Proactive online - age group by interval by distraction

Summary

Here is all of the proactive data we have collected online so far. Each session was made up of two parts:

1. **Learning:** Participants learned 30 image-word associations that were initially presented in study-test blocks of 10 pairs. Each pair was presented for 4 seconds with a .5 second ISI. Following 10 pairs participants were cued to recall words in a random order with each associated image. During this part of the experiment participants were given feedback. The recalled word was presented for .5 seconds in green text if it was correct or red if incorrect. If incorrect, the correct word was then presented with the cue image for restudy for 4 seconds. During the initial phase of learning participants looped through all 30 pairs and if their accuracy across all pairs was under 80% they would loop though the 30 pairs again (3 groups of 10). This continued until the participant got 80% or more correct or 3 loops had been completed (this is referred to as block 1, 2, and 3 in the figure below). Following this there was a final test of learning in which all 30 pairs were cued in a random order.
2. **Working Memory:** There were 16 working memory trials in which participants were presented with 4 to-be-remembered image-word pairs. For 10 of the trials each pair was a different type (presented in random order). Match items were identical to a previously learned pair, mis-match items were a recombination of a previously learned image and word, old-new items presented a learned image with a new word, and for new-new items both image and word had not previously been seen. For 6 of the trials all 4 pairs were new-new. Each pair was presented for 2 seconds with a .5 second ISI. Following a retention interval memory for the 4 pairs was probed by presenting each cue image in a random order. No feedback was given in this part.

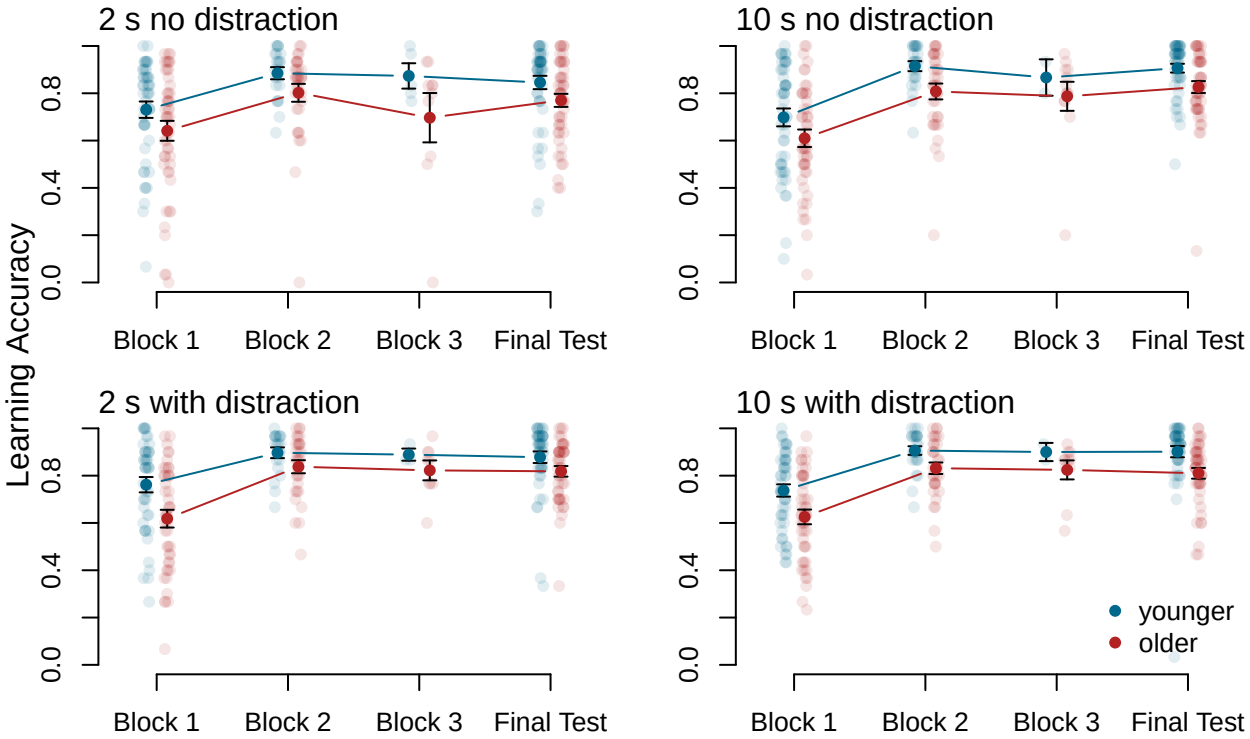
For the working memory task there are 4 conditions that differ in the length of the retention interval between study and test (2 or 10 s) and in the presence or absence of a distracting task (search). In the 2 s interval condition there was one search problem to respond to whereas in the 10 s condition there were four.

Participants

The table below gives the number of participants (who provided complete data sets) in each condition/group and their ages.

interval	distraction	group	N	N_female	M_age	SD_age	min_age	max_age
10 s	no	older	48	26	69.81	4.55	65	83
10 s	no	younger	49	32	24.98	5.26	18	35
10 s	yes	older	47	31	69.79	3.83	65	77
10 s	yes	younger	50	31	24.42	5.06	18	34
2 s	no	older	50	31	68.72	3.68	65	80
2 s	no	younger	49	30	25.51	5.30	18	35
2 s	yes	older	46	27	68.74	4.44	55	82
2 s	yes	younger	47	24	25.77	5.11	18	35

Learning



The figure above shows recall performance during the learning phase of the experiment. Data are presented separately for the different conditions but this phase of the experiment was identical. Any differences are presumably due to allocation of younger/older participants to condition.

Recall accuracy in the final test phase was analyzed with a generalized (logistic) linear mixed effects model (see below).

Table 2: Fixed effects tests (Wald Chi squared) for recall accuracy in the final test of learning.

	Chisq	Df	Pr(>Chisq)
distraction	0.35	1	0.56
interval	5.64	1	0.02
group	39.06	1	0.00
distraction:interval	2.96	1	0.09
distraction:group	0.04	1	0.83
interval:group	1.26	1	0.26
distraction:interval:group	0.02	1	0.90

There is a clear group difference in accuracy, $\chi^2(1) = 39.06$, $p < 0.01$:

```
##     group  acc
## 1   older 0.81
## 2 younger 0.88
```

There is also a difference between the interval conditions in final learning accuracy, $\chi^2(1) = 5.64$, $p < 0.05$, with slightly better performance for participants in the 10 s condition:

```
##   interval  acc
```

```
## 1     10 s 0.86
## 2      2 s 0.83
```

Working Memory

The figure below shows recall accuracy by item type for the four conditions. The results of analysis are presented in the table below.

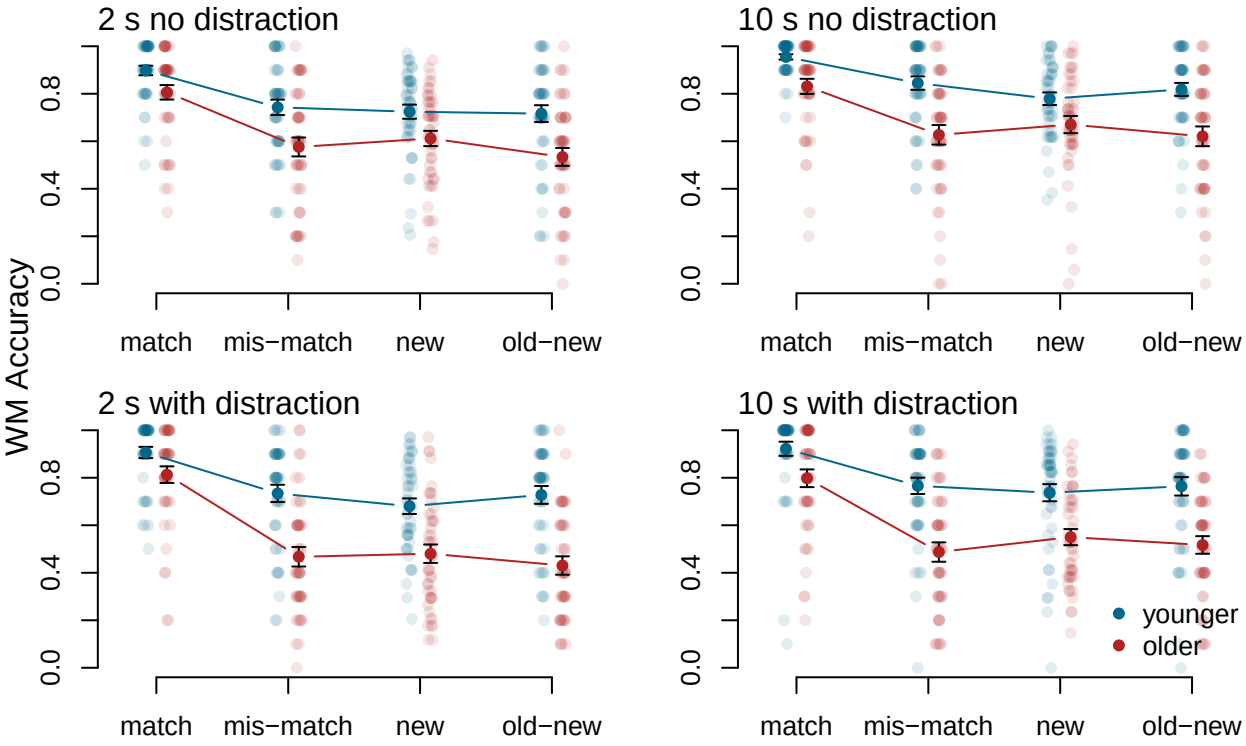


Table 3: Fixed effects tests (Wald Chi squared) for recall accuracy in the working memory task.

	Chisq	Df	Pr(>Chisq)
distraction	14.29	1	0.00
interval	11.36	1	0.00
group	89.54	1	0.00
item_type	401.97	3	0.00
distraction:interval	0.53	1	0.47
distraction:group	2.19	1	0.14
interval:group	0.37	1	0.54
distraction:item_type	10.33	3	0.02
interval:item_type	1.86	3	0.60
group:item_type	37.11	3	0.00
distraction:interval:group	0.22	1	0.64
distraction:interval:item_type	5.11	3	0.16
distraction:group:item_type	1.31	3	0.73
interval:group:item_type	5.95	3	0.11
distraction:interval:group:item_type	1.44	3	0.70

There is an effect of distraction, $\chi^2(1) = 14.29$, $p < 0.01$, with slightly lower performance with the distracting task:

```
##   distraction  acc
## 1          no 0.73
## 2         yes 0.68
```

The effect of interval, $\chi^2(1) = 11.36$, $p < 0.01$, is down to better performance with a 10 s interval vs. 2 s:

```
##   interval  acc
## 1     10 s 0.73
## 2      2 s 0.68
```

The two age groups differ in the expected direction, $\chi^2(1) = 89.54$, $p < 0.01$:

```
##     group  acc
## 1   older 0.61
## 2 younger 0.80
```

For item type, there is a significant main effect, $\chi^2(3) = 401.97$, $p < 0.01$, with the only significant contrast being match vs. others, $b = 1.27$ (SE = 0.07), $z = 19.40$, $p < 0.01$ (new vs. mismatch/old-new: $b = 0.00$ (SE = 0.03), $z = 0.09$, $p = 0.93$; mismatch vs. old-new: $b = 0.04$ (SE = 0.03), $z = 1.52$, $p = 0.13$)

```
##   item_type  acc
## 1     match 0.87
## 2 mis-match 0.66
## 3   new-new 0.66
## 4   old-new 0.64
```

The effect of item type was modified by two interactions; one with distraction and the other with age group. For the item type by distraction interaction, the driver was the contrast of match items vs. the rest, b = -0.12 (SE = 0.05), z = -2.22, $p < 0.05$. The contrasts of new vs. recombined pairs, $b = 0.02$ (SE = 0.02), $z = 0.63$, $p = 0.53$, and mismatch vs. old-new, $b = 0.03$ (SE = 0.03), $z = 1.17$, $p = 0.24$, were both not significant. Means are given below and show that the benefit of match pairs to performance is larger with distraction (or that the effect of distraction was weakest for match pairs):

```
##   item_type distraction  acc
## 1     match          no 0.87
## 2 mis-match          no 0.70
## 3   new-new          no 0.70
## 4   old-new          no 0.67
## 5     match         yes 0.86
## 6 mis-match         yes 0.62
## 7   new-new         yes 0.61
## 8   old-new         yes 0.61
```

For the interaction of age group and item type the driver was the contrast of new pairs with recombined pairs (mismatch/old-new), $b = 0.15$ (SE = 0.03), $z = 5.82$, $p < 0.01$. The match vs. rest, b = -0.06 (SE = 0.06), z = -1.13, $p = 0.26$, and mismatch vs. old-new contrasts, b = -0.01 (SE = 0.03), z = -0.33, $p = 0.74$, were both not significantly moderated by age.

To follow up on this, separate models were fit to the data from younger and older adults. For younger adults the new vs. recombined contrast suggested better performance for mismatch and old-new pairs relative to new, b = -0.15 (SE = 0.04), z = -3.83, $p < 0.01$, whereas for older adults the opposite is the case, $b = 0.15$ (SE = 0.03), $z = 4.46$, $p < 0.01$. This is seen in the pattern of means below:

```
##   item_type   group  acc
## 1     match   older 0.81
## 2 mis-match   older 0.54
## 3   new-new   older 0.58
```

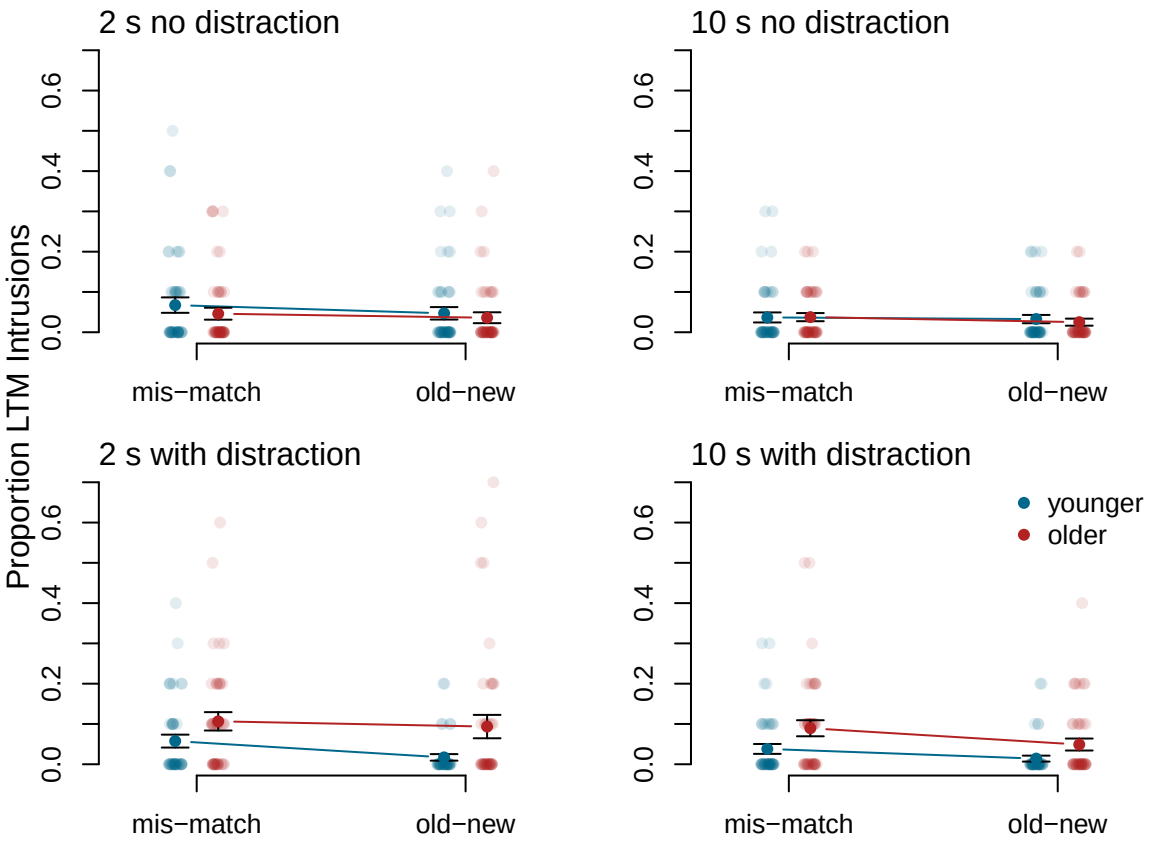
```
## 4   old-new   older 0.53
## 5     match younger 0.92
## 6 mis-match younger 0.77
## 7   new-new younger 0.73
## 8   old-new younger 0.76
```

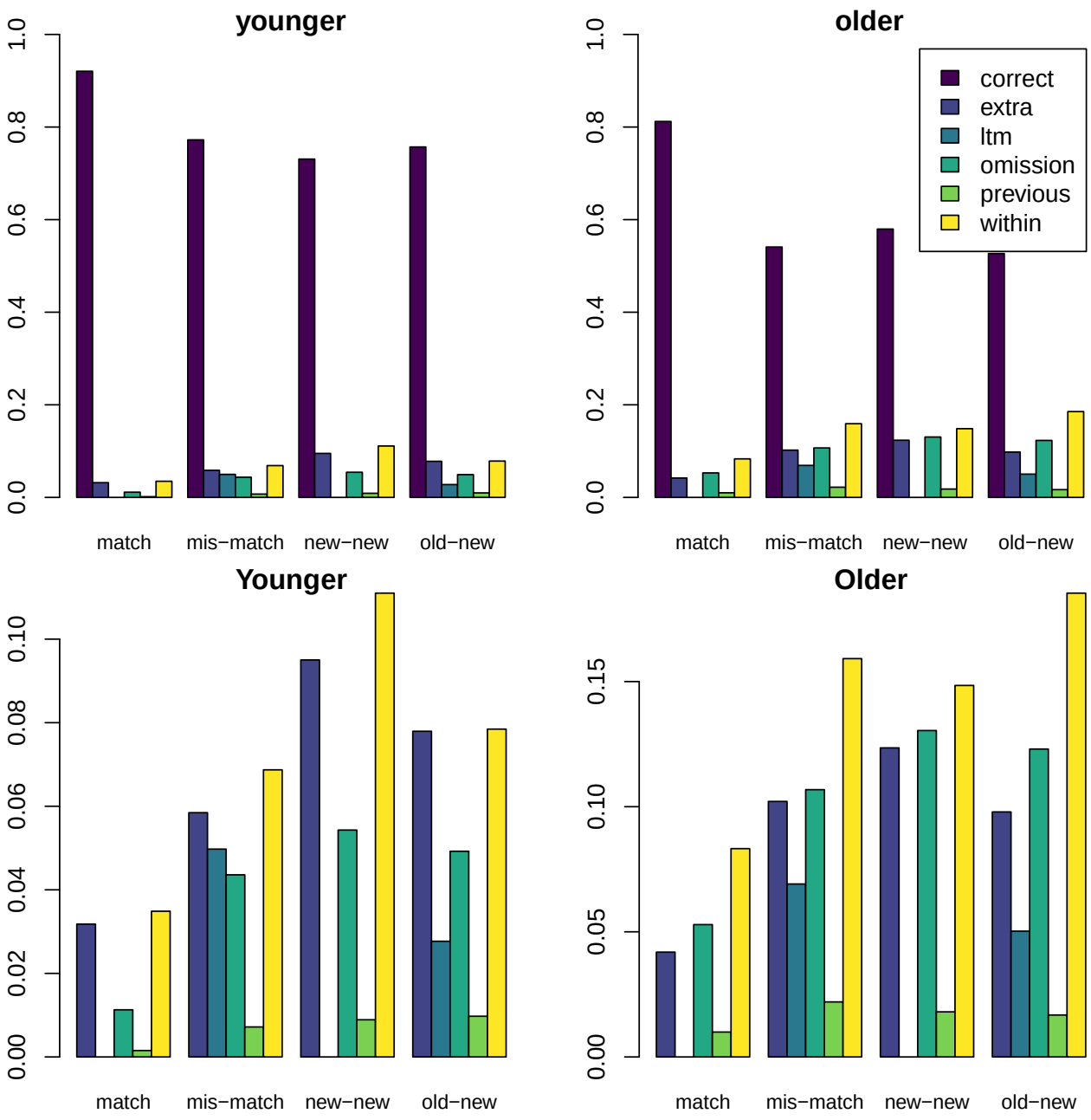
None of the remaining interactions were significant (see table above).

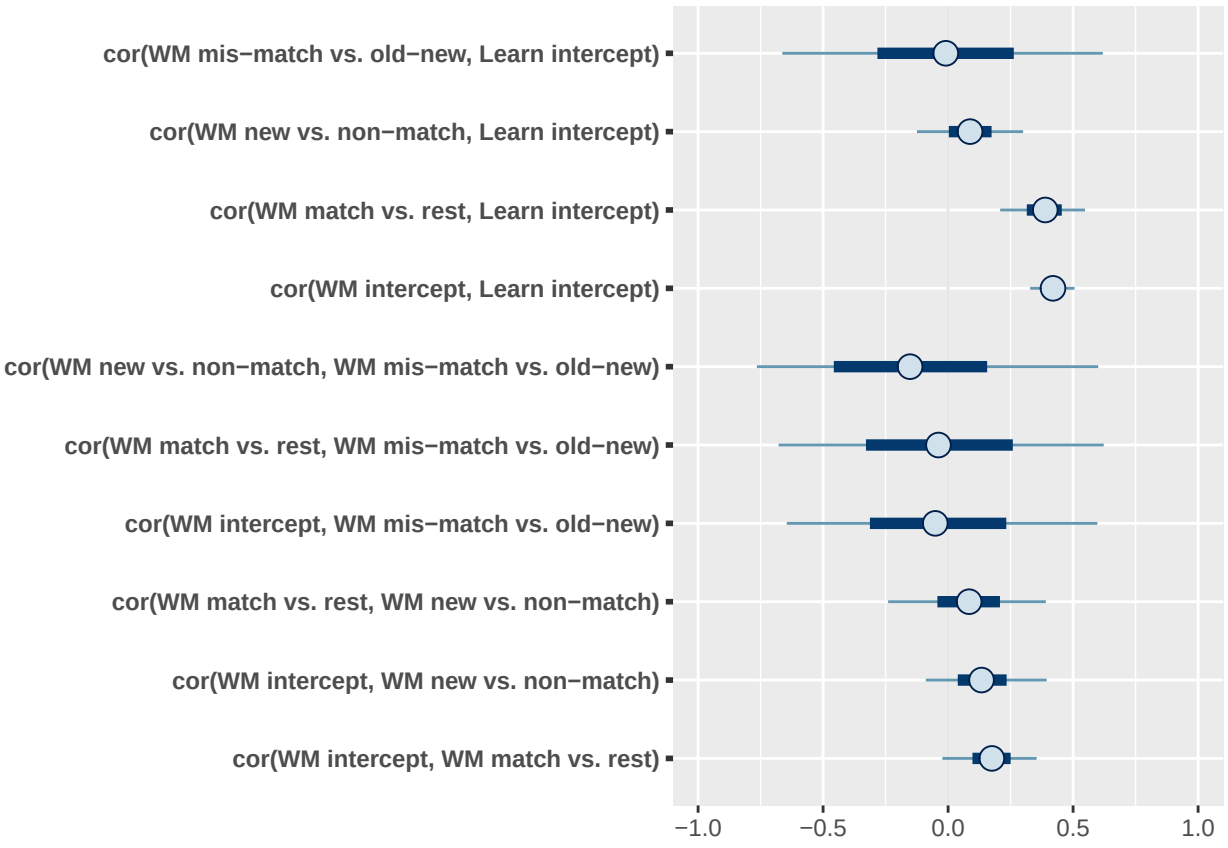
Conclusions

- Older adults show some evidence of PI whereas younger adults perform slightly better when pairs are made up of recombined learned elements (mismatch and old-new pairs) relative to the new pair baseline
- The degree of proactive facilitation (benefit for match pairs) appears to be similar across the two age groups
- The length of the retention interval (2-10 s) and presence of distraction (search) do not appear to influence the magnitude of age differences in PI or PF
- PF is stronger with distraction overall

Additional Analyses




younger
older
Younger
Older
correct
extra
ltm
omission
previous
within
match
mis−match
new−new
old−new
0.0
0.2
0.4
0.6
0.8
1.0
0.00
0.02
0.04
0.06
0.08
0.10
0.05
0.15


cor(WM mis−match vs. old−new, Learn intercept)
cor(WM new vs. non−match, Learn intercept)
cor(WM match vs. rest, Learn intercept)
cor(WM intercept, Learn intercept)
cor(WM new vs. non−match, WM mis−match vs. old−new)
cor(WM match vs. rest, WM mis−match vs. old−new)
cor(WM intercept, WM mis−match vs. old−new)
cor(WM match vs. rest, WM new vs. non−match)
cor(WM intercept, WM new vs. non−match)
cor(WM intercept, WM match vs. rest)
−1.0
−0.5
0.0
0.5
1.0