Preventing family transmission of anxiety: feasibility RCT of a brief intervention for parents

Article (Supplemental Material)

Supplementary information for:

Preventing Family Transmission of Anxiety: Feasibility RCT of a Brief Intervention for Parents.

Statistical models

Parent report SCAS and Parent report FSSC

The model fit to each outcome measure was a hierarchical growth model in which anxiety over time was nested within families. Time was expressed in months from baseline (i.e. 0, 3 or 12). A growth model was fit that summarized the trajectory of child anxiety over time after which the fixed, time invariant, effect of randomization condition was included and its interaction with the growth trajectory[1]. Following Long[2], the inverse cube, inverse square, inverse, inverse square root, log, square root, linear, square, and cube first-order fractional polynomials were fit and assessed by comparing the AICs[i]. For each outcome measure, the square root growth trajectory yielded the best fit and was retained.

A common analysis strategy was used that fit a generalized linear mixed model (GLMM) to the data. The models were fit using the lme function from the nlme package[3] in R. The basic model was a multilevel model with observations (level 1) nested within participants (level 2)[ii]. Following Singer and Willett's[1] notation the level 1 model for individual change is:

$$Anx_{ij} = [\gamma_{00} + \gamma_{10}Time_{ij} + \gamma_{01}Group_i + \gamma_{11}(Group_i \times Time_{ij})] + [\zeta_{0i} + \zeta_{1i}Time_{ij} + \epsilon_{ij}]$$

The structural part of the model states that anxiety in participant *i* and time *j* is predicted from the intercept plus the rate of change for that participant *i* at time *j*, group membership of the participant, and the interaction of group membership and the rate of change at time for participant *i* at time *j*. The stochastic part includes terms representing the difference between the individual's intercept and that of the population average (ζ_{0i}),

variance in the individuals' rates of change (slope) and that of the population average (ζ_{1i}), and a term allowing for random scatter of the individual's data around their particular trajectory (ϵ_{ij}).

Diagnosis

Diagnostic status was measured at only one time point so a binomial regression was used instead of a growth model:

$$Diagnosis_i = Binomial(1, p_i)$$
$$logit(p_i) = b_0 + b_1 Workshop_i$$

In which the variable 'workshop' is a categorical predictor (0 = control, 1 = workshop).

Parameter estimation

Model parameters were estimated in R using Bayesian methods implemented using the rethinking package[4], which is a wrapper for RStan[5].

Prior distributions for diagnosis

Intercept

Based on the classic Turner et al. study[6], 44% of children of anxiety disordered parents had a diagnosis, so we centred our prior distribution on this value, *p*(diagnosis) = 0.44, which reflects a logit of −0.24:

$$logit(0.44) = log\left(\frac{p}{1-p}\right) = log\left(\frac{0.44}{0.66}\right) = -0.24$$

It would be highly unlikely that none or all participants had a diagnosis so we set the limits of the distribution to be the proportions 0.1 and 0.78 (i.e., 10% to 78% having a diagnosis), which reflect logits of –2.2 and 1.27:

$$logit(0.1) = log\left(\frac{p}{1-p}\right) = log\left(\frac{0.1}{0.9}\right) = -2.2$$

$$logit(0.78) = log\left(\frac{p}{1-p}\right) = log\left(\frac{0.78}{0.22}\right) = 1.27$$

As such, the prior distribution should be centred on –0.24 and range from approximately –2.2 to 1.27, and this was achieved using a Gaussian distribution with $M = -0.24$, $SD = 0.6$.

Effect of workshop group

The prior distribution for the effect of workshop group reflects the change in the logit as we move from the control group to the workshop group. Imagine the control contains 44% cases of anxiety disorders (as in Turner et al). The logit is –0.24 (see above). If the workshops had no effect we would also see 44% of cases with diagnosis in this group and the change in logit would be 0.

Our prior belief is that the workshop works, so we do not want to spread our beliefs symmetrically around zero. If we assume a modest 10% success (~5 of the 44 expected cases are diagnosis free), this equates to a 39% diagnosis in the workshop group (with a logit of –0.45) compared to 44% in the control, and a change in logit of –0.45–(–0.24) = –0.21. A 20% success rate (9 of the expected 44 cases are diagnosis free) equates to ~35% diagnosis in the workshop group (logit = –0.62), and a change in logit of –0.62–(–0.24) = –0.38. A realistic extreme might be that 60% (consistent with RCTs of

CBT) are diagnosis free. This scenario equates to ~18% diagnosis in the workshop group (logit = −1.52), and a change in logit of −1.52−(−0.24) = −1.28. Therefore, we reasoned that the parameter for the group effect should be centred on −0.21 (a strong belief in very modest success), with an extreme of −1.52 (a very weak belief in a very strong effect) and 1.1 (a very weak belief in fairly strong effect in the opposite direction). This aim was achieved using a prior distribution that was Guassian with M = −0.21 and SD = 0.4.

Prior distributions for FSSC-P

The intercept prior distribution was normally distributed with M = 170 and SD = 20. The range of FSSC scores is potentially 94 to 282. The mean score in children aged under 10 is 173. This prior essentially represents a belief that the intercept will fall between 130 and 210.

The prior distribution for the slope for the rate of change in anxiety over time was set to be normal with M = 0, SD = 5. This represents a prior belief that the slope could range from -10 to +10 and is centered on 0 (anxiety doesn't change). This prior reflects an open-minded belief that anxiety might go up or down (which across the sample it might because of the control group) and that at most this change would be an approximate maximum of 10 points on the FSSC for each unit change in time.

The prior distribution for the effect of workshop and the interaction term was set to be normal with M = 0, SD = 10. This distribution represents a prior belief that the difference in groups at any time point could range from -20 to +20 and is centered on 0 (anxiety does not change). This prior distribution reflects an open-minded belief that the group

difference on the FSSC could be zero or up to an approximate maximum of 20 units on the FSSC in either direction.

Prior distributions for the standard deviations for the random effects were set to be a half Cauchy with the location parameter set to 0 and the scale parameter set to 2. The correlation between the random effect of intercepts and slopes had a prior of an LKJcorr(4) prior, which represents a prior that is skeptical of correlations close to 1 and -1.

Prior distributions for SCAS-P

The intercept prior distribution was normally distributed with $M = 0$ and $SD = 0.5$. SCAS scores were expressed as *z*-scores so their range is potentially –4 to 4. The mean score will be 0 (by definition). This prior, therefore, represents a belief that the intercept will fall at the average (0) or between about 1 standard deviation of the average.

The prior distributions for the slope for the rate of change, the effect of workshop and the interaction term were set to be normal with $M = 0$, $SD = 0.5$. This prior represents a belief that all these effects could range from –1 to +1 standard deviation and are centered on 0 (anxiety does not change/the workshop has no effect etc.). These priors reflect an open-minded belief that anxiety might go up or down/workshops might work or not and that at most this change would be an approximate maximum of 1 SD.

Prior distributions for the standard deviations were the same as for the FSSC.

Credible Intervals and Parameter Estimates

SCAS-P

As reported in Table S1, the 95% credible interval for the interaction term indicates that the slope in anxiety over time in the control group will differ from the slope in the workshop group by between -0.181 and -0.009. This is a small effect, on average, but one that could lie anywhere from virtually no effect, to not inconsequential.

FSSC-P

As reported in Table S1, the 95% credible interval for the interaction term (Table S1) indicates that the slope in FSSC over time in the control group will differ from the slope in the workshop group by between –2.59 and 1.43 (assuming the intervention has an effect). In the context of the scale of the FSSC (range from 94 to 282), this effect is a tiny change in either direction.

Diagnosis

As reported in Table S1, for diagnosis, the 95% credible interval suggests that the probability mass for the workshop effect falls between -0.77 and 0.37. Assuming that the intervention has an effect, the change in the log odds could lie somewhere between these values, which equates to 37% to 65% diagnosis in the workshop group, compared to 51% in the control group. The workshop could have effects in either direction.

Table S1: *Parameter estimates and 95% Bayesian credible intervals for models predicting FSSC-P, SCAS-P and Diagnosis.*

				95% Credible interval

	Effect	Parameter ($\hat{b}$)	$SD_{\hat{b}}$	Lower	Upper
FSSC-P					
	Intercept	138.92	3.55	131.77	145.63
	Time	–1.78	0.72	–3.24	–0.46
	Workshop Group	–0.97	4.64	–9.97	8.47
	Workshop Group × Time	–0.64	1.02	–2.59	1.43
	Sigma	10.88	0.82	9.29	12.46
SCAS-P					
	Intercept	0.046	0.132	-0.214	0.300
	Time	0.044	0.031	-0.015	0.107
	Workshop Group	-0.146	0.185	-0.511	0.207
	Workshop Group x Time	-0.090	0.044	-0.181	-0.009
	Sigma	0.419	0.033	0.356	0.482
Diagnosis					
	Intercept	0.273	0.249	-0.224	0.745
	Workshop Group	-0.219	0.290	-0.767	0.366

References

1. Singer, J.D. and J.B. Willett, *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. 2003, Oxford: OUP.
2. Long, J.D., *Longitudinal Data Analysis for the Behavioral Sciences Using R*. 2012, Thousand Oaks, CA: Sage.
3. Pinheiro, J., et al., *nlme: Linear and Nonlinear Mixed Effects Models. R package version*. 2015.
4. McElreath, R., *Statistical rethinking: a Bayesian course with examples in R and Stan*. 2016, Boca Raton, Fl: Chapman & Hall/CRC Press.
5. Stan Development Team, *RStan: the R interface to Stan*. 2016.
6. Turner, S.M., D.C. Beidel, and A. Costello, *Psychopathology in the Offspring of Anxiety Disorder Patients.* Journal of Consulting and Clinical Psychology, 1987. **55**(2): p. 229-235.

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[i] Because some of these trajectories cannot be fit to values of 0 (e.g., log) this exploratory analysis was conducted on time + 1.

[ii] There is a case to add a level 3 component of NHS Trust, however, there were so few participants within each trust (and a lot of trusts) that this was not possible. As such our models effectively assume that results do not vary by trust (which is unlikely to be true).