

Evidence for distinct genetic and environmental influences on fear acquisition and extinction

Article (Supplemental Material)

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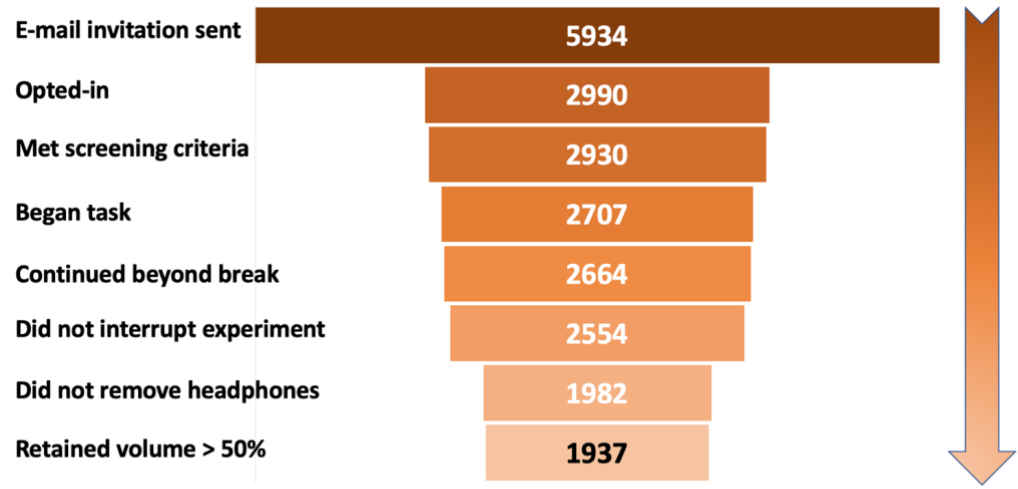
Online supplementary material for manuscript:

Evidence for distinct genetic and environmental influences on fear acquisition and extinction

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Supplementary figures and tables

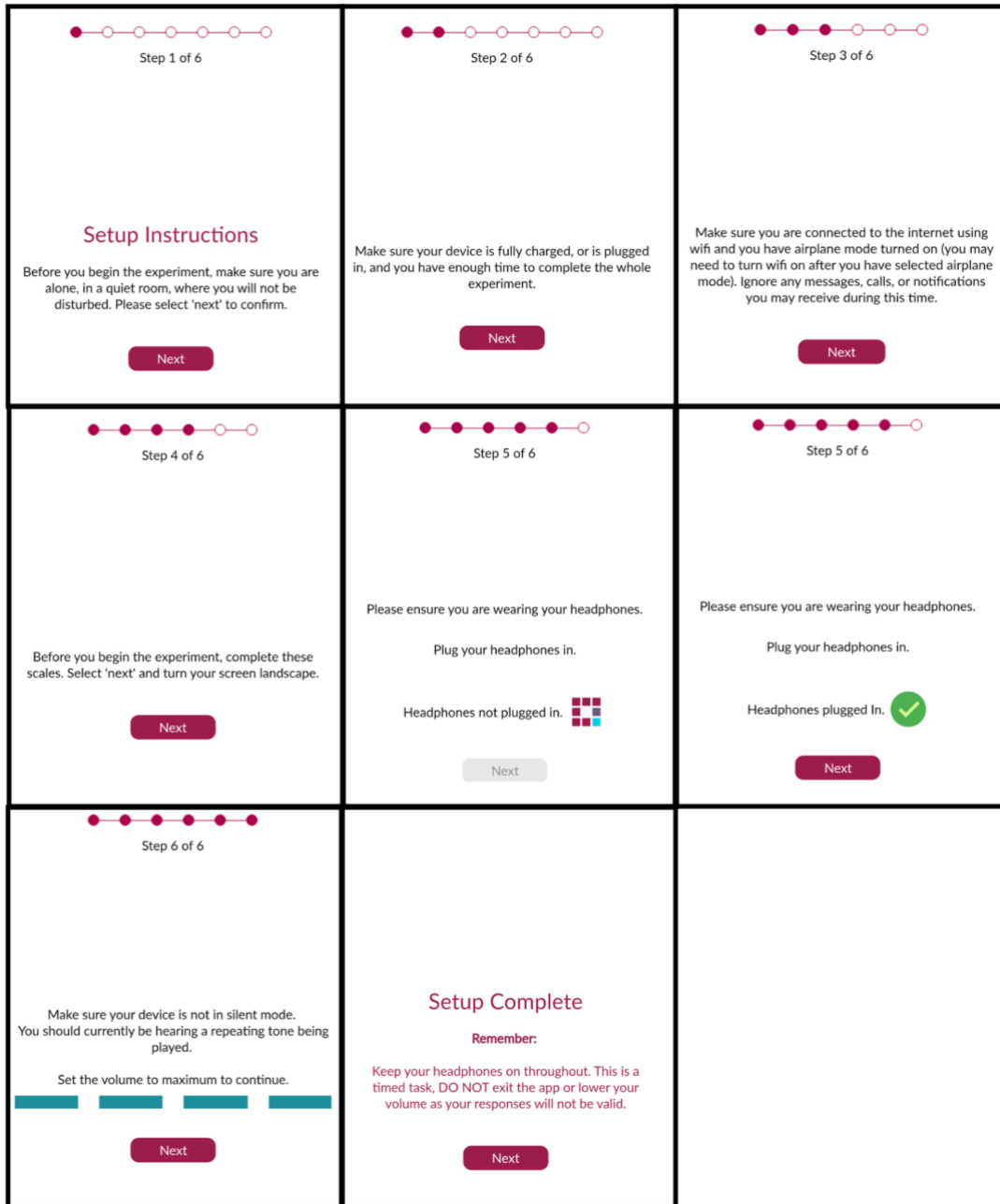
Supplementary figure 1. Number of participants invited and successfully completing the experiment



Sample retained for analyses 1937

The figure shows the sample size from recruitment to final analyses. 'Opting-in' to the study involved downloading and completing informed consent procedures. 'Continued beyond break' indicates that participants returned after the ten-minute break between acquisition and extinction. 'Did not interrupt the experiment' indicates that the participants did not exit or close the app during the task. 'Did not remove headphones' indicates that they did not report removing their headphones during the task. 'Retained volume > 50%' refers to the phone volume during the task in the fear acquisition phase.

Supplementary figure 2. Pre-task and setup instructions



Screenshots of the initial pre-task set-up instructions for the Fear Learning and Anxiety Response (FLARe) app in the order which they are seen by participants. Participants navigate by clicking the buttons labelled 'next' at the bottom of the screen. Where a button is grey, participants are unable to click it to proceed to the next screen. This indicates that some action is required by the participant in order to progress. These screens are seen after consent and screening procedures, but before the task begins.

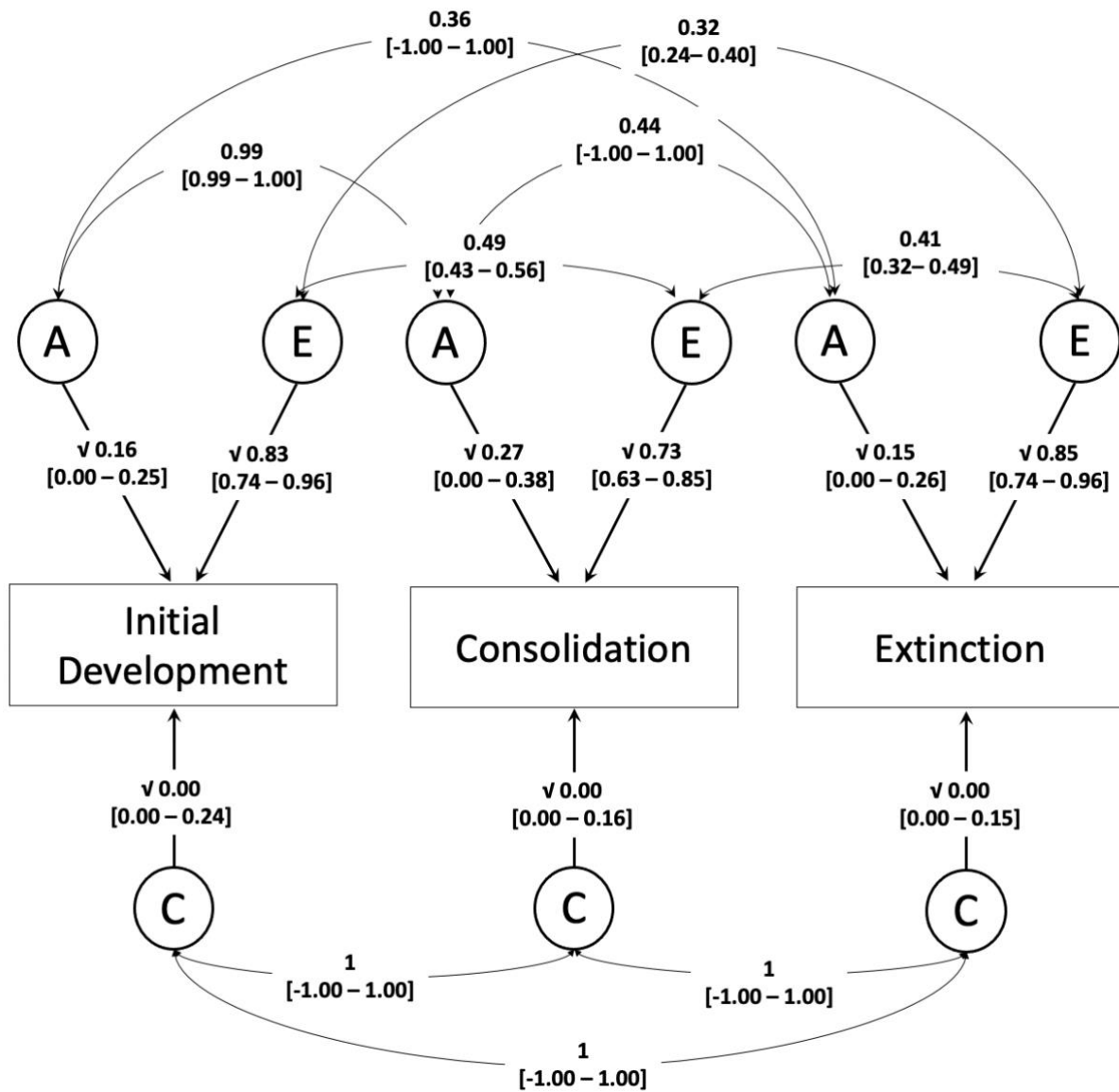
Supplementary figure 3. Fear conditioning task instructions

The figure consists of six panels arranged in a 2x3 grid, each representing a step in the task instructions. Each panel has a progress indicator at the top showing four circles, with the current step highlighted.

- Step 1 of 4:** Titled "Task Instructions". It explains that participants will see circles and sometimes hear a scream. The goal is to learn which circles are followed by a scream. A "Next" button is at the bottom.
- Step 2 of 4:** Explains that a scale will appear at the bottom of the screen. It shows a scale from 1 to 9. Instructions state that participants should press the number they expect to hear a scream. A "Note" says the scale disappears after a few seconds. A "Next" button is at the bottom.
- Step 3 of 4:** Asks participants to practice making a rating. It shows the same 1-9 scale with the number 5 highlighted. Labels below the scale indicate "Certain no scream" at 1, "Uncertain" at 5, and "Certain scream" at 9. A "Next" button is at the bottom.
- Step 4 of 4:** Shows a large black cross on a white background. It instructs participants to keep looking at the cross and wait for the next circle. A "Next" button is at the bottom.
- Instructions Complete:** States "The experiment will now begin." and "You may occasionally hear a scream." It reminds participants to rate how much they expect to hear a scream. A "Start" button is at the bottom.

Screenshots of the task instructions as they appear during participation in the Fear Learning and Anxiety Response (FLARe) app. Screens are shown in the order which they appear. Participants navigate by clicking the buttons labelled 'next' at the bottom of the screen. Screens commenced immediately after the initial set-up was completed, and the fear conditioning task began after the final screen.

Supplementary figure 4. Trivariate correlated factors model showing genetic and environmental influences on the initial development, consolidation and extinction of fear conditioning (full ACE model)



Supplementary table 1. Demographic and sample characteristics

	Monozygotic twins	Dizygotic twins	Whole sample
Total sample size (n complete pairs)	791 (250)	1145 (288)	1937 (538)
n female (%)	559 (71%)	766 (67%)	1325 (68%)
Mean age [range]	23.70 [22.20 – 25.17]	23.51 [22.20 – 25.20]	23.67 [22.20 – 25.17]
Self-reported diagnosis of an anxiety disorder (%)	149 (19%)	206 (18%)	355 (18%)
Self-reported diagnosis of a depressive disorder (%)	122 (15%)	175 (15%)	297 (15%)

Table shows the total number of complete twin pairs and singletons included in the study by zygosity. Mean age, proportion of the sample that are female and proportion of the sample with self-reported diagnoses of any depressive disorder (major depressive disorder or post-natal depression) and any anxiety disorder (generalised anxiety disorder, social anxiety disorder, specific phobia, panic disorder or agoraphobia) are presented for each group.

Note that no participants self-report a diagnosis of Obsessional-Compulsive Disorders or Post traumatic Stress Disorder. None of the differences between monozygotic and dizygotic twin pairs were statistically different.

Supplementary table 2. Goodness of fit statistics for the trivariate twin analysis of all variables

Model	Description	Sources of variance	Model fit			Difference in fit		
			χ^2	df	AIC	$\Delta\chi^2$	Δdf	p
ACE	Full model	$A^1C^1E^1 - A^2C^2E^2 - A^3C^3E^3$	21194.26	5898	9398.26			
AE	Constrain C to zero	$A^1E^1 - A^2E^2 - A^3E^3$	21194.26	5904	9386.26	0.004	6	1.00

Table showing the goodness of fit statistics for the trivariate twin analyses of all variables. A, Additive genetic effects; C, Shared environment effects; E, non-shared environment effects. χ^2 , chi-squared likelihood ratio test; df, degrees of freedom; AIC, Akaike's Information Criterion; $\Delta\chi^2$, difference in chi-squared likelihood ratio between models; Δdf , difference in degrees of freedom between models; p, significance test for the $\Delta\chi^2$. $p < 0.05$ would indicate a significantly worse fit of the model.

Supplementary text

Trial presentation rules

During the fear conditioning acquisition trials, the following rules for trial order applied: The first two trials were a CS+ and CS- (order randomised across participants), the first CS+ was always paired with the aversive US and there were no more than two consecutive trials with the same CS. Between trials, an intertrial interval of a random duration of 2, 2.5 or 3 seconds occurred, during which a black cross was shown on a white screen. During extinction, The first two trials were a CS+ and CS- (order randomised across participants) and there were no more than two consecutive trials with the same CS.