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# Is personalisation a way to operationalise long-term working memory?

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## Introduction

- 5 Ericsson and Kintsch (1995) have presented a new memory theory intending to give an answer to the dilemma between the drastic limitations of short-term memory and the ease with which people face the demands of complex task activities in every day life. It is difficult to understand how very complex cognitive activities can be processed in a restricted space storage such as the working memory (WM). As Kintsch (1998, p. 215) says: “ How can people live with such a terrible memory? ” The purpose of the long-term working memory theory is to give a solution to this dilemma by proposing that under certain conditions, individuals can use retrieval structures to overcome the limits of working memory to perform high-level cognitive tasks.
- 6 After presenting the long-term working memory theory and the personalisation method, an experimental study will be described. The aim was to use the personalisation method to test the characteristics of long-term working memory: a greater storage capacity than WM, a greater resistance to interference and a long-term storage capacity.
- 7 The long-term working memory theory considers that a part of the long-term memory (LTM) can be used as working memory, thus expanding the storage and processing capacities of a human being. The long-term working memory can be defined as the part of the LTM that can be accessed rapidly and reliably by means of retrieval cues in WM. In other words, the available items in WM are the cues that activate a part of the LTM.

This system of retrieval is possible thanks to stable structures in memory: the retrieval structures. They link the subject's knowledge and the information that he is processing (information that becomes a cue). A simple retrieval operation, using the cues in WM, can make available the part of the LTM that is connected. However not everyone can use long-term working memory, only experts in a particular domain of knowledge can do so. It is only after an extensive practice with a type of task that an individual can use retrieval structures. The extension of WM is then possible.

- 8 But what are the prerequisites to be able to build a retrieval structure? First, the subject must have a large body of knowledge and patterns concerning the information he is processing, only like that he will be able to store very quickly information in LTM. But that is not enough, the subject must also be able to anticipate the future demands for the retrieval of important information: for these reasons the task must be very familiar. In addition the subject must have developed very specific encoding strategies, to allow him to store selectively information in LTM.
- 9 How does it work? The subject uses a set of cues and links the incoming information (encoding phase) with these cues. To retrieve the encoded information the subject must just reinstate the encoding conditions by using the same set of cues. The long-term working memory becomes available (but restrained at the expertise field), when a set of cues becomes a stable structure in LTM: a retrieval structure.
- 10 This theory can be comprehended with Tulving and Thompson's (1973) principle of encoding specificity. When an expert activates his long-term working memory, he uses the same cues to create always the same mental context. This context is reinstated during the encoding phase and later in the retrieval phase. Therefore the incoming information is processed with the same well-practiced encoding conditions. Subsequently when the expert wants to retrieve this information, he simply reproduces the encoded conditions with the same retrieval cues. In this way the encoding condition and the retrieval condition are nearly the same, which has for effect a better performance.
- 11 Ericsson and Kintsch's theory is a generalisation of the skilled memory theory of Chase and Ericsson (1982), which involves three principles: the significant encoding, the retrieval structure and the principle of acceleration. The first principle allows the individual to transform the incoming information in meaningful units that can be easily stored in LTM. The second principle, the retrieval structure, concerns a long-term stable structure that becomes available only for experts and permits to link WM elements with LTM elements. Ericsson and Kintsch (1995) give many examples of retrieval structures: in the field of chess, of medical expertise, in text comprehension and for waiters taking a command. The last principle states that with extensive practice, an individual can store information in LTM as fast as in WM. In other words, once a subject has become an expert with hours and hours of training, building up long-term structures, he is prepared to store nearly instantaneously a particular kind of information. Therefore, he is able to use a part of his LTM as a WM, but with a much larger storage capacity.
- 12 Long-term working memory theory has been advanced because WM seems not to account for all experimental data. The classical definition of WM refers to "the temporary storage of information that is being processed in any of a range of cognitive tasks" (Baddeley, 1986, p.34). The storage limits of this system are quite small, about 7 units more or less 2 (Miller, 1956) for a storage task, and 3 or 4 items for a storage plus

a processing task, as it can be measured for example by the reading span (Daneman & Carpenter, 1980, 1983).

- 13 For many researchers, these limits seem to be too short. With these limitations, the WM does not seem to clearly explain some phenomena, such as the span size of mnemonists for example. The WM does not account for the greatly expanded working memory capacity of experts and skilled performers. It does not allow to clearly understand the performance of some chess players, or some experimental results in text comprehension about disrupted reading effects (for a complete review of the WM incapacity to account for these results, see Ericsson & Kinstch, 1995). How can the working memory based on temporary storage account for the fact that skilled activities can be interrupted and later resumed without detrimental effects on performance (Glanzer, Dorfman & Kaplan, 1981; Glanzer, Fisher & Dorfman, 1984)?
- 14 The long-term working memory advances a new explanation for accounting for these data. For this reason the theory has driven interest, for example in the field of chess, where the notion of expert is important (Saariluoma & Kalakoski, 1997; Gobet 1998). The theory is also attractive for the field of text comprehension especially to pinpoint the mechanisms that explain the superiority of experts. Kintsch, Patel & Ericsson (1999) have given a definition of expertise. According to the authors three conditions have to be fulfilled so that participants can use a part of their LTM as WM, and thus be expert. First, participants have to be confirmed readers, second, texts have to be well written, and third, texts must have a familiar content. We used this definition to build our material and to test the characteristics of long-term working memory.
- 15 In order to satisfy the first two requirements of Kintsch *et al.*'s (1999) definition, the texts were tested and all participants were students in their third year at the University. All of them had the skills (language skills), the knowledge (linguistic and world knowledge) and the reading strategies enabling to build a coherent mental representation of a text. We used the third of Kintsch *et al.*'s (1999) condition (familiarity) has a variable with two modalities, a familiar content for a first group of participants, so that they could use their long-term working memory, *versus* a not familiar content for a second group, less convenient to use long-term working memory.
- 16 The familiar and unfamiliar content was obtained using the personalisation method: we presented to the same population of students a story in a personalised version (familiar content), or in a non-personalised version (unfamiliar content). In the first group (familiar content), participants read texts that included very well known locations (their university, their apartment, etc.). In the unfamiliar version, participants read texts with the same kind of places but in a city they had never been to (an Armenian university, an Armenian apartment, etc.). Doing so we did not oppose two populations (expert vs. novice). Usually expertise studies are associated with two populations (expert vs. novice), but the consequence can be that a hidden factor that is linked only with one population may partly explain the results. To overcome this issue, we had the idea to go beyond the classic definition of the expertise applying the personalisation method. This technique permits to have the same population divided into two groups (expert and novice) just introducing well known locations for one group, allowing it to be in an expertise situation. Moreover the fact that we know exactly what kind of expertise is used (knowledge about the location) allows us to better identify the reasons why a group is performing better.

- 17 The technique employed - personalisation - has been known at least since the work of White (1934) on problem solving, although we would like to emphasise the fact that in this study, the situation of expertise is not only created by personalisation. The structure of the texts is very important too, the texts are build in a way that reading them in the familiar condition is like using the Loci method. This method has a long history (Yates, 1966), the ancient Greeks used it to remember important words during speeches. Before a speech Greek orators had to visualise familiar locations and use them to mentally store the important words. During the speech they could retrieve those words just thinking about the familiar locations. Our method of personalisation allowed participants in the personalised condition to be in a similar situation, individuals could use retrieval structures to store words. In fact in our experimental material the character of each text - a university student - went from a location to another, for example from his classroom to the subway, and an object was mentioned in each location (e.g. a pair of glasses in the classroom). Participants had to recall the objects mentioned in the text, recall being cued by the places where the objects were, a situation that is similar to the Loci Method.
- 18 We expected a better cued recall for participants that read texts in the personalised version than for those who read non-personalised texts, since the first group completely fulfilled the conditions to use long-term working memory via retrieval structures, while the other group less.
- 19 We also introduced a delay condition with an interfering task between the reading task and the cued recall. The familiar content group should always have better results with or without a delay, but the difference of performance between the two groups should be more important with the delay. Since the long-term working memory characteristics allow a greater resistance to interference and a more long-term storage capacity than WM.
- 20 At last, the number of objects to be recalled by text was 6 or 10 objects. The hypothesis was that the difference between both groups should increase with the number of object to recall, since a long-term working memory characteristic is to allow participants to have a larger storage space.
- 21 The aim of the experiment is to test with our method the long-term working memory characteristics. The main assumption of the experiment is that the group with the familiar content can use its long-term working memory, while the other group can only rely on its WM and LTM.

#### MethodParticipants and design

- 22 Seventy-two third year students at the University of Psychology Paris V participated in the experiment. They were French native speakers. The average age was 24 years old. The main dependent measure was the percentage of recalled objects, the secondary dependent variable was the percentage of correct responses at a text comprehension task. Personalisation (personalised vs. non-personalised) and memory load (6 objects to recall vs.10 objects to recall) were between-subjects factors, and delay (no delay and a delay with an interfering task) was a within-subjects factor.

#### Materials

- 23 **Texts.** 4 texts were presented (University, Subway, Apartment and Shopping), each of them containing 12 objects and 6 locations. The first sentence is used to introduce the topic of the text, just after it, 6 couples of two sentences are presented: a long one (an

average of 25 words) where a location and two objects are presented, and then a short sentence. The first location of the personalised texts is used as a slot; the location name varies in function of the participant's responses at the questionnaire. The character's name changed as a function of the participant's group and sex. If the participant was in the personalised group the character had a French name, if he was in the non-personalised group the name was Armenian. The sex of the character in the text was the same as the participant reading the text.

- 24 **Questionnaire.** In order to know exactly what kind of locations were familiar to participants, for the personalised version, a questionnaire has been used. For each participant the familiar places were collected. The information was then included in the personalised texts. For example for the first location (cf. Appendix), we asked participants what kind of classroom they went to.
- 25 **The cued recall test.** The cues of the cued recall were the locations that participants read, in the text. There were 6 cues and 6 objects to be recalled for the first condition of the memory load factor, and 6 cues and 10 objects to be recalled for the second condition.
- 26 **The interfering task.** Two interfering texts were presented. Both were 5 sentence texts about the virtual reality, the participants read them in 45 seconds. These texts included 4 spelling mistakes; participants had to find them.
- 27 **Text comprehension task.** After the cued recall task, a text comprehension task was proposed. The participants were asked three factual questions to test their comprehension, in order to make sure that the participants didn't focus only on the locations and the objects.

#### Procedure

- 28 The experiment varied according to the group in which the participants were included. Thirty six participants saw four texts with familiar locations (personalised version) while thirty six saw four texts with unfamiliar locations (non-personalised version). All participants had first to answer to the questionnaire of personalisation, and then the experiment began. Participants saw the text segment by segment on the screen, at the rate of 40 ms per character, which represents one minute per text. The time of presentation allowed a fast but comfortable reading, with no possibility to re-read text.
- 29 At the end of the presentation of each text, a cue (a location of the text) appeared on the screen, participants had to recall the object that was in that location. This was done for each location. When the recall was delayed, the cued recall was done after the interfering task. Participants had to read an interfering text and orally say how many spelling mistakes were in the text.
- 30 After every cued recall session (displayed at the end of each text), three comprehension questions were displayed on the screen and the experimenter noted the answers.

#### Results

- 31 **Text comprehension task.** Statistical analysis showed that the personalised group and the non-personalised group have similar results: 76.8 % of correct answers for the personalised group, and 76.7 % for the non-personalised group. The difference is not significant [Student's  $t$ :  $t(70) = 0.12$ ,  $MS_e = 1.84$ ]. These percentages indicate that the participants have really read the text with the intent to understand it.

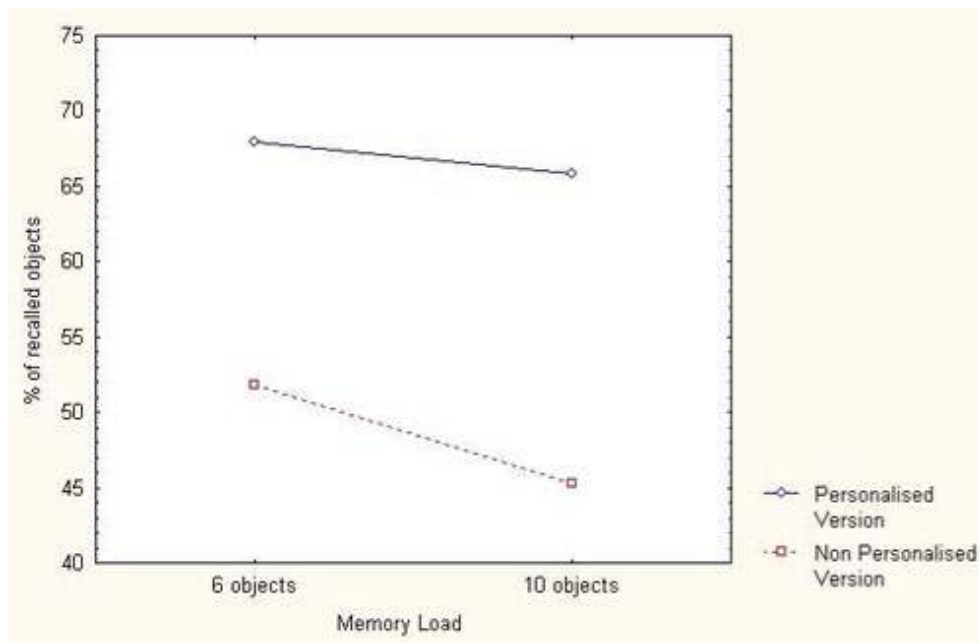
- 32 **Cued recall task.** The results of the experiment are summarised in Table 1. A three-way ANOVA was conducted on the cued recall scores. Scores were analysed in a 2 x 2 x 2 mixed-factors ANOVA, with delay (no delay and a delay with an interfering task) as a within-subjects factor and text version (personalised vs. non-personalised) and memory load (6 objects to recall vs. 10 objects to recall) as between-subjects factors. Results showed a significant effect of the Version factor: the average percentage of recall of objects is 67,4 % in personalised version *versus* 48,5 % in non-personalised version [ $F(1,68) = 23.9, MS_e = 5.07, p < 0.00001$ ].

Table 1. Mean percentage and standard deviation (in italic) of recalled objects as a function of Text version, Memory load and Delay.

		Memory load		Delay	
		6 objects	10 objects	No Delay	Delay
Text version	Personalised	67.82	65.97	67.96	65.83
		<i>21.57</i>	<i>14.58</i>	<i>18.97</i>	<i>19.43</i>
	Non personalised	56.94	40.14	51.81	45.28
		<i>12.78</i>	<i>13.13</i>	<i>17.35</i>	<i>18.57</i>

- 33 A main effect of the memory load factor was also observed: the mean percentage of recalled objects is 62,9 % for 6 objects *versus* 53,1 % for 10 objects to be recalled [ $F(1,68) = 6.2, MS_e = 5.07, p=0.015$ ]. And a main effect of the delay factor is observed: the mean percentage of recalled object is 59,9 % with no delay *versus* 55,6 % with a delay [ $F(1,68) = 5.26, MS_e = 1.28, p=0.025$ ].
- 34 Concerning interactions, only the interaction Version X Memory Load was significant: as shown in Figure 1, the memory load has no effect on the recall performance in the personalised version, while performance decreases in the non-personalised version when the memory load increases [ $F(1,68) = 3.99, MS_e = 5.06 p<0.05$ ].

Figure 1. The effect of Text version on recalling objects as a function of the Memory Load



- 35 Contrary to our assumption, there is no interaction Version X Delay [ $F(1,68) = 1.36$ ,  $MS_e = 1.28$ ], but the effect of delay was significant for the non-personalised group : the mean percentage of recalled objects is 51,8 % when no delay *versus* 45,3 % when delay [ $F(1,68) = 5.98$ ,  $MS_e = 1.28$   $p=0.02$ ]; while it was non significant for the personalised group: the mean percentage of recalled objects is 68 % when no delay *versus* 65,8 % when Delay [ $F(1,68) = 0.63$ ,  $MS_e = 1.28$ ]. This suggests that the delay had an effect on the non-personalised group, while it had not a significant effect on the other group, the lack of interaction just means that the comparison of these two effects is not significant.

#### Discussion

- 36 Our results lead to three conclusions: (1) participants who were supposed to use their long-term working memory (personalised version) recalled more objects than participants who were not (non-personalised version), (2) with the additional delay and interfering task, the performance of participants in the personalised version stayed stable, contrary to the performance of participants in the non-personalised version. (3) participants in the non personalised group were more sensitive to the additional memory load than the participants from the personalised group.
- 37 The first result, which showed that the cued recall for the personalised texts was more important than the cued recall for the non-personalised texts, could be interpreted in the following way: the participants reading a personalised text used their long-term working memory, while participants in the non-personalised version could not rely on it because the conditions to use long-term working memory were not fulfilled.
- 38 It is important to point out that, participants in the non-personalised group were not completely inexpert concerning the text content. The story took place on a campus, a well-known kind of place; it is possible to argue that all participants were experts. But there still is a gradient of expertise between the two groups. The idea is that, although the two groups may rely on a kind of long-term working memory, only the personalised



group can use it completely, the other group will rely more on their space restricted WM and their simple LTM, because they cannot use effective retrieval structures.

- 39 This interpretation seems to be justified since the 3 criteria to be expert in text comprehension (Kintsch *et al.*, 1999) have been completely fulfilled only for the personalised group. In the personalised texts, participants were given the cues to activate knowledge concerning the familiar places. During the processing of locations and objects, they activated the schema of the different locations (ex: the university cafeteria), and the objects were integrated in those schemas. This was possible because a schema possesses slots (variables that can be instantiated), which can be occupied by objects. The schema will just slightly change of form because of the object integration. In the non-personalised version, participants did not have the cues in the text to activate those personalised schemas, they could only activate a generic schema. Hence their lack of expertise concerning the locations did not allow them to activate a well-structured retrieval structure and use completely the long-term working memory.
- 40 During the cued recall task, participants in the personalised version only had to reinstate the schema of the different locations, so they could retrieve the object from the slot. Those schemas constituted a retrieval structure, which allowed participants to use long-term working memory, whereas for the non-personalised version, the less familiar content did not allow the participants to use efficiently such retrieval structures and therefore their long-term working memory. The locations were unknown so the objects could not be integrated into a well-known schema (retrieval structure). While the mental representation of participants in the personalised group is constituted with practiced schemas (their university, their house etc...) used as retrieval structures, the mental representation of participants in the other group is constituted with generic and not so practiced schemas (a university, a house etc...). The consequences are that subjects from the non-personalised group cannot use effectively those schemas as retrieval structures and thus use long-term working memory.
- 41 We think that the schemas used in the personalised version are “domain knowledge” retrieval structures. Gobet (2000, p. 566) has identify three kind of retrieval structures, (1) the generic retrieval structures defined as “arbitrary structures, developed with the deliberate goal of improving their memory” used for example in the digit-span task, (2) the episodic text structures “built up rapidly with the comprehension of a text, but which become more rapidly inaccessible than the first type of structures” and (3) the domain knowledge retrieval structures: mainly patterns and schemas. Our two experimental groups certainly created an episodic text structure while they were reading the texts, but we think that the main factor that explain the difference between the two groups is how the “domain knowledge” retrieval structures are integrating in the episodic text structure. For the non-personalised group this integration can be done only with generic schemas, whereas the other group can use their domain knowledge. The integration process is certainly important, it would be interesting in a next study to design an experiment with a condition with no text to analyse the impact of the integration (or not) of domain knowledge in episodic structures or the eventual impact of the interaction between episodic text structure and domain knowledge retrieval structures.
- 42 Concerning the generic retrieval structure, we do not think that the retrieval structures used by the participants belong to that type. Even if our experimental situation is comparable to the Loci Method, it seems difficult to define the retrieval

structures of our participants as “arbitrary structures, developed with the deliberate goal of improving their memory” (the definition of generic retrieval structures).

- 43 The second main result of the experiment has to do with the Delay. The effect of delay and interference was not the same according to the type of Version. The non-personalised group were the only group bothered by the delay. In this unfamiliar condition, participants could not perfectly rely on their long-term working memory (since the conditions to use it were not completely fulfilled), therefore participants could just use their WM and LTM. WM is limited by the space storage, so once the interfering task was finished a lot of information had been erased from it. Some information was certainly stored in LTM, but not in a rapid and reliable way. This was only possible with a familiar content that is why the delay and the interfering task did not have an effect. Concerning the lack of interaction, it simply means that Delay factor did not increase the recall gap between the two groups.
- 44 The third main result concerned the interaction between the memory load and the type of version. The interaction permitted to compare the two groups of participants when they had a more important memory load. The results showed that participants with a personalised text were not bothered by the increase of the number of objects, while the participants of the other group were. The gap between the two groups increased when the number of object to recall varied from 6 to 10. These results could be interpreted in the following way: by increasing the number of item, the memory load became more important, it overcame the storage possibilities of the WM. But one of the characteristics of the long-term working memory is to allow the participants to go beyond the limits of WM. So participants in the personalised version were no more limited by the WM restrictions, thanks to long-term working memory, whereas participants from the other group were.
- 45 The increase of the mental load factor could also be explained in terms of interference; augmenting the number of objects surely increased the possible interference. This interpretation is interesting because it allows comparing our results to those obtain in one of the dominant paradigms for studying the effects of interference in LTM: the fan effect for recognition of studied facts. Moreover our experimental material is very comparable to the material used in that paradigm. For example, Anderson (1974) had participants to memorise a series of sentences. Each sentence had a character placed in a location, for example "The hippie is in the park", "The lawyer is in the park". Anderson (1974) found that the time to correctly recognise a sentence increased as a function of the number of occurrences of that sentence's character and location descriptions among the other sentences. But other studies showed that the fan effect could be reduced (Moeser, 1979; Smith, Adams & Schorr, 1978) or even reversed (Myers, O'Brien, Balota & Toyofuku, 1984) when participants could form integrated representation with sentences. Similarly Radvansky and Zacks (1991) have shown that participants recognised more rapidly sentences concerning several objects in one location than sentences with several locations associated with a given object. Only the last situation leads to a fan effect, because it is difficulty to generate an integrated representation with several locations associated with one object. These results and our data show that in many cases it is possible to overcome interference by generating an integrated memory representation. And this is precisely the function of retrieval structures, the key to understand long-term working memory, that is what Ericsson and Kintsch tried to explain (1995, p. 220) concerning text comprehension: “In our

subsequent section on text comprehension we will show that the generation of integrated memory representations is the normal mode of processing texts on familiar topics.”

- 46 Put together these results seem to make the personalisation method a valuable way to test long-term working memory. We think that it is an important step for the long-term working memory framework because this paradigm allows the experimentalists to study expertise with every kind of participant. Moreover the experimentalists would know exactly what kind of difference there is between the novice and the expert. However the personalisation method could face some criticisms.
- 47 First, one can argue that the difference of results between the two groups could be explained by the “self” concept. Rogers, Kuiper and Kirker (1977) have shown that explicit instruction to encode information referring to the self increased performances in a memory task; it is known as the self-reference effect. However interpreting the personalised group superiority in terms of self-reference effect did not seem satisfying, because even if the familiar locations were related to the "self", they were not closely related and certainly not prototypical of the "self" concept content. Moreover the self-referent effect was not observed with all kinds of material and paradigms ( Klein & Loftus, 1988; Klein, Loftus & Burton, 1989). The effect was only obtained using personal features that are constituent of the self, like body characteristics, personality, and profession. There is no evidence in the literature that by presenting known locations one could have the same type of impact.
- 48 The second problem about the experiment is related directly to the task. That is, whether our task could measure long-term working memory? The results seemed to indicate it did. But it may be possible to justify these results without using the long-term working memory framework, suggesting that the difference of performance between the two groups could be explained by a difference of knowledge concerning the locations of the text. The personalised group used its knowledge in LTM to form a mental image and to bind the objects together while for the other participants it was more difficult because they knew nothing about Armenia. This means that the difference observed could simply be explained in terms of LTM. However this could be a possibility, Ericsson and Kintsch's theory permits to have some solid hypothesis due to the long-term working memory characteristics, this does not seem possible just using a LTM explanation. The problem of interpretation is more likely to come from the task used; with a cued recall task, the impact of long term memory on working memory can not be directly seen, essentially because it is a task that can viewed as a LTM task. A future experiment should allow us to give an answer to this kind of uncertainty. The personalisation method is going to be applied to a reading span task, assuming that the personalised group will have a bigger reading span than the non-personalised group and than the average reading span (3-3,5 words). If this result is reached, we will have a good reason to think that it concerns WM and that an explanation using only LTM is insufficient. It will be then clear that long-term working memory is an important framework to explain these types of results.
- 49 To conclude, the main interest of the theory of Ericsson and Kintsch (1995) is to point out the links between WM and LTM rather than presenting another type of memory named long-term working memory. WM cannot be viewed as a structure working on its own, a lot of data already corroborate this hypothesis. For example, Hulme, Maughan and Brown (1991) have clearly shown the impact of knowledge in transitory retention

of information: span performance was better for words than for nonwords. Gathercole (1995) has also shown that nonword repetition was better for the more wordlike nonword. The main problem is now to theorise this impact. Cowan (1995) has proposed a similar hypothesis to the long-term working memory framework. The knowledge in LTM that is solidly linked to the participant's current situation can be accessed easily, as if it was held in an activated form in WM, named the "virtual short-term memory".

50 But it is not the only way to imagine the influence of LTM. Baddeley (2000) has modified his model of WM to emphasise the importance of co-ordination between WM and LTM and the need to link them, he proposed the notion of episodic buffer. Baddeley criticised Ericsson and Kintsch's theory, for what can be called the binding problem, which in reality is related to an old issue that concerns the activation models. In the long-term working memory framework, the accessible knowledge is a portion of LTM that becomes activated. From Baddeley's perspective, the activation concept is insufficient to describe cognitive processing. For example, how could the activation concept explain that a human being can imagine an elephant grabbing hold of a hockey stick, since nobody has ever seen one. Baddeley thinks that a structure is needed - the Episodic Buffer - to bind this information; it is impossible to directly activate in LTM something that you have never engraved in your mind.

51 From our point of view, it is possible to solve the elephant playing hockey dilemma using an activation theory, because all the elements that constitute an elephant are already in LTM. One just needs to activate the appropriate elements: an elephant, a hockey stick, a human hand, some elephant skin and the "combine" concept. Instead of having these elements in the episodic buffer and to bind them inside, one can imagine that a simple co-activation of all the elements will be the equivalent of binding. The difference between these two points of view is also directly related to an old question that concerns functionalism *versus* structuralism. But from a pragmatic point of view and concerning the predictions of the models, this kind of difference is not an important issue. In fact, even if Baddeley does not completely adopt the theory of the long-term working memory, the fact that he has added a new component to his model underlines the impact of the long-term working memory and the interest of its theoretical framework. We think that the present and future WM models will have to take into consideration the long-term working memory framework.

Appendix

**Text sample translated from French****Personalised version**

Robert has just arrived at Descartes University, it's only a while since the university was built at Boulogne. He is hurrying up because he is late. He goes to Lagache classroom for the first lesson but sitting down he knocks his neighbour's *glasses* on the floor. He is sorry and apologises. During the pause Robert goes to the second floor where he drinks a *coffee* and reads a *newspaper* that he has bought this morning. The noise of the conversations bothers him. At one o'clock he decides to go to eat at the cafeteria going in, he has to move a *bag* that is in the middle of the doorway. He then takes off his *hat*.

**Unpersonalised version**

Erevo has just arrived at Erevan University, it's only a while since the university was built in Armenia. He is hurrying up because he is late. He goes to Assadourian classroom for the first lesson but sitting down he knocks his neighbour's *glasses* on the floor. He is sorry and apologises. During the pause Erevo goes to the second floor where he drinks a *coffee* and reads a *newspaper* that he has bought this morning. The noise of the conversations bothers him. At one o'clock he decides to go to eat at the cafeteria going in, he has to move a *bag* that is in the middle of the doorway. He then takes off his *hat*.

Words underlined: Locations. Words *in italic*: objects to recall

- 52 **Note:** in the original text, the locations were not underlined and the objects were not written in italic

## BIBLIOGRAPHY

- Anderson, J. R. (1974). Retrieval of propositional information from long-term memory. *Cognitive Psychology*, 6, 451-474.
- Baddeley, A. D. (1986). *Working memory*. New York: Oxford University Press.
- Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, 4, 423-471.
- Chase, W. G., & Ericsson, K. A. (1982). Skill and working memory. In G. H. Bower (Ed.), *The Psychology of Learning and Motivation* (Vol. 16, pp. 1-58). New York: Academic Press
- Cowan, N. (1995). *Attention and Memory: An integrated framework*. New York: Oxford University Press.
- Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, 19, 450-466.
- Daneman, M., & Carpenter, P. A. (1983). Individual differences in integrating information between and within sentences. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 9, 561-584.
- Ericsson, A., & Kintsch, W. (1995). Long term working memory. *Psychological Review*, 102, 211-245.

- Gathercole, S. E. (1995). Is nonword repetition a test of phonological memory or long-term knowledge? It all depends on the nonwords. *Memory and Cognition*, 23, 83-94.
- Glanzer, M., Dorfman, D., & Kaplan, B. (1981). Short-term storage in the processing of text. *Journal of Verbal Learning and Verbal Behavior*, 20, 656-670.
- Glanzer, M., Fisher, B., & Dorfman, D. (1984). Short-term storage in reading. *Journal of Verbal Learning and Verbal Behavior*, 23, 467-486.
- Gobet, F. (1998). Expert memory: A comparison of four theories. *Cognition*, 66, 115-152.
- Gobet, F. (2000). Some shortcomings of long-term working memory. *British Journal of Psychology*, 91, 551-570.
- Hulme C., Maughan S., & Brown G. D. A. (1991). Memory for familiar and unfamiliar words: Evidence for a long-term memory contribution to short-term memory span. *Journal of Memory and Language*, 30, 685-701.
- Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. New York: Cambridge University Press.
- Kintsch, W., Patel, V., & Ericsson, A. (1999). The role of long-term working memory in text comprehension. *Psychologia*, 42, 186-198.
- Klein, S. B., & Loftus, J. (1988). The nature of self-referent encoding: the contributions of elaborative and organizational processes. *Journal of Personality and Social Psychology*, 55, 5-11.
- Klein, S. B., Loftus, J., & Burton, H. A. (1989). Two self-reference effects: The importance of distinguishing between self-descriptiveness judgments and autobiographical retrieval in self referent encoding. *Journal of Personality and Social Psychology*, 56, 853-865.
- Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits of our capacity for processing information. *Psychological Review*, 63, 81-97.
- Moeser, S. D. (1979). The role of experimental design in investigations of the fan effect. *Journal of Experimental Psychology: Human Learning and Memory*, 5, 125-134.
- Myers, J. L., O'Brien, E. J., Balota, D. A., & Toyofuku, M. L. (1984). Memory search with interference: The role of integration. *Cognitive Psychology*, 16, 217-242.
- Radvansky, G. A., & Zacks, R. T. (1991). Mental models and the fan effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17, 940-953.
- Rogers, T. B., Kuiper, N. A., & Kierker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology*, 35, 677-688.
- Saariluoma, P., & Kalakoski, V. (1997). Skilled imagery and long term working memory. *American Journal of Psychology*, 110, 177-201.
- Smith, E. E., Adams, N., & Schorr, D. (1978). Fact retrieval and the paradox of interference. *Cognitive Psychology*, 10, 438-464.
- Tulving E., & Thomson D.M. (1973). Encoding specificity and retrieval processes in episodic memory, *Psychological Review*, 80, 352-373.
- White, H. M. (1934). Does experience in the situation involved affect the solution of a problem? *Education*, 4, 451-455.
- Yates, F. A. (1966). *The art of memory*. Chicago: University of Chicago Press.

## ABSTRACTS

Ericsson and Kintsch (1995) have proposed that in situations of expertise, individuals can overcome working memory limitations by using long-term working memory. It allows a greater and longer storage capacity than working memory and a better resistance to interference. To test these characteristics two groups were contrasted among expertise in text comprehension. The method employed was personalisation; it consisted of introducing biographical elements in texts, allowing the reader to be in an expertise situation. Therefore a personalised group who read texts with familiar locations was compared with a non-personalised group who read texts with unfamiliar locations. In each location were positioned one or two objects, the participants had to recall them using locations as cues. Sensitivity to delay and to memory load were tested among the two groups. As predicted, the personalised group recalled more objects and showed no sensitivity to delay and to memory load, suggesting that the personalisation method is valuable.

Ericsson et Kintsch (1995) ont proposé que les experts pouvaient circonscrire les limites de la mémoire de travail en utilisant la mémoire de travail à long terme, cette dernière permettant une plus grande capacité de stockage. Pour tester ces caractéristiques, deux groupes ont été contrastés sur l'expertise en compréhension de texte. La méthode employée - la personnalisation - consiste à introduire des éléments biographiques dans un texte, permettant au lecteur d'être en situation d'expertise. Ainsi un groupe personnalisé lisant un texte avec des lieux familiers a été comparé à un groupe non-personnalisé lisant un texte contenant des lieux non-familiers. Dans chaque lieu, se trouvaient un ou deux objets, les sujets devaient rappeler ces objets, avec pour indice les lieux. La sensibilité au délai et à la charge en mémoire étaient testées. Comme attendu, le groupe personnalisé a rappelé plus d'objets et n'a pas montré de sensibilité au délai et à la charge en mémoire.

## INDEX

**Keywords:** Long-term working memory, Personalisation, Text comprehension

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