

## **Supplementary Materials**

### **Supplementary Experiment: Subsequent effects of orthographic experience?**

In a subset of the participants from Experiment 1, we tested whether influences of orthography on the mental timeline persist beyond the experience of reading in one direction or the other. This experiment consisted of a training phase followed by a test phase. In the training phase participants completed either the Standard orthography or the Mirror-reversed orthography version of Experiment 1. The test phase consisted in a test for space-time congruity effects with auditorily presented stimuli. Materials used for the training phase were the same as in Experiment 1 while stimuli, apparatus and procedure of the test phase are described below.

### **Methods**

**Participants.** Native Dutch speakers ( $N=44$ ) from the Radboud University community performed the experiment for payment. Half of the participants had performed the Standard orthography version of the main experiment ( $n=22$ ; hence “Standard-Trained participants”), and the other half had performed the Mirror-reversed orthography version of the main experiment ( $n=22$ ; hence “Mirror-Trained participants”).

### **Materials**

**Stimuli.** We selected 52 celebrities, half of whom became popular after 1990 (e.g., Barack Obama, Lady Gaga), and the other half of whom became famous before 1980 (e.g., Charlie Chaplin, Marilyn Monroe; see Supplementary Appendix). The name of

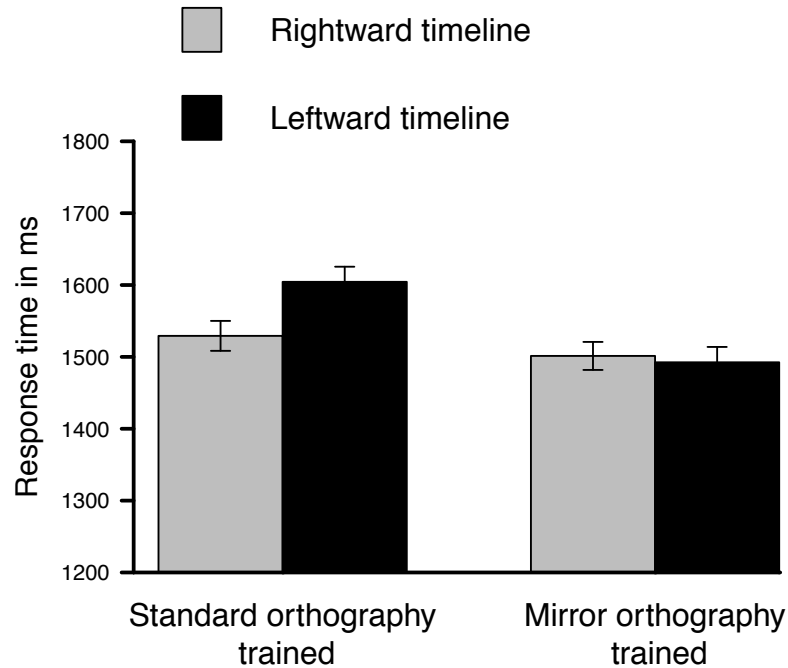
each celebrity was recorded as a sound file in a soundproof room by Dutch native-speaker, who also recorded the instructions.

**Apparatus.** Participants were seated at a desk. A laptop computer was placed in the middle of the desk, with the screen approximately 50 cm from the participant. The screen remained black for the duration of the experiment. All instructions and stimuli were presented auditorily from the laptop's built-in speakers, located symmetrically on the left and right of the screen.

### **Procedure**

The procedure was adapted from Experiment 1 of Weger and Pratt (2008). Instructions were presented auditorily. Each of the 52 names (4 practice items and 48 target items) was presented twice, once in each of 2 blocks, for a total of 104 trials. After hearing each name participants indicated whether the celebrity became popular before or after they (the participants) were born by pressing either the “C” key (on the left of the keyboard) using the left index finger or the “M” key (on the right of the keyboard) using the right index finger. The “C” key indicated an “old” (pre-1980) celebrity and the “M” key a “new” (post-1990) celebrity for one block of trials, consistent with the rightward flow of events along the timeline. The key mapping was reversed for the other block of trials, consistent with the leftward flow of events. The order of blocks was counterbalanced across participants. After each response there was an inter-trial interval that varied randomly between 300-450 ms in 50 ms increments, followed by the next stimulus.

A space-time congruity effect was computed for each subject by comparing response times during button presses that were Congruent and Incongruent with the canonical rightward timeline. Testing lasted about 10 minutes.



*Figure S1.* Participants who had been exposed to Standard Dutch orthography responded faster when key mapping was consistent with the rightward timeline than when it was reversed (left columns). There was no significant congruity effect in participants who had been exposed previously to mirror-reversed orthography (right columns), who showed a trend in the opposite direction from the Standard-trained participants. Error bars indicate s.e.m.

## Results and Discussion

RTs were analyzed using linear mixed-effects regressions fit by maximum likelihood in R (R Core Team, 2012) with the `lmer()` function in the `lme4` library (Baayen, Davidson,

& Bates, 2008). Random intercepts were included for Subjects and Items. All categorical predictors (Congruity, Orthography and Block) were entered using deviation coding. P-values and 95% Highest Posterior Density intervals (HPD) of the parameter estimates were estimated using Markov chain Monte Carlo (MCMC) sampling with 10,000 samples using the `pvals.fnc()` function in the `languageR` library.

RTs were analyzed only for accurate responses. This resulted in the removal of 12% of the data, overall. Response times greater than 2.5 SD from the average were also excluded, which resulted in the removal of 3% of the accurate trials.

There was a highly significant space-time congruity effect in the Standard-Trained participants, who showed a 75-millisecond advantage for button presses consistent with the rightward-directed timeline (i.e., left button for Old celebrities, right button for New celebrities:  $p_{\text{MCMC}} = .0002$ , fig. S1, left columns; table S1). By contrast, Mirror-Trained participants showed a trend in the opposite direction: a 9-millisecond advantage for button presses consistent with the leftward-directed timeline ( $p_{\text{MCMC}} = .50$ ; fig. 1, right columns). Most importantly, there was an interaction of Congruity (Congruent with the rightward timeline, Incongruent with the rightward timeline) with Training (Standard training, Mirror training;  $p_{\text{MCMC}} = .03$ ), indicating a significant effect of exposure to mirror-orthography on participants' subsequent spatial representations of time. An effect of exposure to a new orthography extended beyond the training episode, suggesting that reading experience influenced associations between space and time in memory.

Table S1.

*Results of supplementary experiment. The parameter estimate (Estimate) and standardized parameter estimate (Beta) provide measures of effect size appropriate for the linear mixed regression model. For comparison with previous studies, we also report measures of effect size from an ANOVA by subjects (Ss  $\eta^2_p$ ) and an ANOVA by items (It  $\eta^2_p$ ).*

Fixed Effect	Estimate	HPD	pMCMC	Beta	Ss $\eta^2_p$	It $\eta^2_p$
Congruity (Regular Training)	78	39, 112	.0002***	.08	.04	.32
Congruity (Mirror Training)	13	-25, 49	.50	.01	.009	.06
Congruity $\times$ Ortho	64	11, 115	.01*	.03	.004	.17

### Supplementary References

- Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, 59(4), 390–412. doi:10.1016/j.jml.2007.12.005
- R Core Team. (2012). R: A language and environment for statistical computing [Computer software manual]. Vienna, Austria. Available from <http://www.R-project.org/>
- Weger, U. W., & Pratt, J. (2008). Time flies like an arrow: Space-time compatibility effects suggest the use of a mental time-line. *Psychonomic Bulletin & Review*, 15(2), 426-430. doi: 10.3758/PBR.15.2.426

## Supplementary Appendix

List of celebrities' names used in the test phase.

Popular Before 1980	Popular after 1990
Albert Einstein	Alicia Keys
Alfred Hitchcock	Angela Merkel
Audrey Hepburn	Angelina Jolie
Barbara Streisand	Barack Obama
Bob Dylan	Ben Affleck
Brigitte Bardot	Britney Spears
Charlie Chaplin	Cameron Diaz
Che Guevara	Charlize Theron
Elizabeth Taylor	Cristina Aguilera
Elvis	David Beckham
Frank Sinatra	Eminem
Fred Astaire	Jessica Alba
Grace Kelly	Jim Carrey
Greta Garbo	Jude Law
Jackie Kennedy	Keanu Reeves
Jane Fonda	Kate Moss
Jim Morrison	Kate Winslet
John Lennon	Lady Gaga
Marlene Dietrich	Matt Damon
Marlon Brando	Michael Bublé
Mohammed Ali	Orlando Bloom
Pablo Picasso	Paris Hilton
Rita Hayworth	Penelope Cruz
Sofia Loren	Ricky Martin
Virginia Woolf	Robbie Williams
Yoko Ono	Tiger Woods