or phonologically like the learning material (Laketić, 2010). Some of the methods presented below are more difficult to classify into a single category due to their characteristics.

1.2.1. Organisational mnemonics

Organisational mnemonics are distinguished according to the use of internal or external keys. Methods that use internal keys are the simplest, yet highly effective. The most common of these

are the story method and the chain memory method. Both are based on finding links between the information we want to remember, either in the form of a story or through interconnected visual means.

The problem with methods that rely on internal keys is that before we recall a word, we must remember the previous one. In the case of stories, the hierarchical structure of each fictional story provides the mental keys needed to recall the words in the list. If some words are forgotten, or links in the chain of representations cannot be retrieved, making it difficult to recall the next words in the list.

For methods that use external keys for memorisation (e.g., the location method), we need to remember these (locations) in advance, and then associate the information we want to remember with them. If we later forget any of the information, we can simply move to the next key in the form of a location (Laketić, 2010).

1.2.2. Code mnemonics

Code mnemonics are most often used to remember faces, names and even numbers that are difficult to remember. To help us remember information, we create codes or substitutions for the information. The methods vary depending on the type of labels used for the codes or reference points. This includes the keyword method, which is the most well-known mnemonic in the classroom (McCabe et al., 2013).

They are effective as methods for relatively short-term memorisation of a single set of data. They are difficult to use if the information is presented too quickly, and their effectiveness is achieved through intensive training (Baddley et al., 2009). Typically, only the most recent list can be recalled, but not the previous one (McPherson, 2018). Despite forgetting the intermediate information, we can easily move to the next key, which is in the form of a foothold.

1.3. Mnemonic methods

1.3.1. Link or chain method

This method is based on finding connections between the different pieces of information we want to remember. Interactive visuals link information together in a chain-like list. Thus, the recall of one piece of information in the list provides a cue for the recall of the next piece of information (Putnam, 2015). Bambec and Wolters (1995) refer to this method as the image string method, where we plastically represent and connect the material we want to remember in a string. This can be done directly or indirectly. Following the story and being able to visualise it provides an easy way to recall the stored information (Tostovršnik, & Hawlina, 2023).

The method is most effective if the images and the links between them are as unusual as possible. Take for example the words: tape recorder, bunny, pencil, turquoise, river, etc. A normal set without imagination would look like this: *"A bunny sits in front of a tape recorder and eats the pencil that is turquoise. Turquoise pencil falls into the river, etc."*. Instead, it is much more effective to exaggerate immeasurably in size and number. It is necessary to come up with performances that are as unrealistic, humorous, emotional, undignified, vividly colourful, and surprising as possible. In this case, our set would look something like this: *"Red, green and blue*

miniature bunnies dance on a mountain of tape recorders; the bunnies are bombarded by a pencil by small Turks (association for turquoise); the Turkish army is overwhelmed by a giant wave of the river, etc.". It is also recommended that the set of images is closed, i.e., the last content relates to the first.

1.3.2. Method of locations or memory palace

The method of locations goes by different names in different sources, such as the visualisation method, the locus method, the travel method, or the memory palace (Laketić, 2010). As we have already noted in the introduction, the poet Simonidas is said to have invented a system whereby he imagined a room with all the details, and then he imagined different objects in specific places in the room. Whenever he had to recall these objects, he would look at a specific place in the room in his mind (Cicero, 2016).

To use the location method successfully, we first create a memory palace (a mental map of a building, room, or other space that we know well) and remember it well. Then we use images to group them by room. These can later be recalled to memory by taking a mental walk through the memory palace (Putnam, 2015).

You need to choose a few (e.g., 8) locations: room-table, room-bed, room-closet, bathroom, hallway, kitchen, staircase and living room. These locations represent a palace of memory through which the individual always travels in the same order. The list of objects that the individual wishes to remember is presented to him or her, one by one, in a specific location in the memory palace. "E.g., *a shopping list using the memory palace above would look like putting ice cream in the room on the table, shampoo in the room on the bed, eggs in the room on the wardrobe, etc.*" In a shop, as the individual travels through the memory palace again, this is how he would remember what he needs to buy. By frequent repetition, items are retained in memory for longer, and by expanding the memory palace (increasing the number of locations in it), more information can be remembered (Tostovršnik and Hawlina, 2016).

The disadvantages of the location method are that it is difficult to retrieve a single piece of data without having to go through the entire list of locations until the data is found. This method should only be effective for relatively short-term storage, as when reusing locations, only the most recent list can be recalled and not the previous one. The memory palace is also said to be challenging to use if information is presented too quickly (McPherson, 2018).

1.4.3. Story, rhyme, and rhythm method

Rhyme and rhythm are very powerful memory aids, as can be seen by how quickly we remember the lyrics of a song or an advertising slogan. In this method, words are bound into a larger unit by acting as elements in a story or by being included in a song or rhyme (Putnam, 2015).

The story method is a hybrid between the chain method and the keyword method. In the keyword system, we select the keywords in advance, while in the story method we create a narrative that comes to life through details we invent. First, we list the events and/or concepts, the words we want to remember. The story will be easy to remember because we have a rich imagination, which is why we can invent a new story for each new list. We use our imagination to highlight, add and

enhance all sorts of details and in the end, these are the key to remembering the essential information. The first two items on the list are a backpack and a diamond, which can be linked by saying, "*I rummaged through my dirty backpack and found a shiny diamond ring.*" (Juretič, 2013). An effective mnemonic story should include sensory features, linear composition, and personification. When composing a story, one should consider one's own ability to make sense of visual, auditory, and kinaesthetic mental representations. Mental imagery can also involve other senses such as touch, smell, temperature sensitivity, and can be coloured by different emotions, in addition to being able to use this method to expand one's imagination (Laketić, 2010).

1.4.4. Method of reference points

The method of reference points is very similar to the method of locations. The difference between the two is that the reference point method uses numbers instead of locations and bridges the link between the number and the image by visual similarity or rhyme. It is also called the "Peg Method" and we hang concepts on hooks. There are several types of this method, depending on the type of markings used for the pegs: or the similarity between the notation of the numbers and the analogue images of the numbers, or the phonetic similarity.

The number-form system links the numbers zero to nine with objects that are shaped like numbers. First, we need to choose a series of reference points to which we then attach the concepts we need to remember. "*E. g., we can use a candle as a reference point for the number one, as the writing of one is similar to a candle; two is a swan, as it has a similar posture to the number two; three is a triangle, as it has three sides; four is a suitcase, as it has four edges; five is a hand with five fingers...*" (Laketić, 2010). Each number is first associated with a certain material, which can then be associated with more concepts and pictures (Bambec and Wolters, 1995).

The number-rhyme system links numbers zero to nine with a word that has the same last syllable as the number. In this method, concepts are remembered by matching them with numbers from one to ten that sound similar (phonetically similar). The phonetic alphabet system, on the other hand, uses letters of the alphabet instead of numbers, for which we think of a key memory picture word that starts with a particular letter (Buzan, 2004).

This method, like the location method, is thought to be most effective as a relatively short-term memorisation strategy. It is difficult to use if the information is presented too quickly. However, its effectiveness can only be achieved through intensive training (Baddley et al., 2009).

1.4.5. Keyword method

The keyword method is very effective for learning the meaning of words, vocabulary, essential information and for linking names and faces. It is the most used method in teaching (Juretič, 2013; McCabe et al., 2013). The method is only helpful when the keyword is given, and the visual image is created by the teacher.

It consists of two links. The phonetic link connects the word we want to learn with the key word, and the pictorial link connects the key word with the meaning of the word we want to remember. E.g., if we want to learn the Spanish word "carta" - letter, we create a keyword in our mother tongue that has a similar phonetic image to the word we are learning, e.g., "card" –card game. We

then create a visual representation of the keyword that interacts with the meaning of the word. "E.g., we could create a mental representation of playing poker with letters instead of cards ('carta' - phonetic link - 'card' - pictorial link - 'letter' - representation of playing poker)". In this way, the keyword is supposed to provide a memory mediator that connects the new word with meaning (Laketić, 2010). The next time we hear the word "carta" we think of the word "card", which conjures up the image of playing poker with letters, which would give us the meaning of the original word "carta". In this way, the keyword is supposed to provide a memory mediator that links the new word to its meaning (ibid.).

If we want to understand a word, the keyword method is the best memory strategy. For application, however, mechanical repetition is more appropriate. The main advantage of the keyword method is that information is learned faster, but not necessarily better (McPherson, 2018).

As a close relative of the keyword method is the face-name method. A person who wants to remember a face identifies a keyword (or a clue from a name) that is phonetically like the name of the person he or she is meeting. They then associate the keyword with the appearance of the person's face using visual representations (McCabe, 2010).

1.4.6. Method of encoding numbers

In the number coding method, which Hilton (1997) calls the numerical alphabet, we replace individual numbers with letters to form words that are easier to remember. Each number from 0 to 9 is replaced by a consonant. By adding vowels (a, e, i, o, u) to the consonants, which are not counted as numbers, we can form syllables from the numbers. With a little imagination, we can form words from syllables that are easier to picture vividly (the method of association) and therefore more memorable than the corresponding number (Bambec, & Wolters, 1995). However, these codes need to be well mastered before they can be used.

1.4.7. Method of the first letters

First-letter method are multifunctional and widely useful as a strategic tool (McPherson, 2018).

An acronym or abbreviation is a shortened word made up of the initial letters or syllables of several words. The use of acronyms also facilitates the memorisation of several consecutive, interrelated words if their initials are imprinted in the memory. A well-known English example from the SMART theory of work habits helps us to remember the criteria for setting goals: Specific - Measurable - Achievable - Relevant - Time bound (Hilton, 1997).

An acrostic is a dedication or saying composed of the initial or final letters of the verses of a poem, for example Prešeren's (Slovenian most famous poet) acrostic in his Sonnet wreath: 'Primica's Juliet'.

First-letter mnemonics are a very effective way of recalling a sequence of well-learned material, but they are only cueing strategies, as they make it easier to recall information that we already know. They are therefore only effective as a way of overcoming memory barriers, for example, for learners who experience trepidation during assessments (McPherson, 2018).

2. METHODOLOGY

In the empirical part we were interested in the knowledge and use of different mnemonics among secondary school students of the First high school in Celje. More specifically, we were interested in whether there are differences in the knowledge and use of mnemonics according to gender and year of schooling. We asked the following research questions. (1) Are there differences in knowledge of mnemonics by gender or by year of schooling; (2) How often high school students use mnemonics; (3) Are there differences in the use of mnemonics by gender or year of schooling.

The paper is based on a descriptive-causal, non-experimental method of pedagogical research.

The research was based on an ad hoc sample of high school students of the First high school in Celje, Slovenia. The questionnaire consisted of nine closed-ended questions. It was self-developed, based on the literature. After a testing, it was adapted and sent to all high school students who visited First high school in Celje in school year 2022/23, via the web application Ika. The questionnaire was voluntary and anonymous. It could be accessed from 12 March 2023 to 31 May 2023. 672 high school students (out of a total 854) clicked on the link during this period. 230 students completed the questionnaire properly; more than two thirds of female ($n = 167, 73.0\%$) and less than one third of male students ($n = 63, 27.0\%$), which is in line with the baseline population of the First high school in Celje. The number of high school students that answered the questionnaire was evenly distributed in quarters, according to the year of schooling. The largest number of respondents were from the 1st and 2nd year (both; $n = 61, 27.0\%$), followed by the 4th year ($n = 58, 25.0\%$), with the lowest number of respondents attending the 3rd year ($n = 50, 22.0\%$).

3. RESULTS

3.1. Definition of mnemonics

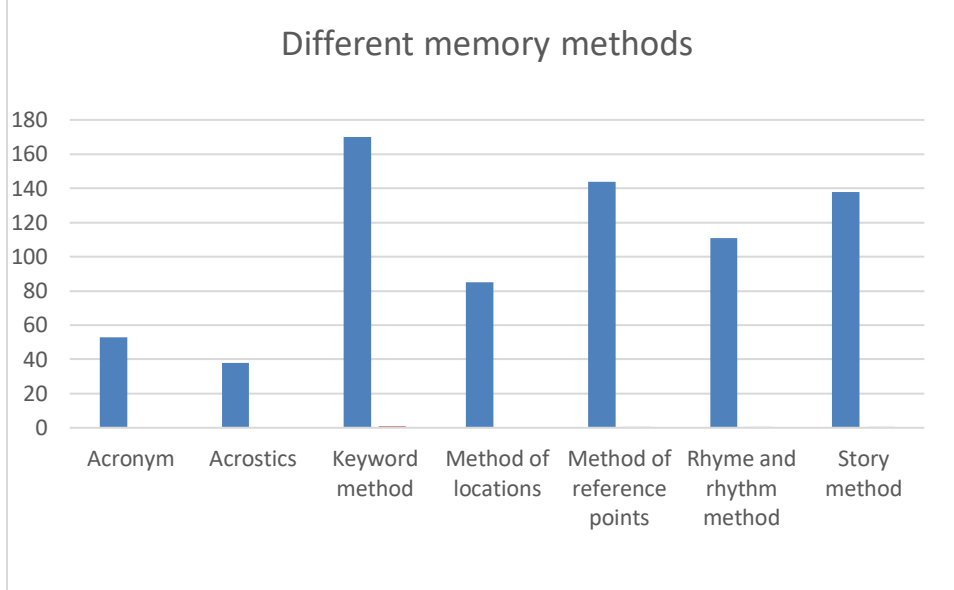
When asked to know the definition of a mnemonic, respondents had to choose between three answers, only one of them was correct. The questions only required recognition of the definition, which is knowledge from a lower taxonomic level (Kennedy, 2015). Of the answers given, most of the high school students identified the definition of mnemonics as: the science concerned with memory training, which is a word that also refers to memory methods and information-processing strategies developed specifically for remembering information that is not meaningfully connected.

Both male and female students recognised the definition of mnemonics in approximately 70.0%. In terms of year of schooling, the definition was most frequently recognised by 3rd year students (76.0%), followed by 4th year students (70.7%) and by 1st and 2nd year students (68.8%). The differences were not statistically significant, regardless of gender and year of schooling.

3.2. Knowledge of specific memory methods

Next, we wanted to know if secondary school students are familiar with each of the mnemonics. We also wanted to know if there are differences according to gender and year of schooling.

Chart 1: Knowledge of mnemonics



The keyword method is the most familiar method (74.0%), followed by the method of reference points (63.0%) and the story method (60.0%). The rhyme and rhythm method is familiar to about half of the respondents, followed by the method of location (or memory palace), which is familiar to almost two-fifths of the respondents, and the acronym method, which is familiar to a good fifth of the respondents surveyed. The last most familiar method is the acrostic method, which is known by only 17.0% of respondents.

Of those who chose to be familiar with a particular memory method, female students are on average more familiar with 5 of the 7 mnemonic methods: acronym, acrostic, keyword, reference points, story (male students are more familiar with the location method and the rhyme and rhythm method). Differences in familiarity with the mnemonics, by gender, are not statistically significant.

In the following, we present the knowledge of mnemonics by year of schooling. In Table 1 we see that secondary school students attending different of school have different levels of familiarity with each memory method.

Table 1: Comparison of the subscale knowledge of mnemonics by year of study

Year of schooling	1st		2nd		3rd		4th		Significance	
	f	f %	f	f %	f	f %	f	f %	χ^2	Sig.
Acronym	14	23,0	10	16,4	17	34,0	12	20,7	5,087	0,166

Acrostics	2	3,3	13	21,3	10	20,0	13	22,4	10,670	0,014*
Keyword method	40	65,6	46	75,4	40	80,0	44	75,9	3,346	0,341
Method of location (memory palaces)	14	23,0	20	32,8	20	40,0	31	53,4	12,560	0,006*
Method of reference points	41	67,2	40	65,6	32	64,0	31	53,4	2,902	0,407
Rhyme and rhythm method	35	57,4	39	63,9	23	46,0	14	24,1	21,651	0,001*
Story method	34	55,7	38	62,3	31	62,0	35	60,3	0,682	0,877

* Statistical significance

1st year students of First high school in Celje, Slovenia are on average (among all the students) most familiar with the method of reference points, while 2nd year students are on average most familiar with the rhyme and rhythm method and the story method. 3rd year students know on average the acronym and keyword methods most often, and 4th year students know on average the acrostic method and the location method (memory palace) most often. For the acrostic, location and rhyme and rhythm methods, the differences between the year of schooling groups are statistically significant.

3.3. Using memory methods

Before answering the question about how often high school students use each of the following mnemonics: acronym, acrostic, keyword, method of location (memory palace), reference points, we gave them a short explanation and an example to avoid any misunderstanding. Below is one of the notes from the questionnaire. Definition of the keyword method: *“A new word or concept is linked to a familiar and similar sounding word (keyword). The meaning of the new word is then linked to the keyword through an interactive mental picture. E. g.: To remember the meaning of the word claustrophobia (fear of enclosed spaces), we use the keyword Claus to create a picture of Santa Claus coming down a chimney (a narrow-enclosed space).”* Students then choose how often they use this mnemonic in their learning, on a five-point Likert scale (1-5): never, rarely, occasionally, often, and always.

As can be seen in Table 2, students, according to their self-assessment, use the keyword method most frequently, followed by the acronym method, the reference point method, the memory palace, and the acrostic method least frequently. It can also be concluded that, on average, high school students of First high school Celje, Slovenia use mnemonics rarely to occasionally.

Next, we were interested in whether there are differences in the use of different memory methods, according to gender.

Table 2: Table of use of memory methods, by gender

Memory methods	\bar{x}	SD	Gender	Mean Rank	U	p
Acronym	2.379	1.223	Male	76.14	5010.50	<0.001*
			Female	107.82		
Acrostics	1.732	0.979	Male	86.52	4471.00	0.036*
			Female	104.12		
Keyword method	2.768	1.839	Male	74.85	5078.00	<0.001*
			Female	108.28		
Method of location (memory palace)	1.980	1.171	Male	94.82	4039.50	0.461
			Female	101.17		
Method of reference points	1.076	1.278	Male	82.21	4695.00	0.007*
			Female	105.66		

Table 2 shows that students of First high school Celje use keyword method most often, followed by acronym. Female students are more likely to use all types of mnemonics (Mann-Whitney). Female students, compared to male students, use mnemonics significantly more often: except in the case of the memory palace method, where we can speak of a tendency.

There are no statistically significant differences in the use of mnemonics by year of schooling.

4. CONCLUSIONS

The results of the survey show a high familiarity with the general concept of mnemonics (more than 70% of the respondents recognised the definition). There is also a noticeable familiarity with only certain mnemonic methods, which may indicate that certain memory methods are more represented in the media or are more frequently represented and used in the classrooms. Among the individual memory methods, most respondents were familiar with the keyword method, the reference points method, and the story method by name, while less than 50% were familiar with the location method (memory palace), the rhyme and rhythm method, the acronym method, and the acrostic method.

The data shows that students do not use all memory methods with the same frequency. They still use the keyword method most frequently ($\bar{x} = 2.177$). We assume that students are probably not motivated, as the initial learning of mnemonics is time consuming, and they do not know all the possible applications and the long-term time savings once the individual has mastered them.

On average, female students are more familiar with and use memory methods more often. In a study conducted by McCabe and colleagues (2013) came to similar findings. In our research female students know all memory methods better than male students, except for the location method (memory palace). The gender difference is not only visible in the knowledge but also in the use of memory methods. Female students are more likely to use most of the memory methods presented. In the future, it would be worthwhile to investigate whether there are correlations between higher learning performance of female students and the use of mnemonics. The data also

show that, although there are minimal differences in the use of memory methods between students in different school years, they are not statistically important. However we cannot generalise the data to the whole student population in Slovenia.

Learning in modern times is becoming increasingly difficult due to a generalised shortening of the ability to sustain attention for long periods of time, for which there are several reasons, one of which is the overuse of technology with access to the Internet (Marsh, & Rajaram, 2019). It is precisely because of the reduced ability to sustain attention that one would think that younger, more technology-impaired generations, would be more likely to turn to mental aids to improve their ability to learn quickly and efficiently (Nanut Planinšek, & Škorjanc Braico, 2014). We would also like to draw attention to the large gap between the knowledge and use of mnemonics. It is not enough to know, but students should be actively taught at least those memory methods that they already know best. It would also be good to raise students' awareness of mnemonics. We believe that the use of thinking aids makes sense, as technological developments mean that we rely on technology all too often, which in the extreme can lead to an increase in the number of patients with dementia, a topic on which research is already being carried out (Horsley, 2021).

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