Event-Related Potential Correlates of Interference Effects on Recognition Memory

Kenneth A. Norman, Tim Curran, and Katharine Tepe
Dept. of Psychology, University of Colorado at Boulder

Computational Cognitive Neuroscience Laboratory

poster presented at the 2002 Cognitive Neuroscience Society meeting
questions/comments? email Ken Norman, norman@psych.colorado.edu

Introduction

The effect of list strength on recognition memory has been the subject of intense scrutiny over the past decade:

Is there a COST associated with memory strengthening, whereby strengthening memory for some list items impairs recognition of other (non-strengthened) list items?

Compare:

> study: Apple, Robot, vs.
> study: Apple, Robot, Robot

Does strengthening your memory for Robot hurt recognition of Apple?

A recently developed computational model of recognition memory (the Complementary Learning Systems model; Norman & O'Reilly, under revision) predicts that increasing list strength should impair one process that contributes to recognition (recollection of specific studied details) but not the other (nonspecific feelings of familiarity).

This prediction is consistent with the fact that list strength typically affects recall more than recognition (Ratcliff, Clark, & Shiffrin, 1990).

Norman (under revision) obtained behavioral evidence in support of this prediction. In this study, Norman isolated the contribution of recollection to recognition in several ways (e.g., by using lures at test that were highly similar to studied items). As predicted, there was a significant LSE for measures of recognition sensitivity that isolate the contribution of recollection; in contrast, the LSE was not significant for sensitivity measures that load more heavily on familiarity

Experiment 1

Testing the Model's Prediction with ERP

In the experiment reported here, we set out to test the CLS model's list strength prediction using Event-Related Potentials.

Curran (2000) has isolated what appear to be ERP correlates of familiarity and recollection: the "FN400 old-new effect" and "parietal old-new effect", respectively. The FN400 old-new effect tracks the global similarity of test probes to studied items, but does not discriminate between studied items and similar lures; in contrast, the parietal old-new effect is present for test probes that exactly match studied items, but is not present for similar lures.

If the Complementary Learning Systems (CLS) model is correct, then increasing list strength should reduce the ERP correlate of recollection (the parietal old-new effect), but the ERP correlate of familiarity-based discrimination (the FN400 old-new effect) should be unaffected.

Method

List strength was manipulated by varying the number of times that non-tested "interference" faces were presented at study.

In each study-test block, subjects studied target items (which were later tested) and interference items (which were not tested).

Compare two study conditions:

Weak Interference

Target 1X, Interference 1X

OR

Strong Interference

Target 1X, Interference repeated (6X)

Then:

Test

Target Lure

If recognition is better in the Weak Interference condition, this constitutes a list strength effect.

Event related potentials were recorded at test using a 128-channel Electrical Geodesics sensor net. The primary results are presented with respect to an average reference (see Appendix for mastoid-referenced ERPs)**.**

Other method details:

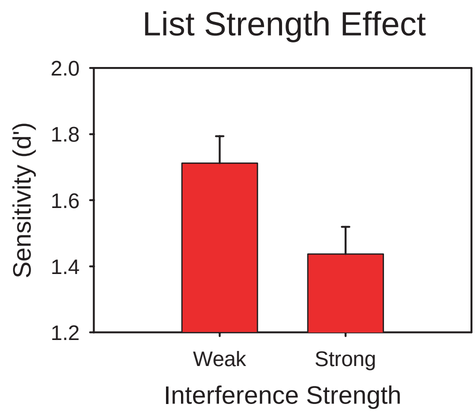
2500 ms per face at study; happy/angry judgment

There were 6 study-test blocks (3 Strong Interference blocks, and 3 Weak Interference blocks); each block used a different category of faces (e.g., women with glasses, bald men) to minimize interference between blocks.

A video game phase was interposed between study and test; the length of this phase was varied to equate the delay between studying and testing target items across conditions.

Results: Overview

In this experiment, the LSE for recognition sensitivity was significant.

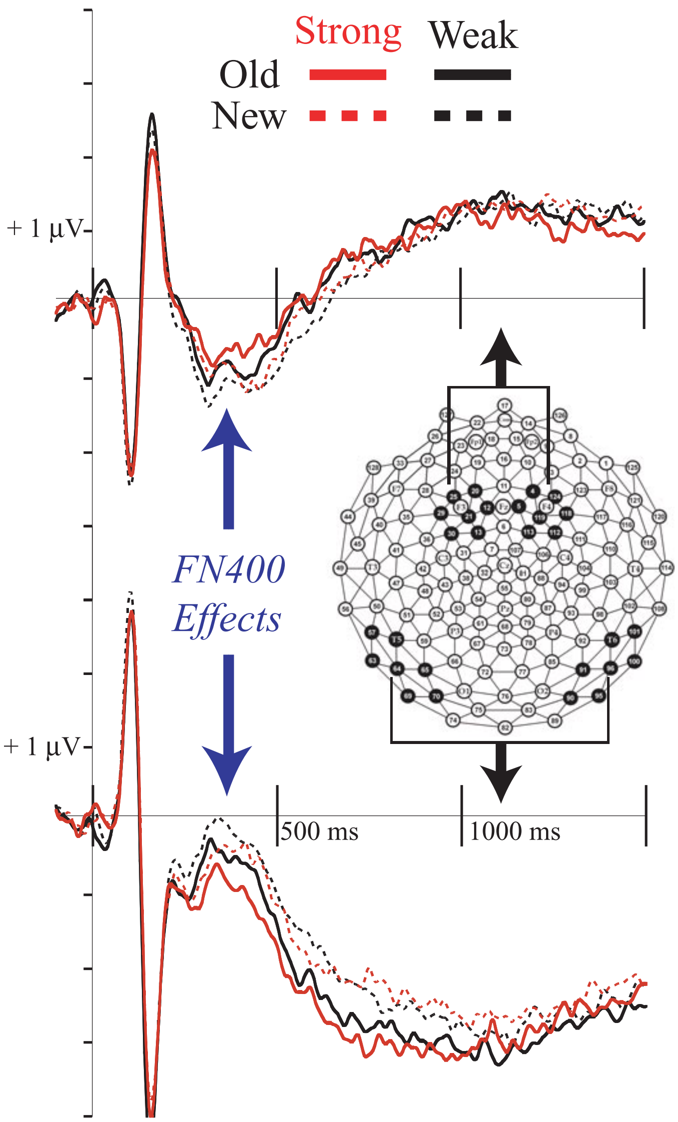


Error bars indicate the standard error of the Weak-Strong *difference* for d'.

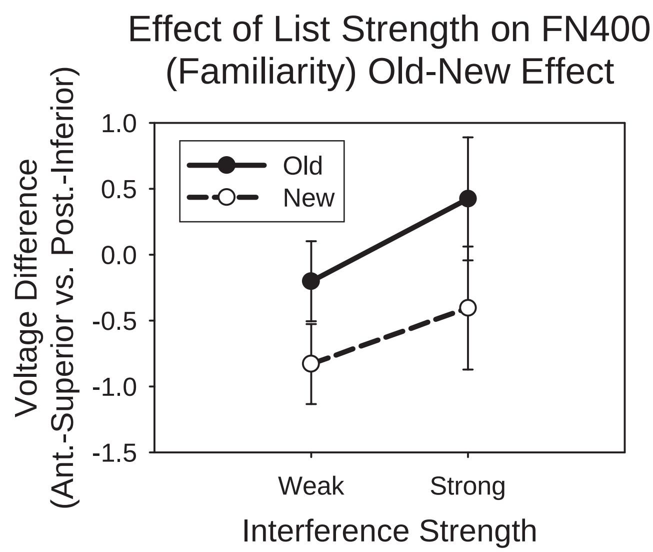
More importantly, the ERP results were exactly as we had predicted: There was a significant LSE for the parietal (recollection) old-new effect, but not for the FN400 (familiarity) old-new effect.

The next two parts of the poster go over the ERP results in detail.

ERP Results: FN400 (Familiarity)



The graph below summarizes how list strength interacts with the FN400 old-new effect. In averaged-reference ERPs, the FN400 old-new effect is observed as opposite polarity differences over the anterior-superior and posterior-inferior regions denoted above. To reduce the FN400 to a single number, we computed the average *difference* in voltage between anterior-superior and posterior-inferior locations across the 300-500ms time window.

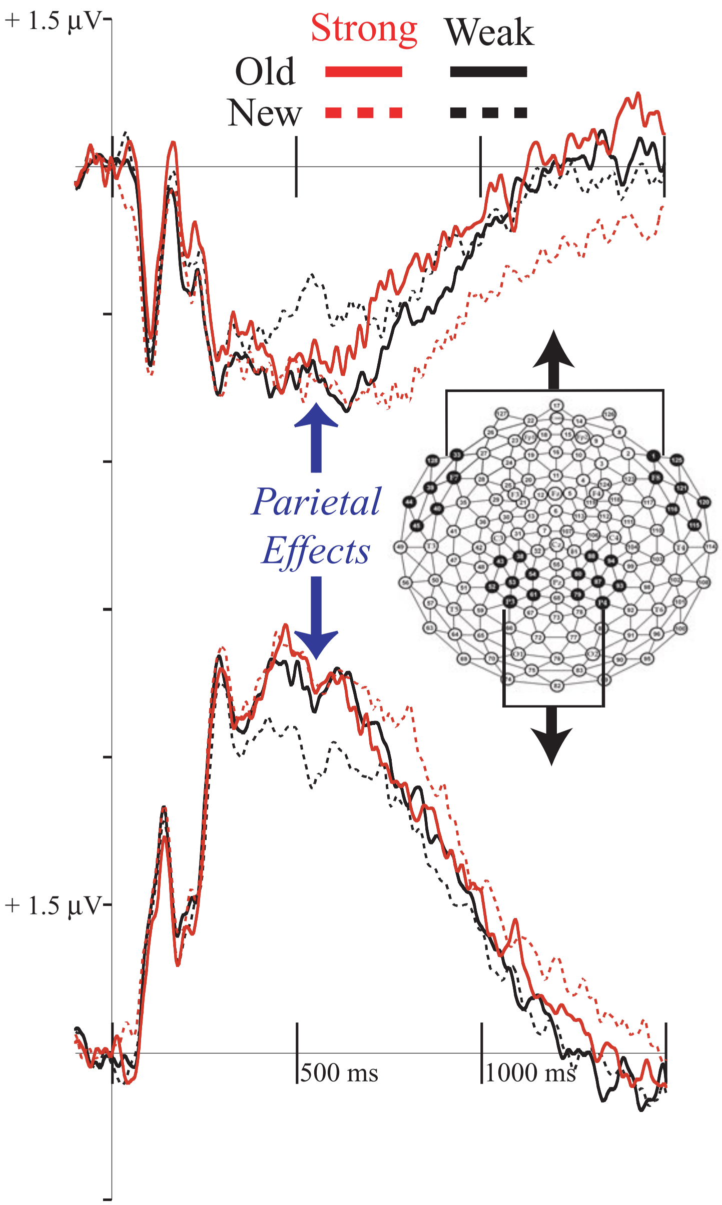


Error bars indicate the standard error of the Old-New difference.

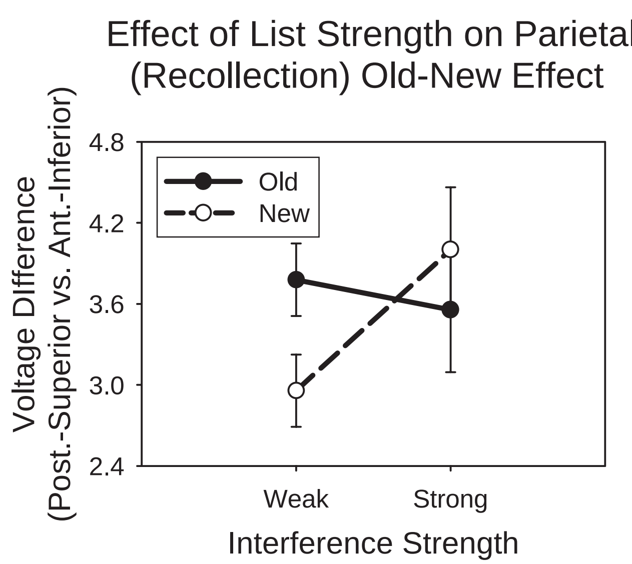
There was a main effect of Interference Strength, whereby the FN400 was larger for both Old and New items in the Strong Interference condition.

However, as predicted, Interference Strength did not interact with Old/New; the FN400 Old-New difference was significant in both conditions, and the size of this difference did not vary as a function of Interference Strength.

ERP Results: Parietal Effect (Recollection)



The graph below summarizes how list strength interacts with the parietal old-new effect. In averaged-reference ERPs, the parietal old-new effect is observed as opposite polarity differences over the posterior-superior and anterior-inferior regions denoted above. To reduce the parietal effect to a single number, we computed the average *difference* in voltage between posterior-superior and anterior-inferior locations across the 400-800ms time window.



Error bars indicate the standard error of the Old-New difference.

As predicted, there was a significant interaction between Old/New and Interference Strength. The parietal Old-New effect was significant in the Weak Interference condition, but not in the Strong Interference condition.

Experiment 2: Subjective-Report Measures of Recollection and Familiarity

We ran a (purely) behavioral experiment to obtain converging evidence for the conclusion that list strength affects recollection but not familiarity.

In this study, whenever subjects called an item "old" at test, we had them say whether they remembered the item (i.e., they recollected specific details) or whether it just seemed familiar.

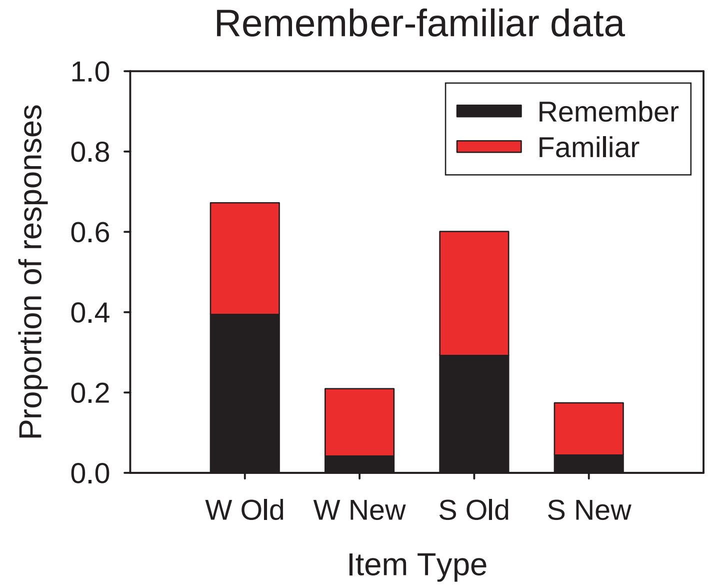
Apart from the use of "remember/familiar" testing, the behavioral paradigm was identical to the paradigm used in the ERP experiment

Following the procedure outlined by Jacoby, Yonelinas, & Jennings (1997), which assumes that recollection and familiarity are independent, we used remember-familiar data to estimate the probability of saying "old" based on recollection vs. familiarity.

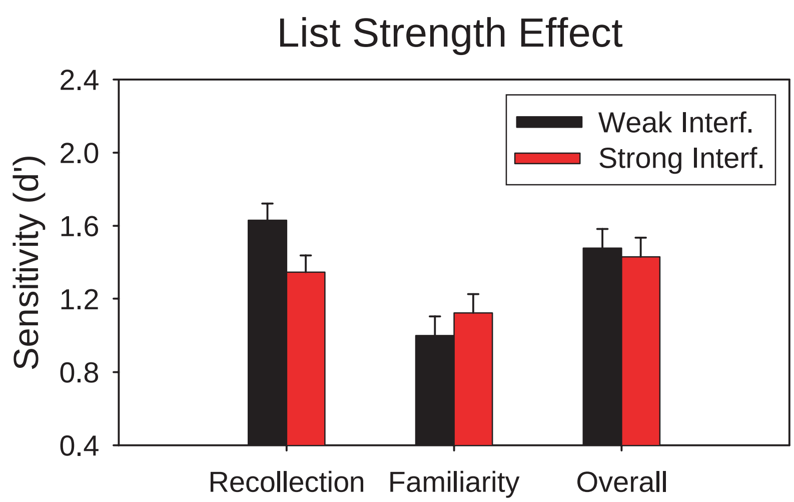
Then, we plugged these "recollection old" and "familiarity old" values into the formula for d' to compute separate estimates of recollection-based sensitivity and familiarity-based sensitivity. Similar results werre obtained when sensitivity was measured with A'.

Prediction: List strength should affect recollection-based sensitivity, but not familiarity-based sensitivity.

The graph below shows the raw data from the remember-familiar experiment (W = Weak Interference, S = Strong Interference):



The next graph shows derived measures of sensitivity for recollection and familiarity, along with overall sensitivity (computed based on whether subjects thought the item was "old" or "new"):



Error bars indicate the standard error of the Weak - Strong Interference difference

As predicted, the LSE for d'(Recollection) was highly significant; the LSE for d'(Familiarity) was numerically negative, and not significant. This is exactly the pattern of results that was obtained in the ERP experiment.

Conclusions

The ERP results and the remember-familiar results, taken together, provide converging evidence in favor of the Complementary Learning Systems model's prediction that list strength affects recollection but not familiarity.

Also, more generally, the fact that the FN400 and parietal effects converged with behavioral measures of familiarity and recollection, and with theoretical predictions regarding these processes, provides support for the claim made by Curran (2000) that the FN400 and parietal ERP effects constitute dissociable indices of familiarity and recollection, respectively.

Finally, these results extend the results of Norman (under revision), who found differential effects of list strength on recollection and familiarity using word stimuli -- the results presented here show that the dissociation also applies when faces are used as stimuli.

We are currently running studies that explore how well the FN400 and parietal effects conform to other predictions of the CLS model (e.g., regarding how list *length* affects recollection and familiarity).

References

Curran, T. (2000). Brain potentials of recollection and familiarity. *Memory & Cognition, 20*, 923-938.

Jacoby, L. L., Yonelinas, A. P., & Jennings, J. M (1997). The relation between conscious and unconscious (automatic) influences: A declaration of independence. In J. D. Cohen & J. W. Schooler (Eds.), *Scientific approaches to consciousness* (pp. 13-47). Mahwah, NJ: Erlbaum.

Norman, K. A. (under revision). Differential effects of list strength on recollection and familiarity. *Journal of Experimental Psychology: Learning, Memory, & Cognition*.

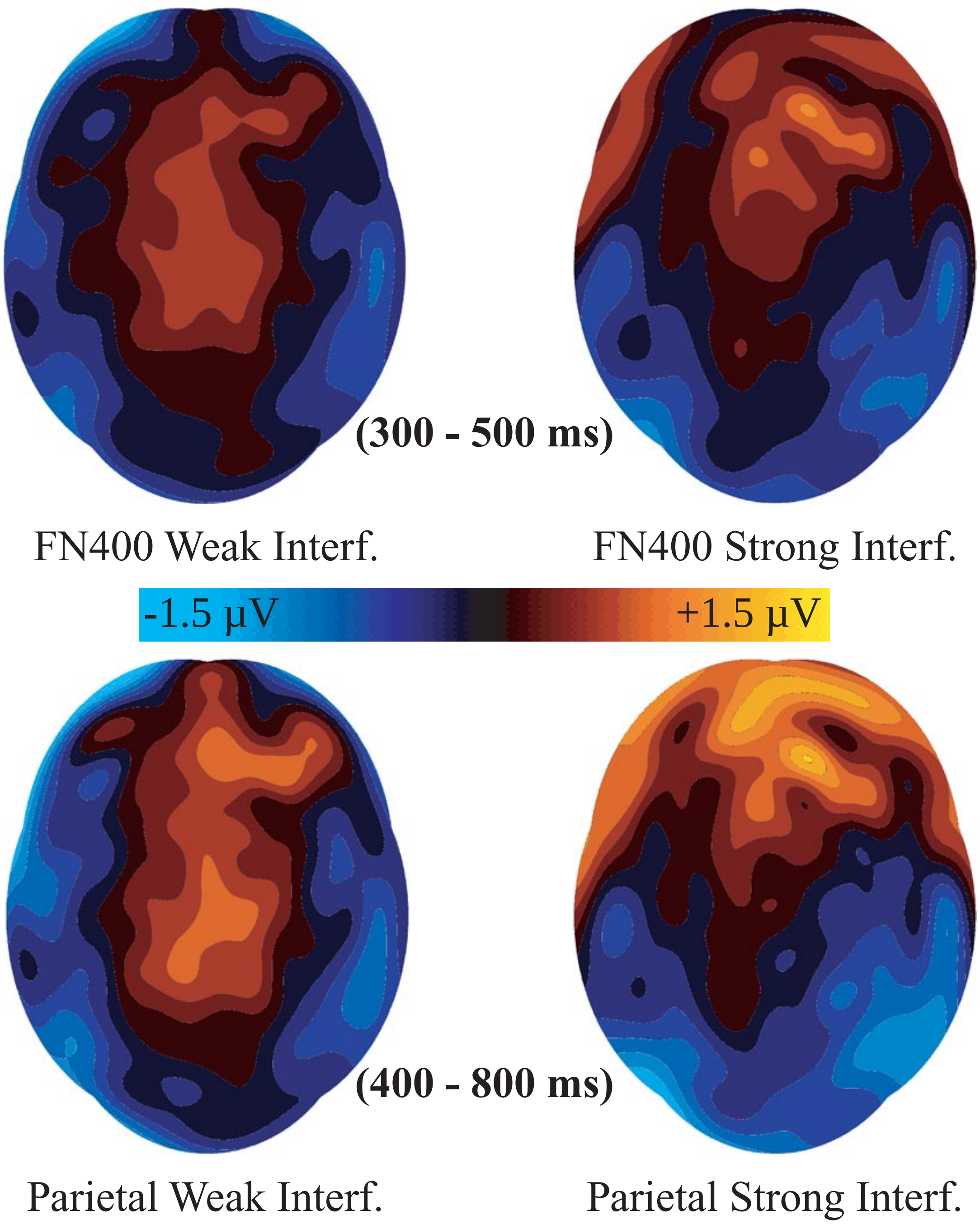
Norman, K. A. & O'Reilly, R. C. (under revision). Modeling hippocampal and neocortical contributions to recognition memory: A complementary learning systems approach. *Psychological Review*.

Ratcliff, R., Clark, S. E., & Shiffrin, R. M. (1990). List strength effect: I. Data and discussion. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 20*, 763-785.

This research was supported by NIH NRSA Postdoctoral Fellowship 1 F32 MH12582-01, awarded to Kenneth A. Norman, NIMH grant MH64812, and a grant from the McDonnell-Pew Foundation Program in Cognitive Neuroscience. We thank Dan Collins, Cathy Anderson, and Carley Piatt for research assistance.

Appendix A

Topography of the ERP Old-New Effects



The figures above show interpolated differences between old and new conditions.

Appendix B

10-20 Plot of Mastoid-Referenced ERPs