

# **Schema Theory: Effect of Prerequisite Context on Recall**

Psychology SL

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## Introduction

For any given situation, the brain receives more raw data input from the senses than it can process systematically, within an appropriate time scale, and without conscious effort. The brain therefore constructs **schemata** from a plethora of prior interactions, such that already-experienced scenarios are not re-processed entirely.

A schema is a cognitive structure which organizes categories of information and the abstract relationships among them, creating a simplified representation of reality. Although schemata give rise to several **cognitive biases** (e.g. social prejudice), they are an important **heuristic technique**, which relieves the brain of the strenuous processing of new perceptions. The brain attempts to **assimilate** new information into existing schema, resulting in deeply-ingrained schemata for regularly encountered scenarios. Occasionally, a new perception is encountered which is incompatible with existing schemata, and so these schema must be modified to account for the new information; this process is known as **accommodation**.

Schema theory is especially relevant in the study of memory and recall. Bartlett (1932) pioneered the idea of a schema as an *organized store of information* in his 'War of the Ghosts' study. In a later study, Bransford and Johnson (1972) performed several experiments, in which participants (**Ps**) were asked to recall various spoken passages in order to investigate the effect of prior knowledge on recall task performance. This investigation will focus on replicating *one* of the 4 experiments from this study.

B&J (1972) was predicated on *transformational linguistics*: that language has phonological surface structure *and* deeper semantic meaning. Comprehension and memory therefore involve the interpretation and recovery of that semantic meaning, while memory does not necessitate the retention of the phonological structure. However, some research had suggested that this mechanism could not be attributed entirely to the processing of semantic content, noting that **Ps** would often recall information which could only have been

*inferred* from the source material, through the integration of information not directly expressed in the presented passage. This supported the idea that **Ps** do not simply interpret the meaning of passage sentences, but rather:

**“...[Ps] create semantic products that are a joint function of input information and prior knowledge” (B&J (1972) p.718)**

The purpose of the B&J (1972) study was therefore to demonstrate the importance of prior knowledge on comprehension and recall performance, and further, the *necessity* of existing schemas for comprehension; comprehension was assumed to be a prerequisite for recall.

In Experiment I of the study, **Ps** were presented with a description of an extraordinary scenario for which **Ps would not have had an existing schema**; findings showed that only **Ps** that were provided with contextual information prior to the presentation performed significantly better than other groups, suggesting that full (as opposed to *partial* - see Appendix A) contextual knowledge was key to understanding and thus to recall.

Experiment IV thus investigated the effect of the activation of existing schema - constructing and flying a kite - on comprehension and recall performance. The source material was presented auditorily in the form of 14 consecutive sentences (see Appendix B); **Ps** were asked to recall the passage as accurately as possible immediately after. The **Ps** were separated into 3 groups: *Context Before*, *Context After*, and *No Context*. Results showed that while the *Context After* group rated their comprehension as significantly higher than that of the *No Context* group, there was no significant difference in recall accuracy. Whereas, the *Context Before* group scored significantly higher than the other two in recall accuracy: demonstrating that even when relevant schemas are present in **Ps'** knowledge, their activation is necessary in improving recall.

Experiment IV was chosen for reproduction, because the experimental design could be easily modified to suit the following research aim (which better reflects the general objective of the B&J (1972) study):

***To investigate the effect of semantic contextual prerequisites of presented sentences on Ps' ability to recall those sentences.***

Although in Experiment IV of B&J (1972) comprehension was measured explicitly, in this investigation it will be inferred from the recall scores. The **amount of statements accurately recalled (out of 14)** (dependent variable) will be measured for each ***P***, to determine the relationship between it and **whether (or not) *Ps* are provided with the context of the sentences (shown the word 'kite')** prior to their auditory presentation (independent variable). Thus, only two ***P*** groups will be included: *No Context*, and *Context Before*. The experimental hypothesis was:

*The **Ps** who are provided with the context of the sentences (shown the word 'kite') prior to hearing the 14 sentences (which relate to the construction and use of kites) will correctly recall more of those 14 sentences than those who are not.*

The null hypothesis for which being:

*There will be no significant difference in the number of statements recalled out of 14 by the **Ps** who are provided with the context for the sentences (shown the word 'kite') prior to auditory presentation and by those who are not.*

## Exploration

The **Ps** - a mix of 20 female and male college students, aged 16-18, were separated into two groups: *Context Before* and *No Context* (10 **Ps** in each). An independent measures experimental design was chosen, mainly because it was important that the **Ps** only performed the task once, as their performance may have been augmented if asked to memorize similar or identical material later under different conditions (order effects). Also, **Ps** were scarcely available; **Ps** were identified through opportunity sampling, by selecting students from the college canteen.

**Ps** were numbered 1-20, and assigned to groups based on whether their number was odd or even; the groups were then separated, each facing opposite directions. **Ps** were encouraged to read and sign the consent form (see Appendix C). The consent form explained the nature of the experiment, that the **Ps**' data would be anonymous, and that it could be withdrawn at any point during the experiment. Instructions, displayed at the front of the room, were read out and explained once all 20 **Ps** were present (see Appendix F).

Experimenters (**Es**) then displayed the word 'kite' shown in large print on A4 paper, to *Context Before*, while taking care to prevent any **Ps** from *No Context* from seeing it. It was explained to the **Ps** that they would hear a recording of several sentences, and that they should try to memorise as much of the material as possible, as they would subsequently be asked to recall the content of the recording.

A digital recording of the 14 sentences used in *B&J (1972) Experiment IV* was played to the **Ps** through the smartboard speakers, with a 2-second pause inserted between each sentence; this was created using Google Cloud TTS Engine, in order to improve on the low reliability and replicability of the presentation being read by a human.

Immediately following the recording, **Ps** were handed an answer sheet with either A or B written at the top (to distinguish the two groups), and were asked to reproduce the statements as accurately as possible. After the allowed 1 minute had elapsed, the answer

sheets were collected. **P**s were then debriefed, and were each handed a debrief form (see Appendix D) as they left the room, which gave further details of the nature of the experiment, and of the original experiment. Researchers' contact details were provided for subsequent queries.

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## Analysis

To generate a quantitative score for each **P**, answer sheets were each compared to the original sentences, with a mark given for each sentence if the semantic meaning of the original sentences had been accurately recalled (minor phonological discrepancies were ignored). This meant a maximum of 1 mark could be scored for each sentence, and a maximum of 14 could be scored overall. 3 of the **E**s agreed on a score for each **P**.

## Inferential Statistics

Given that the experiment had an independent measures design, at least ordinal data, and was testing for a difference between two conditions, the Mann-Whitney-U test was appropriate. The observed value, U, for each group is given below (see Table 1). A full table, including the recall scores and MWU ranks of each **P**, is given in Appendix E.

**Table 1:**  
Descriptive Statistics & Calculated U-Values

Group	Context Before	No Context
Mean	5.3	3.2
Median	5	3
Mode	5	3
Range	8	6
Std. Dev. ( $\sigma$ )	2.193	1.661
U	78.5	21.5

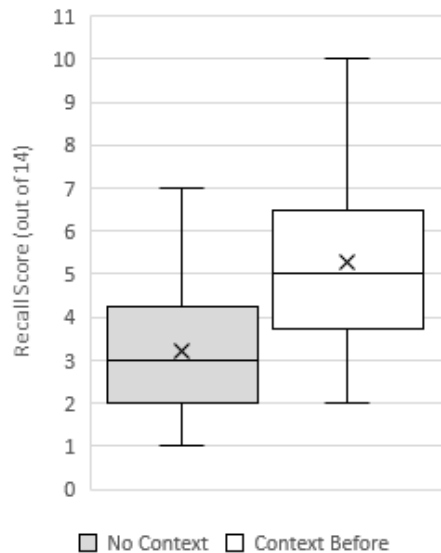
As each group had 10 *Ps*, the critical value for the (one-tailed in this case) hypothesis was 22 (the level of significance being  $p \leq 0.05$ ). The calculated value (the smaller of the U-values - the *No Context* group), 21.5, was lower than this critical value. Thus, the null hypothesis can be rejected with 95% confidence ( $p \leq 0.05$ ); there was a significant difference between the number of statements recalled out of 14 by the *Ps* who were provided with the context of the sentences (shown the word 'kite') prior to auditory presentation and by those who were not.

### Descriptive Statistics

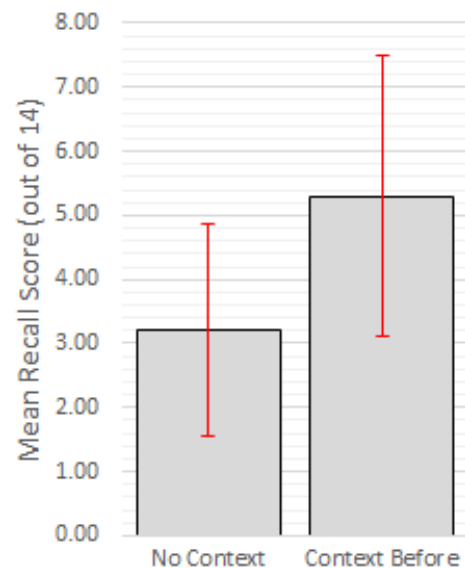
The data from Table 1 also shows that the mean recall score for the *Context Before* group (5.3) was 2.1 higher than that of the *No Context* group (3.2), as demonstrated in Figures 1 and 2. This is consistent with the experimental hypothesis: that the *Context Before* group would recall more sentences out of 14 than the *No Context* group. In addition, the modes and medians are higher for the *Context Before* group than for the *No Context* group, further corroborating the experimental hypothesis. The ranges and standard deviations (shown in Figures 1 & 2, respectively), suggest a large error. However, this is not critical because a significant difference has already been established.



**Figure 1:**  
Box & Whisker Plot of Recall Scores (out of 14)



**Figure 2:**  
Bar Graph of Mean Recall Scores (out of 14)



## Evaluation

In the analysis of the results of this investigation, the calculated value (21.5) was lower than the critical value (22), so the null hypothesis was rejected ( $p < 0.05$ ); there was a significant difference between the recall scores of the *Context Before* and *No Context* groups. Further, on average, the amount of recalled sentences was higher in the *Context Before* group (5.3) than in the *No Context* group (3.2). This is consistent with the experimental hypothesis, and corroborates part of the B&J (1972) study, which found the *Context Before* to score significantly higher in recall accuracy than the *No Context* group. Experiment IV of the B&J (1972) study also directly measured comprehension- a design aspect that was relevant to the *Context After* group. However, in this reproduction of the

experiment, comprehension was not measured directly, nor was a *Context After* group included.

The superior performance of the *Context Before* group compared to the *No Context* group suggests that relevant schemas (kite flying, for example) are crucial to *Ps*' comprehension and recall of a passage. Further, even if the said schemas are already present in a *P*'s body of knowledge, they have no effect unless 'activated': brought to the *P*'s conscious attention. Perhaps, without the identification of a schema relevant to the task material by the conscious mind, the process of assimilation cannot occur.

In investigating a *Context After* group, B&J (1972) Experiment IV isolated the application of the schema to the retrieval stage, ensuring the relevant schema was not available to the *Ps* during their encoding of the material. It found that while *Context After* scored their comprehension higher on average than the *No Context* group, there was no significant difference between the two groups in recall performance, suggesting any improvement in recall requires the activation of a relevant schema at the encoding stage.

This has implications in the context of education; students will find it difficult to comprehend and later recall a new topic, if they lack the necessary scaffolding of fundamental concepts. Rather, each of these concepts should be fully consolidated *before* the teaching of the new topic. That said, students' understanding of a topic may be improved by learning the topic context *after* being taught the topic itself, although their recall performance would remain severely impaired. Education may be an area for further research in this regard: with students' test scores being compared against how each student was taught.

An independent measures design was selected for this investigation, because it allowed the elimination of order effects. However, it presents the possibility of confounding individual differences. For example, some Psychology students may have participated; they would be at an advantage if they had previously studied B&J (1972), because the original

sentences were used in this experiment. A solution would be to create new material, although this risks changing conditions of experiment - for example fewer subjects might have an existing schema for a different context. Further, a matched participant design, enforced by testing the **Ps** prior to the experiment, could have balanced out any uneven distributions in memory ability.

Ideally, subjects should have been positioned further apart, to prevent them from copying each other's answer sheets. Nonetheless, instructions were given clearly and ethical standards were followed. Also, using a digitally synthesised recording of the sentences (technology not available at the time of B&J (1972) ) in this investigation improved the consistency and replicability of the sentences' presentation. In the future the study could be performed on a much larger scale by incorporating the experiment into an online application.

In conclusion, this investigation achieved its research aim by providing greater insight into schema theory - specifically, the effect of contextual schema on recall. Its findings support those of the B&J (1972) study.

## **Bibliography**

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- Bransford, J. and Johnson, M. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior*, 11(6), pp.717-726
- Google Cloud. (2018). Cloud Text-to-Speech - Speech Synthesis | Cloud Text-to-Speech API | Google Cloud. [online] Available at: <https://cloud.google.com/text-to-speech/> [Accessed Jun. 2018].

## Appendices

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### Appendix A

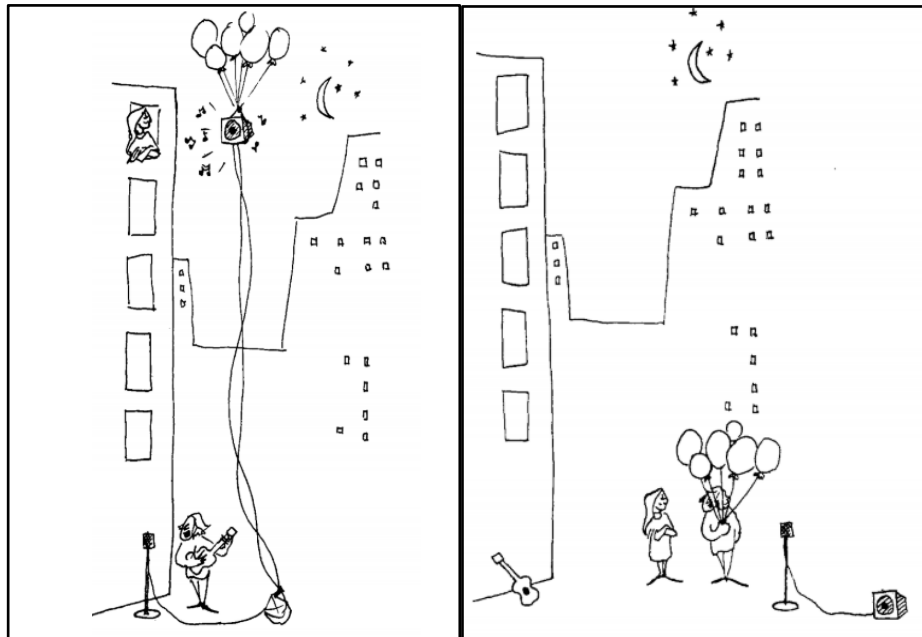


Figure 1

Figure 2

Original illustrations from *Bransford & Johnson (1972)*

They differ in that while Figure 1 illustrates the relationships between objects in the story, objects shown in Figure 2 are randomly arranged.

In Experiment I of B&J (1972), some *Ps* were provided with context in the form of illustrations. *Ps* were separated into 5 groups: *Context Before* and *Context After*, *Partial Context*, and two *No Context* groups. *Context Before* and *Context After Ps* received the illustration shown in Figure 1, before and after presentation of the passage, respectively. *Partial Context Ps* received the illustration shown in Figure 2 prior to presentation of the passage. *Context Before Ps* were found to score higher in comprehension *and* recall than

those in all other groups; no statistically significant difference was found between these other groups.

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## **Appendix B**

*Sentences (from original Bransford & Johnson (1972)<sup>1</sup> study) used as material in investigation*

A newspaper is better than a magazine.

A seashore is a better place than the street.

At first it is better to run than to walk.

You may have to try several times.

It takes some skill but it's easy to learn.

Even young children can enjoy it.

Once successful, complications are minimal.

Birds seldom get too close.

Rain, however, soaks in very fast.

Too many people doing the same thing can also cause problems.

One needs lots of room.

If there are no complications, it can be very peaceful.

A rock will serve as an anchor.

If things break loose from it, however, you will not get a second chance.

*A 2-second pause was inserted between each consecutive sentence; Ps were allowed 1 minute to recall the passage.*

## Appendix C

Consent: *Experimenters' names and college have been omitted*

Memory Study: Ethics Consent Form

**Thank you for considering participating in our experiment**

**Experimenters:**

Anya Rehman-Wood, Louie Garnett, Tom Wright, Josie Proton

We are performing an experiment as part of our internal assessment for our IB Psychology class. The experiment involves testing your memory recall under various conditions. We would like to ask you to be part of our experiment.

If you agree to take part in this experiment, you should know that:

- All data that we obtain will be kept confidential and anonymous
- You may stop participating in this experiment and/or withdraw your results at any time
- After the experiment, there will be a debrief, where you will be able to discuss the procedure and the findings with us. Any questions you may have will be answered honestly and as fully as possible
- If you wish, you shall be contacted with information about the results of the experiment as soon as possible after the research is concluded.

The experiment will take **5-10 minutes** to complete.

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I, \_\_\_\_\_, understand the nature of this experiment and I agree to participate voluntarily. I give the researchers permission to use my data as part of their experimental study. I confirm that I am fluent in English and am a student at Varndean College.

If you would like to be contacted with the results of the experiment, please leave your email address/ phone number below:

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

## Appendix D

Debrief: *Experimenters' emails have been omitted.*

Memory Study: Debrief

### Thank you for participating in our experiment

The purpose of this experiment was to test the effects of semantic context on your memory recall.

The experiment was based on a section of a study by **Bransford & Johnson (1972)** involved separating participants into two condition groups *A* and *B*, whereby subjects in *Group A* **were** given the context of a set of sentences (kite flying) prior to those sentences being read to them, and those in *Group B* **were not**. Results suggested that participants in *Group A* performed better on average.

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If you have any questions please ask now, or email the experimenters (see below).

If you wish to withdraw your results, you have the opportunity to do so now.

If you would like to receive any of the data we have gathered with regards to you, please contact one of the experimenters via:

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## Appendix E

	No Context	Rank	Context Before	Rank
P <sub>1</sub>	7	18.0	8	19.0
P <sub>2</sub>	4	10.5	5	14.0
P <sub>3</sub>	3	7.5	6	17.0
P <sub>4</sub>	5	14.0	5	14.0
P <sub>5</sub>	2	3.5	4	10.5
P <sub>6</sub>	2	3.5	5	14.0
P <sub>7</sub>	2	3.5	5	14.0
P <sub>8</sub>	3	7.5	3	7.5
P <sub>9</sub>	1	1.0	2	3.5
P <sub>10</sub>	3	7.5	10	20.0
R		76.5		133.5
U		21.5		78.5

Full Mann-Whitney U test data

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## Appendix F

*Standardised instructions displayed and read to Ps during experiment*

- Listen to the recording.
- When the recording is finished you will be handed a piece of lined paper.
- Recall and write down as many of the statements as you can.
- Attempt to replicate the statements as accurately as possible.