# Supporting Information

## Supplementary Methods

**Static detection.** In the static detection protocol, a vibrotactile stimulus was pseudorandomly administered to either left digit two or left digit three (frequency = 25 Hz; starting amplitude = 20 m; duration = 500 ms). The participants were asked to report on which finger they felt the stimulation. The static detection protocol included 24 trials. During the first ten trials, the stimulus decreased for each correct response and increased for each incorrect response (one-up–one-down tracking paradigm). For the rest of the trials, a different pattern on which the vibrotactile stimulus decreased for every two correct answers and increased for one incorrect answer was used (two-up–one-down tracking paradigm). The final static detection threshold was determined using the last five trials.

**Dynamic detection.** In the dynamic detection protocol, participants received a gradually increasing 25-Hz vibration stimulus from zero amplitude. Participants were instructed to respond as soon as possible on which finger they felt the stimulation. Each trial started with a different delay (0-2500 ms), and there was a 10-seconds intervening period between each delivered stimulus. The dynamic detection protocol included 7 trials. The final dynamic detection threshold was determined using the mean of stimulus amplitude of all the correct trials.

**Amplitude discrimination.** In the amplitude discrimination protocol, participants received vibrations to left digit 2 and left digit 3 simultaneously. The standard stimulus (amplitude = 100 m) was always delivered to one finger, while the comparative stimulus (initial amplitude = 200 m) was delivered to the other one. The two stimuli were pseudorandomly delivered to any digit. Participants were instructed to determine which of the two simultaneously provided vibrations had the higher amplitude (frequency = 25 Hz; duration = 500 ms; standard stimulus amplitude = 100 μm; initial comparison stimulus amplitude = 200 μm).

In the first ten trials, the comparative stimulus amplitude was reduced by 10 μm for a correct answer and increased by 10 μm for an incorrect answer. For the rest of the trials, a different pattern on which the comparative stimulus amplitude was decreased for every two correct answers and increased for one incorrect answer was used (two-up–one-down tracking paradigm). The amplitude discrimination protocol included 20 trials with a 5-second intervening period between trials. The final amplitude discrimination threshold was determined using the last five trials.

**Temporal order judgement.** In temporal order judgement protocols, participants were assessed on their ability to estimate the order of sequentially delivered tactile stimuli. Within a 1-s interval, two single-cycle vibrotactile pulses (duration = 40 ms; frequency = 25 Hz; amplitude = 200 μm) were given to left digits 2 and 3, separated temporally by a beginning inter-trial interval of 150 ms (the initial pulse was assigned to either digit pseudorandomly). The time between the sequentially delivered pulses was decreased by 10% for each correct answer and increased by 10% for each incorrect answer. The participants were asked to choose which digit they thought got the initial pulse. The protocol included 20 trials which were delivered with an intervening period of 5 seconds. The mean of the inter-trial interval of the five ultimate trials was used to determine the temporal order judgement threshold.

## Supplementary Results

**Supplementary Table 1.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Male (N = 32)** | | | | **Female (N = 6)** | | | | **Group differences** |
|  | ***SD*** | ***Range*** | ***Mean*** | ***Median*** | ***SD*** | ***Range*** | ***Mean*** | ***Median*** | ***p-value*** |
| Age (years) | 1.3 | 8.2 – 12.6 | 10.3 | 10.4 | 1.8 | 8.1 – 12.5 | 10.6 | 11.1 | .562 |
| IQ | 15.7 | 63.0 – 132.0 | 99.2 | 98.0 | 15.4 | 93.0 – 130.0 | 111.0 | 112.0 | .133 |
| SCARED | 12.2 | 0 - 56.0 | 15.7 | 12.0 | 15.3 | 4.0 – 46.0 | 20.8 | 17.0 | .356 |
| SPM | 6.1 | 46.0 – 75.0 | 64.3 | 64.0 | 9.5 | 44.0 – 73.0 | 61.5 | 62.5 | .470 |
| IUSC | 14.9 | 34.0 – 101.0 | 52.7 | 48.5 | 20.3 | 28.0 – 83.0 | 59.5 | 59.0 | .307 |
| SFD threshold | 3.6 | 2.8 – 17.6 | 11.0 | 11.4 | 2.4 | 9.0 – 14.4 | 11.5 | 11.4 | .918 |

*Group differences between male and female participants for demographic data and study variables*

*Note*. Wilcoxon Rank Sum tests were run to test for differences between male and female participants. SPM: Sensory Processing Measure; IUSC: Intolerance of Uncertainty Scale for Children; SCARED: Screen for Child Anxiety Related Emotional Disorders; IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination; SD: Standard deviation.

**Supplementary Table 2.**

*Pearson correlations between all study variables*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Age** | **SR** | **IU** | **ANX-p** | **ANX-c** |
| **SR** | -0.23 (.161) | - | - | - | 0.26 (.116) |
| **IU** | 0.17 (.307) | 0.40 (.013)\* | - | - | 0.45 (.005)\*\* |
| **ANX-p** | 0.07 (.658) | 0.37 (.023)\* | 0.48 (.002)\*\* | - | 0.53 (.001)\*\*\* |
| **SFD**a | -0.24 (.148) | 0.41 (.011)\* | 0.14 (.399) | 0.21 (.218) | 0.10 (.555) |
| **SDT**b | -0.53 (.002)\*\* | 0.30 (.096) | 0.13 (.464) | 0.24 (.191) | 0.03 (.837) |
| **DDT**c | -0.03 (.845) | 0.14 (.432) | 0.25 (.148) | 0.19 (.278) | 0.01 (.976) |
| **ADT**d | -0.32 (.066) | 0.28 (.104) | 0.04 (.838) | -0.13 (.458) | -0.19 (.286) |
| **TOJ**b | -0.69 (.000)\*\*\* | 0.22 (.228) | -0.23 (.214) | -0.33 (.064) | -0.27 (.144) |
| **SR-r** | -0.17 (.303) | 0.94 (.000)\*\*\* | 0.44 (.006)\*\* | 0.41 (.011)\* | 0.19 (.249) |

*Note*. Sensory reactivity, IU and anxiety correspond to SPM Total Sensory Systems T-scores, IUSC (child-report) total scores, and SCARED (parent-report) total scores, respectively. SPM: Sensory Processing Measure; IUSC: Intolerance of Uncertainty Scale for Children; SCARED: Screen for Child Anxiety Related Emotional Disorders; SR: Sensory reactivity (SPM Total Sensory Systems T-scores); SR-r: sensory reactivity (SPM Total Sensory Systems raw scores); ANX-p: anxiety (parent-reported SCARED anxiety total scores); ANX-c: anxiety (child-reported SCARED anxiety total scores); IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination threshold; SDT: static detection threshold; DDT: dynamic detection threshold; ADT: amplitude discrimination threshold; TOJ: temporal order judgement threshold. n = 38; a: n = 37; b: n = 32; c: n = 36; d: n = 34. \*\*\**p* ≤ .001; \*\**p* ≤ .01; \**p* ≤ .05. No correlation between SR, IU, or ANX scores and the vibrotactile thresholds (SFD, SDT, DDT, ADT, and TOJ) met the Bonferroni-adjusted significance level of *p* ≤ .006.

**Supplementary Table 3.**

*Pearson correlations after outliers removed and Spearman correlations between all study variables*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pearson (*r*) after Cook’s Distance** |  | **SR** | **IU** | **ANX-p** |
|  | **IU** | 0.35 (.036)\* | - | - |
|  | **ANX-p** | 0.36 (.031)\* | 0.41 (.012)\* | - |
|  | **SFD** | 0.41 (.011)\* | 0.13 (.440) | 0.21 (.218) |
| **Spearman (ρ)** |  |  |  |  |
|  | **IU** | 0.25 (.031)\* | - | - |
|  | **ANX-p** | 0.28 (.083) | 0.30 (.066) | - |
|  | **SFD**† | 0.41 (.012)\* | 0.10 (.570) | 0.20 (.230) |

*Note*. Sensory reactivity, IU and anxiety correspond to SPM Total Sensory Systems T-scores, IUSC (child-report) total scores, and SCARED (parent-report) total scores, respectively. Values are given as either Pearson’s ror Spearman’s rho, and p-value in brackets. SPM: Sensory Processing Measure; IUSC: Intolerance of Uncertainty Scale for Children; SCARED: Screen for Child Anxiety Related Emotional Disorders; SR: Sensory reactivity (SPM Total Sensory Systems T-scores); ANX-p: anxiety (parent-reported SCARED anxiety total scores); IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination threshold. n = 38 (or 37 for analyses involving SFD). \**p* ≤ .05.

**Supplementary Table 4.**

*Mediation analyses using SPM Total Sensory Systems T-scores as the measure of sensory reactivity*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Total effect** | | | | **Indirect effect** | | | | | **Direct effect** | | | | |
| **Predictor** | **Mediator** | **Outcome** | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** |
| SR | IU | ANX | **0.70** | **0.17** | **1.39** | **.010\*\*** | | **0.30** | **0.03** | **0.76** | **.016\*** | | 0.40 | -0.07 | 0.99 | .098 |
| SR | ANX | IU | **0.94** | **0.20** | **1.94** | **.012\*** | | **0.34** | **0.04** | **0.74** | **.015\*** | | **0.61** | **0.01** | **1.46** | **.046\*** |
| SFD | SR | ANX | 0.77 | -0.25 | 1.68 | .120 | | **0.58** | **0.05** | **1.50** | **.023\*** | | 0.19 | -1.31 | 1.19 | .751 |
| SFD | SR | IU | 0.67 | -0.96 | 2.60 | .440 | | **0.80** | **0.12** | **1.97** | **.010\*\*** | | -0.12 | -1.91 | 1.67 | .870 |
| ANX | IU | SR | **0.18** | **0.06** | **0.35** | **.011\*** | | 0.07 | 0.00 | 0.19 | .052 | | 0.12 | -0.02 | 0.27 | .098 |
| IU | ANX | SR | **0.17** | **0.05** | **0.27** | **.010\*\*** | | 0.05 | -0.01 | 0.11 | .097 | | **0.12** | **0.01** | **0.24** | **.041\*** |
| ANX | SR | SFD | 0.06 | -0.01 | 0.15 | .110 | | **0.04**† | **0.00** | **0.10** | **.010\*\*** | | 0.01 | -0.07 | 0.11 | .770 |
| IU | SR | SFD | 0.03 | -0.06 | 0.10 | .444 | | **0.04**† | **0.00** | **0.07** | **.024\*** | | -0.01 | -0.09 | 0.07 | .874 |
| SFD | ANX | SR | **0.82** | **0.35** | **1.47** | **.002\*\*** | | 0.13 | -0.05 | 0.38 | .133 | | **0.69** | **0.23** | **1.31** | **.003\*\*** |
| SFD | IU | SR | **0.82** | **0.34** | **1.45** | **.002\*\*** | | 0.10 | -0.15 | 0.44 | .438 | | **0.72** | **0.23** | **1.30** | **.005\*\*** |

*Note*. Sensory reactivity, IU and anxiety correspond to SPM Total Sensory Systems T-scores, IUSC (child-report) total scores, and SCARED (parent-report) total scores, respectively. SR: sensory reactivity; ANX: anxiety; IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination threshold; SPM: Sensory Processing Measure; SCARED: Screen for Child Anxiety Related Emotional Disorders; IUSC: Intolerance of Uncertainty Scale for Children; LL: lower limit confidence interval, UL: upper limit confidence interval; n = 38 (or 37 for analyses involving SFD). Significant effects at the p ≤ .05 level are highlighted in bold. \*\**p* ≤ .01; \**p* ≤ .05; †β estimate is very small and therefore unlikely to be meaningful, despite yielding a significant *p*‑value.

Timeline

Description automatically generated

**Supplementary Figure 1**. Visual schematic of the mediation path models that were fitted to the data. Mediation analyses were run using bootstrapping (10,000 simulations). Predictors are shown on the left, mediators in the middle, and outcomes on the right. Dashed arrows indicate the indirect effect. Solid arrows between the predictor and outcome indicate the total effect, with the direct effect in parentheses. SPM Total Sensory Systems raw scores, IUSC total scores, and SCARED total scores were used as measures for sensory reactivity, IU, and anxiety, respectively. **a.** Full mediation effect of IU on the relationship between sensory reactivity and anxiety. **b.** |Full mediation effect of anxiety on the relationship between sensory reactivity and IU. **c.**Full mediation effect of sensory reactivity on the relationship between SFD threshold and anxiety. **d.** Full mediation effect of sensory reactivity on the relationship between SFD threshold and IU.SPM: Sensory Processing Measure; SCARED: Screen for Child Anxiety Related Emotional Disorders; IUSC: Intolerance of Uncertainty Scale for Children; SFD: simultaneous frequency discrimination. \**p* ≤ .05.

**Supplementary Table 5.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **Total effect** | | | | **Indirect effect** | | | | | **Direct effect** | | | | |
| **Predictor** | **Mediator** | **Outcome** | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** |
| SR-r | IU | ANX | **0.25** | **0.04** | **0.47** | **.016\*** | | **0.10** | **0.01** | **0.22** | **.028\*** | | 0.15 | -0.02 | 0.38 | .091 |
| SR-r | ANX | IU | **0.34** | **0.04** | **0.60** | **.023\*** | | **0.11** | **0.01** | **0.22** | **.028\*** | | 0.22 | -0.01 | 0.49 | .064 |
| SFD | SR-r | ANX | 0.77 | -0.24 | 1.66 | .122 | | **0.65** | **0.04** | **1.77** | **.029\*** | | 0.12 | -1.38 | 1.17 | .846 |
| SFD | SR-r | IU | 0.67 | -0.97 | 2.59 | .444 | | **0.88** | **0.07** | **2.23** | **.021\*** | | -0.20 | -1.97 | 1.52 | .802 |
| ANX | IU | SR-r | **0.67** | **0.17** | **1.12** | **.019\*** | | 0.25 | -0.01 | 0.64 | .063 | | 0.42 | -0.09 | 0.84 | .097 |
| IU | ANX | SR-r | **0.57** | **0.10** | **0.87** | **.022\*** | | 0.16 | -0.03 | 0.36 | .101 | | 0.41 | -0.03 | 0.77 | .061 |
| ANX | SR-r | SFD | 0.06 | -0.01 | 0.15 | .114 | | **0.05**† | **0.01** | **0.12** | **.023\*** | | 0.01 | -0.09 | 0.11 | .844 |
| IU | SR-r | SFD | 0.03 | -0.06 | 0.10 | .455 | | **0.04**† | **0.00** | **0.09** | **.037\*** | | -0.01 | -0.09 | 0.07 | .809 |
| SFD | ANX | SR-r | **2.49** | **0.93** | **4.07** | **.007\*\*** | | 0.47 | -0.16 | 1.28 | .143 | | **2.01** | **0.51** | **3.60** | **.014\*** |
| SFD | IU | SR-r | **2.49** | **0.98** | **3.99** | **.006\*\*** | | 0.34 | -0.47 | 1.65 | .454 | | **2.15** | **0.44** | **3.52** | **.017\*** |

*Mediation analyses using SPM Total Sensory Systems raw scores as the measure of sensory reactivity*

*Note*. Sensory reactivity, IU and anxiety correspond to SPM Total Sensory Systems raw scores, IUSC child-report total scores, and SCARED parent-report total scores, respectively. SR-r: sensory reactivity (SPM Total Sensory Systems raw scores); ANX: anxiety; IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination; SPM: Sensory Processing Measure; SCARED: Screen for Child Anxiety Related Emotional Disorders; IUSC: Intolerance of Uncertainty Scale for Children; LL: lower limit confidence interval, UL: upper limit confidence interval; n = 38 (or 37 for analyses involving SFD). Significant effects at the *p* ≤ .05 level are highlighted in bold. \*\**p* ≤ .01; \**p* ≤ .05; †β estimate is very small and therefore unlikely to be meaningful, despite yielding a significant *p*-value.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Total effect** | | | | **Indirect effect** | | | | | **Direct effect** | | | | |
| **Predictor** | **Mediator** | **Outcome** | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** |
| **Percentile bootstrap** | | | | | | | | | | | | | | | | |
| SR | IU | ANX | **0.70** | **0.17** | **1.39** | **.010\*\*** | | **0.30** | **0.03** | **0.76** | **.016\*** | | 0.40 | -0.07 | 0.99 | .098 |
| SR | ANX | IU | **0.94** | **0.20** | **1.94** | **.012\*** | | **0.34** | **0.04** | **0.74** | **.015\*** | | **0.61** | **0.01** | **1.46** | **.046\*** |
| SFD | SR | ANX | 0.77 | -0.25 | 1.68 | .120 | | **0.58** | **0.05** | **1.50** | **.023\*** | | 0.19 | -1.31 | 1.19 | .751 |
| SFD | SR | IU | 0.67 | -0.96 | 2.60 | .440 | | **0.80** | **0.12** | **1.97** | **.010\*\*** | | -0.12 | -1.91 | 1.67 | .870 |
| **Multivariate winsorization** | | | | | | | | | | | | | | | | |
| SR | IU | ANX | **0.66** | **0.07** | **1.29** | **.028\*** | | **0.29** | **0.03** | **0.77** | **.015\*** | | 0.36 | -0.16 | 0.91 | .171 |
| SR | ANX | IU | **0.94** | **0.12** | **1.80** | **.025\*** | | **0.33** | **0.04** | **0.82** | **.010\*** | | 0.61 | -0.04 | 1.30 | .075 |
| SFD | SR | ANX | 0.76 | -0.17 | 1.68 | .110 | | **0.54** | **0.03** | **1.42** | **.030\*** | | 0.22 | -1.05 | 1.35 | .807 |
| SFD | SR | IU | 0.55 | -1.07 | 2.22 | .490 | | **0.76** | **0.12** | **1.96** | **.015\*** | | -0.20 | -1.94 | 1.48 | .791 |

**Supplementary Table 6.**

*Mediation analyses comparing percentile bootstrapping method with multivariate winsorization bootstrapping method*

*Note*. Sensory reactivity, IU and anxiety correspond to SPM Total Sensory Systems T-scores, IUSC (child-report) total scores, and SCARED (parent-report) total scores, respectively. SR: sensory reactivity; ANX: anxiety; IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination; SPM: Sensory Processing Measure; SCARED: Screen for Child Anxiety Related Emotional Disorders; IUSC: Intolerance of Uncertainty Scale for Children; LL: lower limit confidence interval, UL: upper limit confidence interval; n = 38 (or 37 for analyses involving SFD). Significant effects at the p ≤ .05 level are highlighted in bold. \*\**p* ≤ .01; \**p* ≤ .05.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Supplementary Table 7**.  *Mediation analyses with Conners and DuPauls scores added as covariates* | | | | | | | | | | | | | | | | |
|  | | | **Total effect** | | | | **Indirect effect** | | | | | **Direct effect** | | | | |
| **Predictor** | **Mediator** | **Outcome** | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** | | **β** | **LL** | **UL** | **p-value** |
| **Conners Hyper-impulsivity**† | | | | | | | | | | | | | | | | |
| SR | IU | ANX | **0.48** | **0.11** | **1.38** | **.017\*** | | **0.28** | **0.01** | **0.75** | **.026\*** | | 0.20 | -0.11 | 0.97 | .128 |
| SR | ANX | IU | **0.91** | **0.17** | **1.99** | **.015\*** | | **0.25** | **0.03** | **0.78** | **.021\*** | | **0.66** | **0.00** | **1.48** | **.049\*** |
| SFD‡ | SR | ANX | 0.44 | -0.34 | 1.64 | .173 | | **0.36** | **0.04** | **1.52** | **.029\*** | | 0.08 | -1.36 | 1.17 | .825 |
| SFD‡ | SR | IU | 0.51 | -1.04 | 2.68 | .485 | | **0.66** | **0.10** | **1.97** | **.012\*** | | -0.15 | -1.94 | 1.68 | .857 |
| **Conners Inattention**† | | | | | | | | | | | | | | | | |
| SR | IU | ANX | **0.49** | **0.13** | **1.40** | **.016\*** | | **0.18** | **0.01** | **0.76** | **.025\*** | | 0.31 | -0.10 | 0.98 | .119 |
| SR | ANX | IU | **0.60** | **0.18** | **1.96** | **.018\*** | | **0.22** | **0.02** | **0.75** | **.026\*** | | **0.38** | **0.00** | **1.46** | **.049\*** |
| SFD‡ | SR | ANX | 0.12 | -0.32 | 1.63 | .160 | | **0.21** | **0.03** | **1.52** | **.030\*** | | -0.08 | -1.35 | 1.15 | .850 |
| SFD‡ | SR | IU | -0.36 | -1.07 | 2.62 | .478 | | **0.25** | **0.11** | **2.01** | **.012\*** | | -0.61 | -1.97 | 1.66 | .861 |
| **DuPauls**‡ | | | | | | | | | | | | | | | | |
| SR | IU | ANX | **0.22** | **0.09** | **1.33** | **.025\*** | | **0.24** | **0.05** | **0.89** | **.014\*** | | -0.02 | -0.19 | 0.80 | .251 |
| SR | ANX | IU | **0.74** | **0.26** | **2.11** | **.005\*** | | **0.11** | **0.02** | **0.79** | **.026\*** | | **0.63** | **0.08** | **1.60** | **.024\*** |
| SFD§ | SR | ANX | -0.03 | -0.59 | 1.60 | .349 | | **0.15** | **0.04** | **1.74** | **.027\*** | | -0.18 | -1.76 | 1.12 | .891 |
| SFD§ | SR | IU | 0.79 | -0.55 | 3.11 | .159 | | **0.39** | **0.08** | **2.13** | **.019\*** | | 0.40 | -1.54 | 2.08 | .649 |

*Note*. Sensory reactivity, IU and anxiety correspond to SPM Total Sensory Systems T-scores, IUSC (child-report) total scores, and SCARED (parent-report) total scores, respectively. SR: sensory reactivity; ANX: anxiety; IU: intolerance of uncertainty; SFD: simultaneous frequency discrimination; SPM: Sensory Processing Measure; SCARED: Screen for Child Anxiety Related Emotional Disorders; IUSC: Intolerance of Uncertainty Scale for Children; LL: lower limit confidence interval, UL: upper limit confidence interval. Significant effects at the p ≤ 0.05 level are highlighted in bold. \*p ≤ .05; †n = 37; ‡n = 36; §n = 35.