Online Supplement

Signal-Detection Model

For a simple analysis of Gardiner's (1988) Experiment 1 data, Gardiner and Java's (1990) Experiment 2 and 3 data, and our own data, we implemented a four-parameter and a six-parameter signal detection model using a maximum-likelihood approach. The model is suited for analysis of group-level data, the only level available from the papers. For generality, we provide the model for Gardiner and Java's (1990) Experiment 2. The model may be easily applied to all other experiments except Gardiner's (1988) Experiment 1, where a simple restriction of the model is needed.

We may use the following notation: Let j denote lexicality status where $j = nw, w$ for nonwords and words, respectively. Let k denote old ($k = o$) and new ($k = n$) items. Additionally, let ℓ denote the response option. For the remember-know paradigm, $\ell = r, k, n$ for *remember*, *know*, and *new*. Let $Y_{ij\ell}$ be the response frequency. For example, if $Y_{wor} = 113$ for Gardiner and Java's Experiment 2, that indicates that participants responded *remember* to old words 113 times. We may place Binomial distributions on these frequencies:

$$Y_{jk\ell} \sim \text{Binomial}(N_{jk}, \pi_{jk\ell}),$$

where N_{jk} is the number of trials in each condition and $\pi_{jk\ell}$ is the probability of the ℓth response category in the jkth condition. These $\pi_{jk\ell}$ are the target of a signal-detection model.

The signal-detection model is illustrated in Figure 4. The model assumes one underlying dimension of mnemonic strength and three separate curves: one for new items, both nonwords and words; one for old nonwords and one for old words. These curves have the same shape, typically normal distributions, and different means; typically the mean for new items is set to zero and the mean for old items is d'_j, which serves as a measure of sensitivity and is allowed to vary by lexical status. Additionally, response criteria are

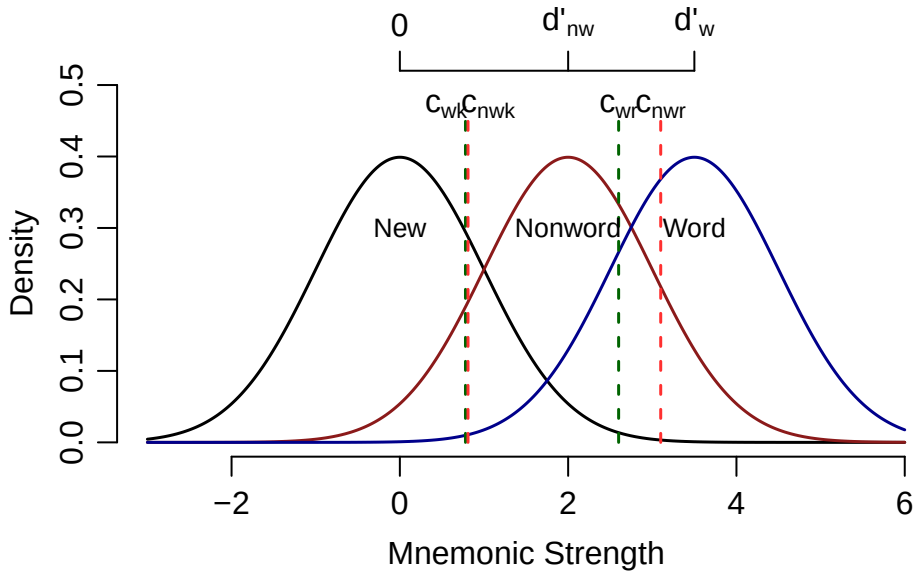

Figure 4. Signal detection model for Gardiner and Java's (1990) Experiment 2. Here, mnemonic strength parameters d', and criteria, c, are allowed to vary across words and nonwords.

required to map mnemonic strength onto a specific response option (remember-know). These response criteria, $c_{j\ell}$, can also be allowed to vary by lexical status. Mnemonic strength values smaller than c_{jk} produce a *new* response; those falling above c_{jk} but below c_{jr} produce *know* responses, whereas values greater than c_{jr} result in a *remember response*. With that in mind, response probabilities π are the area under the curve between different response criteria. For example, the probability of responding *remember* to old nonwords is given by the area under the middle curve to the right of the criterion c_{nwr}. Using these areas under the curves we may now define the response probabilities $\pi_{jk\ell}$ for all $j \times k \times \ell = 12$ conditions and response options:

$$\pi_{jkr} = 1 - \Phi(c_{jr} - d'_j),$$

$$\pi_{jkk} = \Phi(c_{jr} - d'_j) - \Phi(c_{jk} - d'_j),$$

$$\pi_{jkn} = \Phi(c_{jk} - d'_j).$$

Here Φ is the cumulative density function (CDF) of a standard normal distribution. Note also that there are only four criteria, $c_{j\ell}$, necessary: No criterion for *new* responses is needed.

Material

Below are the words and nonwords presented to the participants during the study phase. The items in italic are the ones only used for Experiment 1. The other items are used for all three experiments.

Words

"BATH", "BEEF", "BIRD", "BLUE", "BOOK", "CAKE", *"CALL"*, "CASH", "COAT", "COLD", "DATE", "DOOR", "FACE", "FACT", "FEET", "GATE", "GIRL", "GOOD", "HALF", "HALL", "HAND", *"HAVE"*, "HEAD", *"HELP"*, *"HOLD"*, "HOME", "KISS", "KNEE", "LEFT", "LIFE", "LIKE", "LINE", "LOOK", "MAKE", "MIND", "NOTE", "PAGE", "RAIN", "REST", "ROAD", *"ROOM"*, "SALT", "SEAT", *"SELF"*, "SHOP", "SKIN", "SNOW", *"SOAP"*, *"SOFT"*, "SONG", "TALK", "TIME", "TREE", "WALK", *"WANT"*, *"WARM"*, "WASH", "WIND", "WORK", "YEAR"

Nonwords

"WUIL", "RILM", "DENC", *"ZYSE"*, "LODD", "CHIE", "SEFS", *"JAUK"*, "GWIC", "WONE", "PLOK", "DAPT", "RETE", "KLIB", "SIME", "LATT", "SWAZ", "DUFE", "WONS", *"HEWF"*, "MENC", *"ZUNK"*, "COLV", "CLOF", "ABST", *"YOGG"*, "DAUV", "VEUL", "HOAB", "DOYS", "SPIZ", "NARN", *"ZELF"*, "YAIL", "CWEB", "NOGE", *"WONC"*, "DWEK", "ZARC", *"GWUZ"*, *"NALN"*, "HESP", "JALT", "UFTS", "CWUL", "KEPH", "MYDE", "SOTE", "CHUR", "FOMB", "FOSK", "TRUV", "SNUZ", "TASP", "NAUC", "VABB", "ZEAM", *"TUCE"*, "JOSP", "LORT"

Instructions

Experiment 1.

Now is the memory test for the words and nonwords you studied before. You will see a single item at a time; some of these will be from the set you studied in the first part of the experiment (OLD), others will be ones you did not study (NEW). Please work carefully through each item, indicating for each one whether you recognize it from the first part of the study or not. If you recognize an item, please click the OLD button. If you do not recognize it, please click the NEW button.

Additionally, as you make your decision about recognizing each word/ nonword, bear in mind the following: Often, when remembering a previous event or occurrence, we consciously RECOLLECT and become aware of aspects of the previous experience. At other times, we simply KNOW that something has occurred before, but without being able consciously to recollect anything about its occurrence or what we experienced at the time. Thus in addition to your indicating your recognition of a word/ nonword from the original study set, you will be asked to click "R" to show that you recollect the item consciously, or click "K" if you feel you simply know that the item was in the previous study set. So, for each item that you recognize as OLD, please click "R" if you recollect its occurrence, or "K" if you simply know that it was shown in the first part of the experiment.

Experiment 2.

After you decide an item is old, we would like you to tell us how you know that. We are going to give you two choices. One is what we call recollection. To recollect something means you remember seeing it. Perhaps you remember a specific thought or perhaps you remember what came before or after. The key here is that you remember some details about the experience of studying that item. Another way of that you may think an item is old is to know it. Knowing means that you know its old, but can't recall any of the details. But you still know that item was studied. If you are recollecting an item, please hit the "R" button. If you know it is old, hit the "K" button.

After that, further verbal instructions were given by the experimenter who followed a script:

OK, so let's do a few examples. Suppose you are asked about the word FROG, and you happen to remember seeing frog because you thought about Kermit. In this case, you are recollecting and should press "R". Recollection is when you can remember actually seeing the word. But suppose, alternatively, in your gut, you know FROG was there, but can't actually remember seeing the word at study. In this case, press "K". The difference between recollection and knowing is kind of like trying to figure out where you parked your car at the mall. Sometimes you can recall the act of parking including a detail or two like the car next to you or the song on the radio. Other times you just walk back there because you know where to go.

Experiment 3.

After you decide an item is old, we would like you to tell us how sure you are in your decision. If you are very sure it is old, that is you might even bet a lot of money on it,

> *hit the "S" button for sure. If you are not quite this sure, that is, you wouldn't want to bet on it, hit the "U" button for unsure.*

These instructions were supported by the following verbal instructions:

> *OK, so let's do a few examples. Suppose you are asked about the word FROG, and you happen to strongly remember seeing FROG, and you are equally sure it wasn't TOAD or anything like that. Hit "S" for sure, bet on it. But suppose your memory is a bit fuzzier. Maybe there was reptile, maybe toad, maybe not. Then hit "U" for unsure. Don't bet on things you don't know for sure.*

Analysis Code

This paper was written in `R`-Markdown. In `R`-Markdown, the text and the code for analysis may be included in a single document. The document for this paper, with all text and code, can be found at github.com/PerceptionAndCognitionLab/rm-gardiner-java. We used R (Version 3.4.4; R Core Team, 2017) and the R-packages *BayesFactor* (Version 0.9.12.4.2; Morey & Rouder, 2015), *coda* (Version 0.19.1; Plummer, Best, Cowles, & Vines, 2006), *knitr* (Version 1.20; Xie, 2015), *Matrix* (Version 1.2.14; Bates & Maechler, 2016), *papaja* (Version 0.1.0.9709; Aust & Barth, 2017), *plyr* (Version 1.8.4; Wickham, 2011), *reshape2* (Version 1.4.3; Wickham, 2007), *rvest* (Version 0.3.2; Wickham, 2016), *stringr* (Version 1.3.1; Wickham, 2017), and *xml2* (Version 1.2.0; Wickham, Hester, & Ooms, 2017) for all our analyses.