

Behavioural evidence of suppression-induced forgetting and its interaction with psychological traits

M. Usman Afzali¹ , Richard D. Jones^{1,2,3,4} , Joshua Lynskey¹ , Julia Newlands¹ , Ewald Neumann^{1,5} 

ARTICLE HISTORY

Compiled April 12, 2023

¹ School of Psychology, Speech and Hearing, University of Canterbury, Christchurch, New Zealand

² School of Electrical and Computer Engineering, University of Canterbury, Christchurch, New Zealand

³ School of Medicine, University of Otago, Christchurch, New Zealand

⁴ Christchurch Nanotechnology Research Programme, New Zealand Brain Research Institute, Christchurch, New Zealand

⁵ New Zealand Institute of Language Brain and Behaviour, University of Canterbury, Christchurch, New Zealand

ABSTRACT

During the past two decades, Anderson and colleagues continuously reported significant No-Think suppression effect - also known as suppression-induced forgetting - with behavioural as well as neurophysiological studies. Notwithstanding, many researchers, including Wessel et al. (2020. A multiverse analysis of early attempts to replicate memory suppression with the Think/No-think Task, *Memory*, 28(7). 870-887) reported failed replications of this effect. Here, we report two studies examining the Think/No-Think paradigm. In Study 1 ($N = 46$) we report significant suppression-induced forgetting effect despite a smaller frequency of suppression attempts (compared to Anderson) as a result of *behavioural only* experiments. In the pre-registered Study 2, we examined the Think/No-Think paradigm in relation to psychological traits: obsessive compulsive disorder and post-traumatic stress disorder. After screening $N = 367$ subjects for Study 2, we recruited the highest and lowest scorers on Yale-Brown Obsessive Compulsive Scale and PTSD-CheckList - Civilian Version scale ($N = 75$) employing the Think/No-Think paradigm. Overall, we report successful suppression-induced forgetting effect, and that the low trait scorers were relatively more capable of forgetting unwanted memories than the high trait scorers. In addition, our studies demonstrate opposing patterns of the Think manipulation effect with respect to the type of testing with the original cue versus an independent cue, suggestive of the cognitive bias, *functional fixedness*.

KEYWORDS

Suppression-induced forgetting; unwanted memories; executive deficit; OCD; PTSD; Think/No-Think; T/NT

CONTACT: M. Usman Afzali. Email: usman.afzali@canterbury.ac.nz.

1. Introduction

In the past, considerable research has taken place on passive mechanisms of forgetting such as decay over time and changed associations between memory traces in the brain (Anderson et al. 2004; Anderson and Hanslmayr 2014). Another passive mechanism of forgetting pertains to interference from cluttering of many similar events in memory (Anderson 2003) resulting in limited access to a certain memory overtime. These mechanisms, however, neglected motivated and deliberate attempts of memory suppression employed to push unwanted troubling memories from consciousness when reminded (Anderson and Hanslmayr 2014). People often engage in active and motivated forgetting when reminded of troubling experiences rather than waiting for passive forgetting to take place (Anderson and Hanslmayr 2014; Anderson 2003; Benoit and Anderson 2012). These active and deliberate attempts could be employed during memory encoding or memory retrieval. If attempted during memory encoding, it would prevent memory consolidation and memory formation. If motivated forgetting is attempted during retrieval of unwanted memories, it would stop the automatic association between memory reminders and the resultant unwanted memories, known as `\emph{retrieval suppression}` `\citep{anderson_neural_2014}`. Research has shown that attempting deliberate retrieval suppression when someone is being reminded of unwanted memories led to difficulty accessing these memories in the future `\citep{green_suppressing_2001, benoit_opposing_2012, levy_individual_2008, anderson_rethinking_2003}`. These deliberate attempts form the basis of the Think/No-Think (T/NT) paradigm. With the T/NT paradigm, it has also been shown that actively stopping a behavioural response to an unwanted item by control mechanisms can result in its temporary amnesia in a subsequent recall test even if recollection is desired `\citep{green_suppressing_2001, levy_individual_2008}`. T/NT is commonly employed to investigate whether people can suppress unwanted memories and the degree to which such suppression can affect subsequent recall.

This quarto extension format supports PDF and HTML outputs. This template is primarily focused on generating acceptable \LaTeX outputs from Quarto, but renders an acceptable HTML output using the standard Quarto options.

2. Quarto

Quarto enables you to weave together content and executable code into a finished document. To learn more about Quarto see <https://quarto.org>.

3. Running Code

When you click the **Render** button a document will be generated that includes both content and the output of embedded code. You can embed code like this:

```
[1] 2
```

This format hide chunks by default, but you can set `echo` option to `true` locally in the chunk:

Table 1.: A table.

term	estimate	std.error	statistic	p.value
(Intercept)	2.9324591	0.0982638	29.8427305	0.0000000
EthN	-0.1739938	0.1213351	-1.4339937	0.1515741
SexM	-0.7145197	0.1222943	-5.8426235	0.0000000
AgeF1	-0.0426993	0.1269111	-0.3364507	0.7365310
AgeF2	-0.0863239	0.1616403	-0.5340495	0.5933073
AgeF3	-0.1528978	0.1189753	-1.2851227	0.1987494
LrnSL	0.2160818	0.1455811	1.4842716	0.1377369
EthN:SexM	0.4390243	0.0920790	4.7679077	0.0000019
EthN:AgeF1	-0.9288934	0.1465738	-6.3373786	0.0000000
EthN:AgeF2	-1.3339773	0.1350383	-9.8785113	0.0000000
EthN:AgeF3	-0.1124246	0.1347842	-0.8341080	0.4042202
EthN:LrnSL	0.2641524	0.1137843	2.3215200	0.0202588
SexM:AgeF1	-0.0556536	0.1630311	-0.3413682	0.7328264
SexM:AgeF2	1.0994244	0.1528125	7.1945973	0.0000000
SexM:AgeF3	1.1594892	0.1385899	8.3663319	0.0000000
SexM:LrnSL	0.0414270	0.1371756	0.3019998	0.7626522
AgeF1:LrnSL	-0.1301879	0.1568800	-0.8298561	0.4066201
AgeF2:LrnSL	0.3734020	0.1456293	2.5640585	0.0103456
AgeF3:LrnSL	NA	NA	NA	NA

```
# install.packages("broom")
# install.packages("kableExtra")
data("quine", package = "MASS")
m_pois <- glm(Days ~ (Eth + Sex + Age + Lrn)^2, data = quine, family = poisson)
kableExtra::kable_styling(
  kableExtra::kbl(broom::tidy(m_pois))
)
```

4. Markdown Basics

This section of the template is adapted from [Quarto's documentation on Markdown basics](#).

4.1. Text Formatting

Markdown Syntax	Output
<i>*italics*</i> and **bold**	<i>italics</i> and bold
superscript ² / subscript ₂	superscript ² / subscript ₂
~strikethrough~	strikethrough
`verbatim code`	verbatim code

4.2. Headings

Markdown Syntax	Output
# Header 1	5. Header 1
## Header 2	5.1. <i>Header 2</i>
### Header 3	<i>5.1.1. Header 3</i>

5.2. *Equations*

Use `$` delimiters for inline math and `$$` delimiters for display math. For example:

Markdown Syntax	Output
inline math: <code>\$E = mc^2\$</code>	inline math: $E = mc^2$
display math: <code>\$\$E = mc^2\$\$</code>	display math: $E = mc^2$

If assigned an ID, display math equations will be automatically numbered:

$$\frac{\partial C}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 C}{\partial C^2} + rS \frac{\partial C}{\partial S} = rC \quad (1)$$

5.3. *Other Blocks*

Markdown Syntax	Output
> Blockquote	Blockquote
Line Block	Line Block
Spaces and newlines	Spaces and newlines
are preserved	are preserved

5.4. *Cross-references*

Markdown Format	Output
@fig-sunflower is pretty.	Figure 1 is pretty.
@tbl-glm was created from code.	Table 1 was created from code.
@sec-crf is this section.	Section 5.4 is this section.
@eq-black-scholes is above.	Equation 1 is above.

See the [Quarto documentation on cross-references](#) for more.

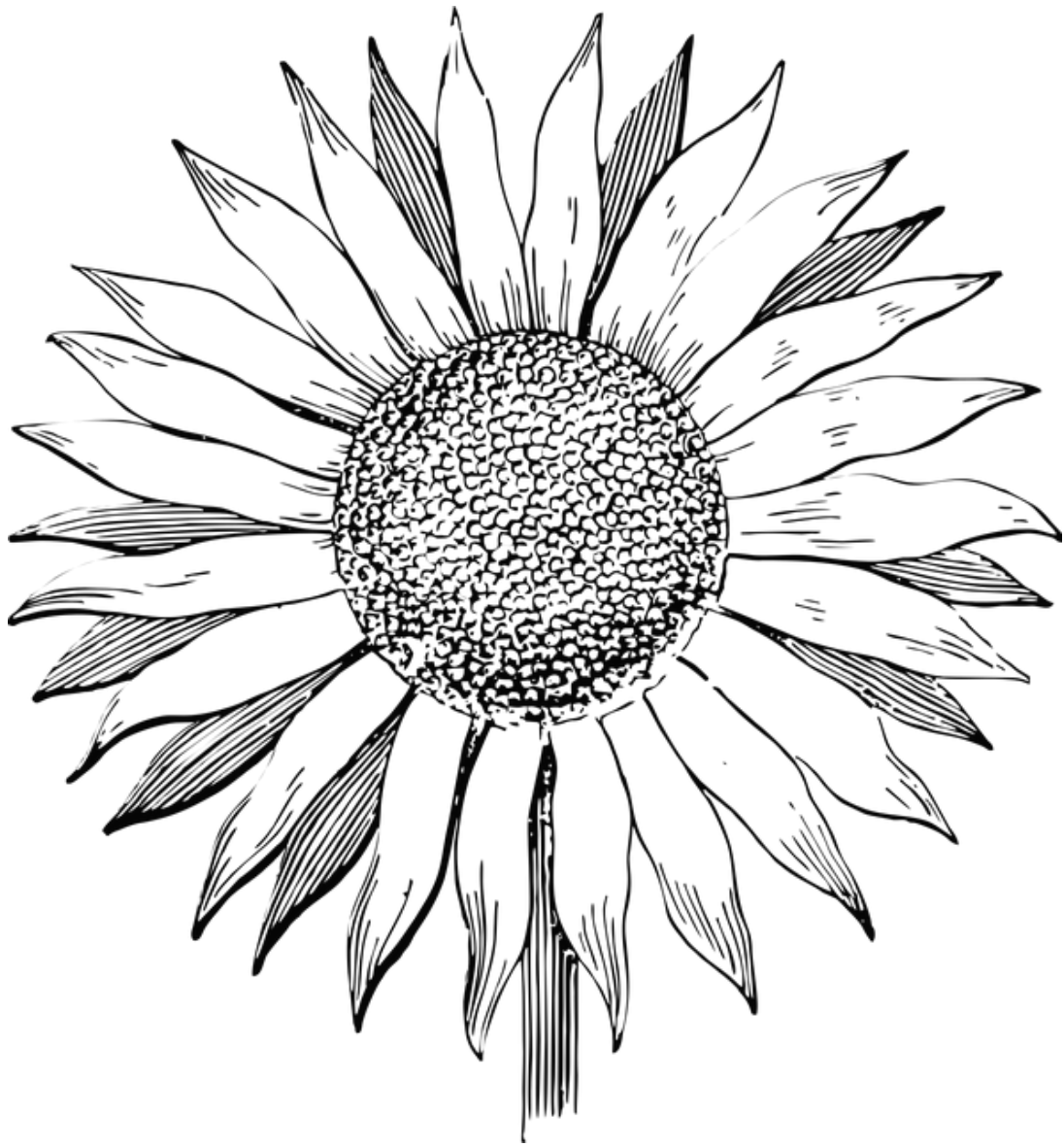


Figure 1.: A sunflower

6. Citations

This section of the template is adapted from the [Quarto citation documentation](#).

Quarto supports bibliography files in a wide variety of formats including BibTeX and CSL. Add a bibliography to your document using the `bibliography` YAML metadata field. For example:

```
---
title: "My Document"
bibliography: references.bib
---
```

See the [Pandoc Citations](#) documentation for additional information on bibliography formats.

7. Citations

This section of the template is adapted from the [Quarto citation documentation](#).

Quarto supports bibliography files in a wide variety of formats including BibTeX and CSL. Add a bibliography to your document using the `bibliography` YAML metadata field. For example:

```
---
title: "My Document"
bibliography: references.bib
---
```

See the [Pandoc Citations](#) documentation for additional information on bibliography formats.

7.1. Citation Syntax

Quarto uses the standard Pandoc markdown representation for citations. Here are some examples:

Markdown Format	Output
Blah Blah [see @knuth1984, pp. 33–35; also @wickham2015, chap. 1]	Blah Blah [see Knuth 1984, 33–35; also Wickham 2015, chap. 1]
Blah Blah [@knuth1984, pp. 33–35, 38–39 and passim]	Blah Blah (Knuth 1984, 33–35, 38–39 and passim)
Blah Blah [@wickham2015; @knuth1984].	Blah Blah (Wickham 2015; Knuth 1984).
Wickham says blah [–@wickham2015]	Wickham says blah (2015)

You can also write in-text citations, as follows:

Markdown Format	Output
@knuth1984 says blah.	Knuth (1984) says blah.
@knuth1984 [p. 33] says blah.	Knuth (1984, 33) says blah.

See the [Pandoc Citations](#) documentation for additional information on citation syntax.

To provide a custom citation stylesheet, provide a path to a CSL file using the `csl` metadata field in your document, for example:

```

---
title: "My Document"
bibliography: references.bib
csl: nature.csl
---
```

References

- Anderson, Michael C. 2003. "Rethinking Interference Theory: Executive Control and the Mechanisms of Forgetting." *Journal of Memory and Language* 49 (4): 415–45.
- Anderson, Michael C., and Simon Hanslmayr. 2014. "Neural Mechanisms of Motivated Forgetting." *Trends in Cognitive Sciences* 18 (6): 279–92.
- Anderson, Michael C., Kevin N. Ochsner, Brice Kuhl, Jeffrey Cooper, Elaine Robertson, Susan W. Gabrieli, Gary H. Glover, and John DE Gabrieli. 2004. "Neural Systems Underlying the Suppression of Unwanted Memories." *Science* 303 (5655): 232–35.
- Benoit, Roland G, and Michael C Anderson. 2012. "Opposing Mechanisms Support the Voluntary Forgetting of Unwanted Memories." *Neuron* 76 (2): 450–60.
- Knuth, Donald E. 1984. "Literate Programming." *The Computer Journal* 27 (2): 97–111.
- Wickham, Hadley. 2015. *R Packages*. 1st ed. O'Reilly Media, Inc.