# ***Supplementary material***

# **Emotional salience enhances the forward flow of memory**

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### **Conditional response probability curves are not modulated upon oddball recall**

We investigated whether CRP curves were modulated depending on whether oddballs were remembered or forgotten. A 4-way RM ANOVA (oddball type [emotional, perceptual] x lag [1-5] x direction [backwards, forwards] x recall [oddball recalled, oddball forgotten]) showed a significant main effect of lag (F(3.24, 220.23)=96.75, p<0.0001) as well as lag x direction (F(3.24, 220.34)=10.20, p<0.0001). Post-hoc uncorrected t-tests showed that contiguity effect was preserved (specially at lags 1 and 2) as well as a forward effect at lags 1 (t(279)=-4.70, p<0.0001) and 5 (t(278)=3.64, p<0.001). Furthermore, we found a significant main effect of recall (F(1,68)=43.33, p<0.0001) which showed overall enhanced CRP curves for lists where oddballs were recalled (Fig. 1). We found no significant main effects of oddball types (F(1, 68)=0.91, p=0.35), direction (F(1, 68)=0.34, p=0.56), oddball x lag (F(4, 272)=1.51, p=0.20), oddball x direction (F(1, 68)=0.55, p=0.46), oddball x recall (F(1, 68)=0.77, p=0.38), lag x recall (F(4,272)=1.09, p=0.36) nor a significant direction x recall (F(1, 68)=1.19, p=0.28).

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| **Figure 1.** CRP curves showed a preserved forward-contiguity effect both when items were recalled as well as forgotten. Lists in which emotional oddballs were recalled showed overall enhanced CRP curves compared to those that were not. |

**Post-hoc t-tests of the interaction direction x transition**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **contrast** | **estimate** | **SE** | **df** | **t.ratio** | **p.value** |
| backwards from - forwards from | -0.036279403 | 0.028031576 | 1049.820776 | -1.294233471 | 0.195869411 |
| backwards from - backwards to | 0.037560747 | 0.028157209 | 1053.217739 | 1.333965538 | 0.195869411 |
| backwards from - forwards to | 0.079507975 | 0.027572509 | 1058.026186 | 2.883595893 | 0.012033784 |
| forwards from - backwards to | 0.07384015 | 0.028109069 | 1058.608544 | 2.62691557 | 0.017481512 |
| forwards from - forwards to | 0.115787378 | 0.027518138 | 1052.642163 | 4.20767492 | 0.000168002 |
| backwards to - forwards to | 0.041947228 | 0.027643853 | 1048.828672 | 1.517416075 | 0.194194514 |

**Table 1.** Post-hoc t-tests, fdr corrected as a follow-up for the significant interaction direction x transition.

**Post-hoc t-tests of the interaction direction x transition x SOA**

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| --- | --- | --- | --- | --- | --- |
| **contrast** | **estimate** | **SE** | **df** | **t.ratio** | **p.value** |
| backwards from 1 - forwards to 3 | 0.179131155 | 0.063728988 | 1062.979203 | 2.810826919 | 0.041570319 |
| backwards from 1 - forwards to 4 | 0.271866049 | 0.063139153 | 1057.750285 | 4.305823491 | 0.001151527 |
| backwards from 1 - forwards to 6 | 0.254999211 | 0.063729191 | 1062.979203 | 4.001293706 | 0.002263827 |
| forwards from 1 - forwards to 4 | 0.19591487 | 0.062714983 | 1058.456546 | 3.123892602 | 0.019351179 |
| forwards from 1 - forwards to 6 | 0.179048032 | 0.063305157 | 1060.025731 | 2.828332474 | 0.041171867 |
| forwards to 1 - forwards to 2 | 0.204428897 | 0.065254443 | 1066.371936 | 3.132796588 | 0.019351179 |
| forwards to 1 - backwards to 3 | 0.213416087 | 0.065488416 | 1063.876302 | 3.258837242 | 0.014618738 |
| forwards to 1 - forwards to 3 | 0.218111071 | 0.064165643 | 1062.325344 | 3.399187787 | 0.010244852 |
| forwards to 1 - forwards to 4 | 0.310845964 | 0.063585514 | 1060.706554 | 4.8886286 | 0.000222718 |
| forwards to 1 - backwards to 6 | 0.185486649 | 0.065025387 | 1066.984048 | 2.85252665 | 0.039999979 |
| forwards to 1 - forwards to 6 | 0.293979126 | 0.064168035 | 1064.123062 | 4.581395148 | 0.000490672 |
| backwards from 2 - forwards to 4 | 0.163287337 | 0.059809367 | 1051.558563 | 2.730129819 | 0.048919041 |
| forwards from 2 - forwards to 4 | 0.245893084 | 0.060463343 | 1053.69159 | 4.066812568 | 0.002263827 |
| forwards from 2 - forwards to 6 | 0.229026246 | 0.061070767 | 1051.40056 | 3.750178005 | 0.004425759 |
| backwards to 2 - forwards to 4 | 0.192708242 | 0.058622787 | 1047.382574 | 3.2872583 | 0.014186059 |
| backwards to 2 - forwards to 6 | 0.175841405 | 0.059252423 | 1048.670585 | 2.96766606 | 0.029153883 |
| forwards from 3 - forwards to 4 | 0.205710853 | 0.058081658 | 1045.341326 | 3.541752437 | 0.0071683 |
| forwards from 3 - forwards to 6 | 0.188844015 | 0.058716988 | 1046.58005 | 3.216173392 | 0.015899736 |
| backwards from 4 - forwards to 4 | 0.200640399 | 0.058906221 | 1048.415018 | 3.406098647 | 0.010244852 |
| backwards from 4 - forwards to 6 | 0.183773562 | 0.059533581 | 1051.558563 | 3.086889094 | 0.020755832 |
| forwards from 4 - forwards to 4 | 0.231840796 | 0.058621753 | 1045.546961 | 3.954859468 | 0.002263827 |
| forwards from 4 - forwards to 6 | 0.214973958 | 0.05925203 | 1048.670585 | 3.628128171 | 0.005971186 |
| backwards to 4 - forwards to 4 | 0.155929338 | 0.056857339 | 1038.547535 | 2.742466322 | 0.048919041 |
| forwards to 4 - forwards from 6 | -0.226442051 | 0.057326993 | 1042.33947 | -3.950007468 | 0.002263827 |
| forwards from 6 - forwards to 6 | 0.209575213 | 0.057967475 | 1039.756407 | 3.615393159 | 0.005971186 |

**Table 2.** Post-hoc t-tests, fdr corrected as a follow-up for the significant interaction direction x transition x SOA. Only significant post-hoc comparisons are reported.

## **Emotional and perceptual oddballs are remembered late during free recall**

Following predictions from the eCMR model, we expected oddball recall to occur early in recall order which was not the case. To further investigate whether the oddballs were recalled early-on we calculated the relative recall position of the oddballs to all the words recalled in each list across all trials in which the oddball was recalled. If, say, an item was recalled on the 6th position out of a total of 6 items recalled, this would translate to a relative recall position of 1, whereas an item recalled on the 1st position, would have a relative recall of 0.167. Contrary to prediction, both emotional and perceptual oddballs were remembered later on in recall; at a relative recall position of approximately 0.6 [emotional oddballs (0.65); perceptual oddballs (0.59)]. An unpaired Wilcoxon rank sum test showed that emotional oddballs were recalled significantly later than perceptual oddballs (W=395538; p<0.001).

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| **Figure 2.** Oddballs are recalled late in serial recall order. Bars show mean 95%  confidence intervals. Emotional items were recalled slightly later than perceptual  oddballs (p<0.001). |

**Items preceding and following emotional and perceptual oddballs are less well-remembered than the oddballs**

We next tested overall recall of the oddballs and the items nearby to determine whether the previously-reported retrograde (Strange et al., 2003) amnesic effects in the words near the oddball were present in the current Spanish version of the task. We found an overall mnemonic enhancement of both emotional and perceptual oddballs accompanied with an anterograde and retrograde amnesia for items preceding and following the oddballs at encoding, although less pronounced than the effects observed for the English and German versions of this task (Strange et al., 2003). Item recall was normalized with respect to a pre-selected control noun within the list. Normalized recall, therefore, was calculated by subtracting the proportion of recalled control items to the proportion of recalled items of interest separately for emotional and perceptual lists for each subject.

A repeated measures two-way ANOVA (word position [odd-2, odd-1, odd, odd+1] x oddball type [emotional, perceptual]) showed a significant interaction between the two factors (F(3, 207)=3.61, p=0.01), a significant main effect of word position (F(3,207)=55.19, p<0.001) and a trend towards significance in oddball type (F(1, 69)=3.44, p=0.07). Post-hoc t-tests showed a significant enhancement in oddball recall compared to its nearby items (vs. odd-1 t(139)=-10.75, p<0.001, *Cohen’s d*=- 0.91; vs. odd-2 t(139)=-9.5, p<0.001, *Cohen’s d*= -0.80; vs. odd+1 t(139)=10.41, p<0.001, *Cohen’s d*=0.88). Furthermore, emotional oddballs were significantly better recalled than perceptual oddballs (t(69)=3.93, p<0.001, *Cohen’s d*=0.47) (Fig. 3).

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| **Figure 3.** Oddballs were better recalled than their surrounding items. The proportion of normalized recalled words (minus control) items across word positions i.e -2 (item presented two serial positions preceding the oddball at encoding), -1 (item presented one serial position preceding the oddball at encoding), +1 (item presented one serial position after the oddball at encoding) was lower than for oddballs (odd). Bars show mean ± 95% confidence intervals. |

### **Enhanced forward-contiguity transitions from emotional oddballs does not account for reduced memory for E-1 items**

We correlated E-1 normalized recall values with lag +1 transitions from emotional oddballs to evaluate whether enhanced transitions from emotional oddballs explained reduced memory for E-1 items, however this did not seem to be the case (Spearman’s rho=-0.04, p=0.76).

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| **Figure 4.** Spearman’s correlation between normalized recall values of E-1 items and CRP values at lag +1 in transitions from emotional oddballs. |