Table S1. Search strategies for each database.

Database	Order	Keywords	Results
		("elective surgical procedures" [MH] OR surgery [MH] OR surgery [TIAB]) OR	
PubMed	#1	("Anesthesia" [MH] OR anesthesia [TIAB] OR anaesthesia [TIAB] OR anesth* [TIAB] OR	3927681
		anaesth*[TIAB])	
	#2	"virtual reality"[MH] OR "virtual reality"[TIAB]	10378
	#3	#1 AND #2	2580
	#4	#3 AND HSSS(S)	732
	"-	Surgery/exp OR surgery:ab,ti OR anesthesia:exp OR anesthesia:ab,ti OR	
EMBASE	#1	anaesthesia:ab,ti OR anesth*:ab,ti OR anaesth*:ab,ti	5726915
	#2	'virtual reality'/exp OR 'virtual reality':ab,ti	20579
	#3	#1 AND #2	5273
		'crossover procedure'/exp OR 'crossover procedure' OR 'double blind procedure'/exp	
		OR 'double blind procedure' OR 'randomized controlled trial'/exp OR 'randomized	
	#4	controlled trial' OR 'single blind procedure'/exp OR 'single blind procedure' OR	2587811
	"-	random* OR factorial* OR crossover* OR 'cross over' OR 'cross-over' OR placebo* OR	200,011
		(doubl* AND blind*) OR (singl* AND blind*) OR assign* OR allocat* OR volunteer*	
	#5	#3 AND #4	865
	#6	#5 AND [embase]/lim	786
		[mh "elective surgical procedures"] OR [mh "general surgery"] OR surgery:ti,ab,kw	
CENTRAL	#1	OR [mh anesthesia] OR anesthesia:ti,ab,kw OR anaesthesia:ti,ab,kw OR	237521
		anesth*:ti,ab,kw OR anaesth*:ti,ab,kw	
	#2	[mh "virtual reality"] OR "virtual reality":ti,ab,kw	2932
	#3	#1 AND #2	509
	#4	#3 AND Trials	506
CINAHL	S1	MH(Surgery, Elective+)	1944
	S2	MH(Surgery, Operative+)	211371
	S3	TI (surgery) OR AB(surgery)	79736
	S4	MH(anesthesia+) OR TI(anesth*) OR AB(anesth*) OR TI(anaesth*)	21598
	S5	S1 OR S2 OR S3 OR S4	254624
	S6	MH(Virtual Reality+) OR TI(virtual reality) OR AB(virtual reality)	3041
	S7	S5 AND S6	542
		MH(Clinical Trials) OR PT(Clinical trial) OR TX (clinic* n1 trial*) OR TX ( (singl* n1	
		blind*) OR (singl* n1 mask*) ) OR TX ( (doubl* n1 blind*) OR (doubl* n1 mask*) ) OR	
	S8	TX ( (tripl* n1 blind*) OR (tripl* n1 mask*) ) OR TX ( (trebl* n1 blind*) or (trebl* n1	586436
		mask*) ) OR TX (randomi* control* trial*) OR MH(Random Assignment) OR	
		TX(random* allocat*) OR TX(placebo*)	
	S9	S7 AND S8	106
		(INDEXTERMS(elective surgical procedures) OR INDEXTERMS(surgery) OR TITLE-	
Scopus	#1	ABS(sugery)) OR (INDEXTERMS(anesthesia) OR TITLE-ABS(anesthesia) OR TITLE-	1857596
•		ABS(anaesthesia) OR TITLE-ABS(anesth*) OR TITLE-ABS(anaesth*)	
	#2	INDEXTERMS(virtual reality) OR TITLE-ABS(virtual reality)	128389
	#3	#1 AND #2	5215
	0	(INDEXTERMS(randomized controlled trial) OR INDEXTERMS(controlled clinical	3210
		trial) OR TITLE-ABS(randomized) OR TITLE-ABS(placebo) OR INDEXTERMS(drug	
	#4	therapy) OR TITLE-ABS(randomly) OR TITLE-ABS(trial) OR TITLE-ABS(groups))	9284998
		177	
	#5	AND NOT (INDEXTERMS(animals) AND NOT INDEXTERMS(humans))	045
TA7 1 C	#5	#3 AND #4	965
Web of	#1	TS=(surgery OR anesthesia OR anaesthesia OR anesth* OR anaesth*)	1378220
Science			
	#2	TS=("virtual reality")	21372
	#3	#1 AND #2	2723
	#4	TS=(random* OR blind* OR allocat* OR assign* OR trial* OR placebo* OR crossover	4147905
	π <b>*±</b>	OR cross-over* OR intervention)	<b>414/20</b> 3
		#3 AND #4	869

**Table S2.** Details for judgement for each risk of bias for randomized controlled studies.

Study	Bias	Author's judgement	Reason for judgement					
	Random							
Bekelis	sequence	Low	A block randomization design was used with randomly permuted					
2017	generation	LOW	block sizes of 4 on the basis of a computerized random-numb					
	(selection bias)		<del>_</del>					
	Allocation		generator with sequentially numbered opaque, sealed envelopes for each stratum.					
	concealment	Low	each stratum.					
	(selection bias)							
	Blinding (detection bias)	Low	The physicians conducting the interviews to collect the primary and secondary outcome data, and the data analysts were blinded to the group assignments.					
	Incomplete							
	outcome data	Low	Some patients were excluded from the final analysis in both groups					
	(attrition bias)		but reasons for this are both reported and balance across groups.					
	Selective							
	reporting	Low	All pre-specified and expected outcomes are reported.					
	(reporting bias)	LOW	7 in pre specifica and expected outcomes are reported.					
	Other bias	Low	No other bias was detected.					
	Random	LOW	No other bias was detected.					
Dohahan			Allocations to groups were performed randomly by assigning					
Dehghan	sequence	Low	patients with even hospital bed numbers in the interventional group					
2019	generation		and those with odd hospital bed numbers in the control group.					
	(selection bias)							
	Allocation							
	concealment	Unclear	Allocations seemed to be unconcealed.					
	(selection bias)							
	Blinding	Unclear	Not described					
	(detection bias)	Officieat	Not described					
	Incomplete							
	outcome data	Low	All patients completed the study and there were no losses.					
	(attrition bias)							
	Selective							
	reporting	Low	All pre-specified and expected outcomes are reported.					
	(reporting bias)		1 1 1					
	Other bias	Low	No other bias was detected.					
	Random							
	sequence							
Eijlers 2019	generation	Low	Block randomization was performed, stratified by type of surgery.					
	(selection bias)							
	` ,							
	Allocation	I I1	NT-1-111					
	concealment	Unclear	Not described					
	(selection bias)							
	Blinding	Low	Assessments after randomization were performed by the blinded					
	(detection bias)		researcher, blinded recovery nurse.					
	Incomplete		Patients in VR group discontinued intervention, but the outcomes					
	outcome data	Low	were analyzed as intention-to-treat.					
	(attrition bias)		were unanyzed as intention-to-treat.					
	Selective							
	reporting	Low	All pre-specified and expected outcomes are reported.					
	(reporting bias)							
	Other bias	Low	No other bias was detected.					
	Random							
Haisley	sequence	<b>T</b>	Patients were then randomized via computer software to the VR or					
2020	generation	Low	the non-VR arm.					
	(selection bias)							
	Allocation							
	concealment	Unclear	Not described					
	(selection bias)	Officient	rot described					
	Blinding	Unclear	Not described					
	(detection bias)							
	Incomplete outcome data	Τ.	All matients consulated that ( 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					
		Low	All patients completed the study and there were no losses.					
	(attrition bias)	2011	im patients completed the stady and there were no issues.					

Noben 2019 Robertson 2017	Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Blinding (detection bias) Incomplete outcome data	Low Low Unclear Unclear Low Low Low Low Low Low	All pre-specified and expected outcomes are reported.  No other bias was detected.  Randomization was performed by the researcher using a Web-based computer randomizer generating a randomization list. Randomization blocks of 10 were used.  Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator  Participants were not made aware of their allocated group until after
Noben 2019 Robertson 2017	Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Unclear Unclear Low Low Low Low	Randomization was performed by the researcher using a Web-based computer randomizer generating a randomization list. Randomization blocks of 10 were used.  Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Unclear Unclear Low Low Low Low	Randomization was performed by the researcher using a Web-based computer randomizer generating a randomization list. Randomization blocks of 10 were used.  Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Unclear Unclear Low Low Low Low	computer randomizer generating a randomization list. Randomization blocks of 10 were used.  Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Unclear Unclear Low Low Low Low	computer randomizer generating a randomization list. Randomization blocks of 10 were used.  Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	(selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Unclear Unclear Low Low Low Low	Randomization blocks of 10 were used.  Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	Allocation concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Unclear  Low  Low  Low  Low	Not described  Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	concealment (selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Unclear  Low  Low  Low  Low	Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	(selection bias) Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Unclear  Low  Low  Low  Low	Not described  Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	Blinding (detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low Low	Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	(detection bias) Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low Low	Outcomes were reported for all patients.  All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	Incomplete outcome data (attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low	All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	outcome data (attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low	All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	(attrition bias) Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low	All pre-specified and expected outcomes are reported.  No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	Selective reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low	No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	reporting (reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low	No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	(reporting bias) Other bias Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low Low	No other bias was detected.  They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
Robertson 2017	Other bias  Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low	They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
2017	Random sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low Low	They were then randomly allocated into one of three groups using a random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
2017	sequence generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low	random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
2017	generation (selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete	Low	random number generator.  Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
	(selection bias) Allocation concealment (selection bias) Blinding (detection bias) Incomplete		Patient randomization numbers were concealed in opaque envelopes that were opened by the study investigator
	Allocation concealment (selection bias) Blinding (detection bias) Incomplete		that were opened by the study investigator
	concealment (selection bias) Blinding (detection bias) Incomplete		that were opened by the study investigator
	(selection bias) Blinding (detection bias) Incomplete		
	Blinding (detection bias) Incomplete	Low	Participants were not made aware of their allocated group until after
	(detection bias) Incomplete	Low	Turucipunto were not mude uware of their unocuted group until utter
	Incomplete		their response to the initial HADS.
	•		then responde to the militarian iso.
		Low	Outcomes were reported for all patients.
	(attrition bias)		
	Selective		
	reporting	Low	All pre-specified and expected outcomes are reported.
	(reporting bias)		r r
	Other bias	Low	No other bias was detected.
	Random		
D 2017	sequence	<b>T</b>	Randomization was performed by an independent anaesthetist not
Ryu 2017	generation	Low	otherwise involved in the trial.
	(selection bias)		
	Allocation		A computer-generated randomization code (Random Allocation
	concealment	Low	Software version 1.0) with opaque envelopes containing sequential
	(selection bias)		numbers was used.
	Blinding	Low	A single-blinded assessor collected the observational scores to
	(detection bias)	Low	maintain consistency and uniformy.
	Incomplete		
	outcome data	Low	One patient discontinued intervention due to acceptable reason.
	(attrition bias)		
	Selective		
	reporting	Low	All pre-specified and expected outcomes are reported.
	(reporting bias)		
	Other bias	Low	No other bias was detected.
	Random		
Ryu 2018	sequence	Low	Using a computer-generated randomization code, the enrolled
-	generation		patients were randomly allocated to one of two groups.
	(selection bias)		
	Allocation	<b>T</b>	
	concealment	Low	An opaque envelope containing sequential numbers
	(selection bias)		
	Blinding	Low	All outcomes were assessed by a blind single evaluator
	(detection bias)		, ,
	Incomplete	I	One patient allocated to the VR group was excluded due to
	outcome data	Low	acceptable reason.
	(attrition bias) Selective		- -
		Low	All pre-specified and expected outcomes are reported.
	reporting		3

	(reporting bias)							
	Other bias	Low	No other bias was detected.					
Ryu 2019	Random sequence generation (selection bias)	Low	A computer-generated randomized code with nontransparent envelopes that contained sequential numbers was used.					
	Allocation concealment (selection bias)	Low	chvelopes that contained sequential numbers was used.					
	Blinding (detection bias)	Low	The outcome assessor and an anesthesiologist were blinded to group assignment.					
	Incomplete outcome data (attrition bias)	Low	Three patients were losses to follow-up, but acceptable reason was described.					
	Selective reporting (reporting bias)	Low	All pre-specified and expected outcomes are reported.					
	Other bias	Low	No other bias was detected.					
Yang 2019	Random sequence generation (selection bias)	Low	Patients were randomized into 2 groups using a computer-generated random sequence.					
	Allocation concealment (selection bias)	Unclear	Not described					
	Blinding (detection bias)	Low	The single assessor collecting the outcome data was blinded to the study group assignments.					
	Incomplete outcome data (attrition bias)	Low	All patients completed the study and there were no losses.					
	Selective reporting (reporting bias)	Low	All pre-specified and expected outcomes are reported.					
	Other bias	Low	No other bias was detected.					

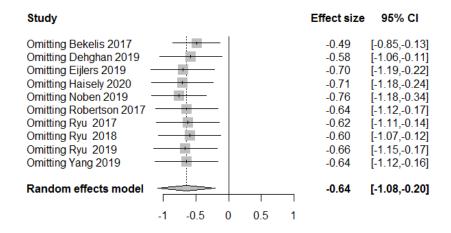


Figure S1. Sensitivity analysis of preoperative anxiety.

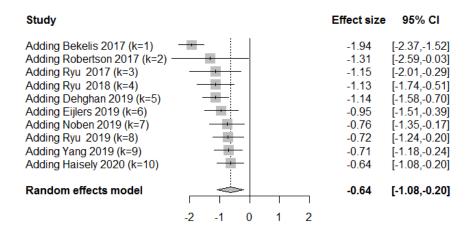
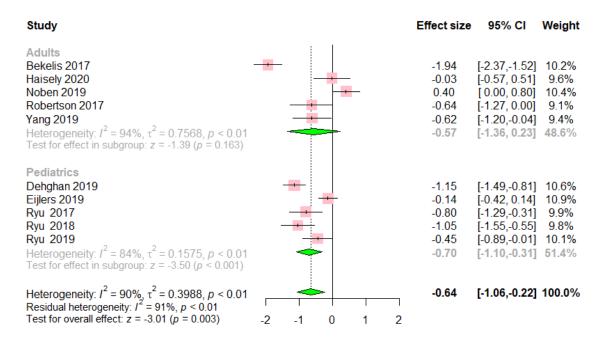


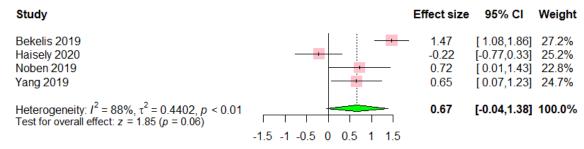
Figure S2. Cumulative meta-analysis of preoperative anxiety.

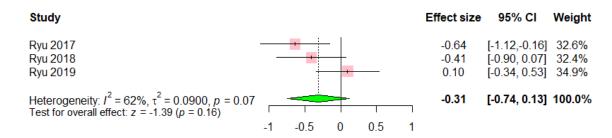
#### 1. Likelihood based model

## A) Preoperative anxiety



#### B) Satisfaction

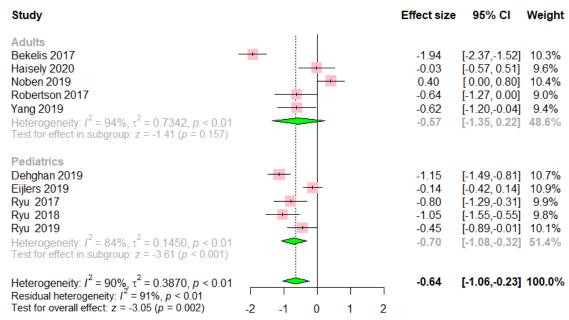




## C) Behavior disturbances

## 2. Empirical Bayesian methods

# A) Preoperative anxiety



## B) Satisfaction

Study		Effect size	95% CI	Weight
Bekelis 2019 Haisely 2020 Noben 2019 Yang 2019		- 1.47 -0.22 0.72 0.65	[ 1.08,1.86] [-0.77,0.33] [ 0.01,1.43] [ 0.07,1.23]	25.2% 22.8%
Heterogeneity: $I^2 = 88\%$ , $\tau^2 = 0.4179$ , $p < 0.01$ Test for overall effect: $z = 1.90$ ( $p = 0.06$ )	5 0 0.5 1 1.5	0.67	[-0.02,1.36]	100.0%

Study				Effect size	95% CI	Weight
Ryu 2017 Ryu 2018 Ryu 2019	 -	-		-0.64 -0.41 0.10	[-1.12,-0.16] [-0.90, 0.07] [-0.34, 0.53]	32.4%
Heterogeneity: $I^2 = 62\%$ , $\tau^2 = 0.0872$ , $p = 0.07$ Test for overall effect: $z = -1.41$ ( $p = 0.16$ )	 -0.5	0	0.5	 -0.31	[-0.74, 0.12]	100.0%

## C) Behavior disturbances