Acoustic startle and Pre-pulse Inhibition (PPI) IMPC_ACS_003

Purpose

The acoustic startle response is characterized by an exaggerated flinching response to an unexpected strong auditory stimulus (pulse). This response can be attenuated when it is preceded by a weaker stimulus (pre-pulse) and is the principle underlying pre-pulse inhibition (PPI). PPI has been described in numerous species, including mice and humans and provides an operational measure of sensorimotor gating reflecting the ability of an animal to successfully integrate and inhibit sensory information. Several clinical studies have shown that a number of human disorders have impaired PPI including: schizophrenia, Huntington's disease, fragile X syndrome, and autism. The acoustic startle and PPI paradigm is therefore largely used to assess sensorimotor gating and the effects of a number of treatment modalities such as putative anti-psychotics, and to explore genetic and neurobiological mechanisms underlying behaviors of relevance to psychosis (Geyer, 1999; Ouagazzal et al., 2001).

Ontological description: MP:0002067 - abnormal sensory capabilities/reflexes/nociception.

Experimental Design

Minimum number of mutant animals: 7 mice for each sex.

Age of animal at test: over 8 weeks, but not greater than 12 weeks, ideal age: 10 weeks.

Sexual dimorphism: yes, the results of this test tend to be sexually dimorphic.

Equipment

The experimental apparatus consists of an outer attenuated chamber that serves to prevent external noise or vibrations interfering with experiment. Within this chamber a load cell platform that records the startle response is linked to the transducer and amplifier, which calibrates the load cell platform. An animal holder rests upon the load cell platform. A sound generator and the appropriate software regulate pulses from the amplifier.

Procedure

1. Transport mice (in their rack if possible) to the testing suite and leave undisturbed for a minimum of 30 minutes in the antechamber.   Take care not to stimulate the mouse before starting the experiment. Do not change the cage on the day of the experiment.
2. The session is initiated with a 5 minute acclimation period (only background noise is on). In addition, it is an option to acclimate to the startle pulse in which 110-120 dB/40-60ms of white noise is presented alone, 5 times. These will be excluded from the statistical analysis.
3. The session is then continued by presentations of different trial types, each of which should be presented 6-10 times in pseudorandom order, with an inter-trial interval (ITI) varying randomly between 20 and 30 seconds (or 10 and 20 if preferred). The trials are:

1. Different pre-pulse trials of 20 ms duration of white noise stimuli which are presented alone (PP1, PP2, PP3, or PP4 dB; a minimum of 3 different pre-pulses should be utilized) or precede the pulse by 50-120 ms (PP1 + pulse, PP2 + pulse, PP3 + pulse, or PP4 + pulse) to derive the pre-pulse inhibition response. The intensities of the pre-pulse should be kept at levels above the background noise (BN) that do not elicit a significant startle response on their own, being approximately 2-20dB above BN (e.g. PP1=BN+5dB, PP2=BN+10, PP3=BN+15 and PP4=BN+20).

2. Startle pulse trials where 110-120 dB/40-60 ms of white noise is presented alone.

3. No stimulus (NOSTIM) trials in which only background noise is presented to measure baseline movement of the animal in the chamber.

4. The BN set will vary according to the apparatus used (generally around 65-70dB depending on the noise of the environment).

4. Startle response is recorded every millisecond for 65-100 ms after the onset of startle, i.e. 40-60 ms during the startle plus 25-40 ms after the startle ended; 65-100 ms from the end of the previous ITI for NOSTIM (see Fig. 1).
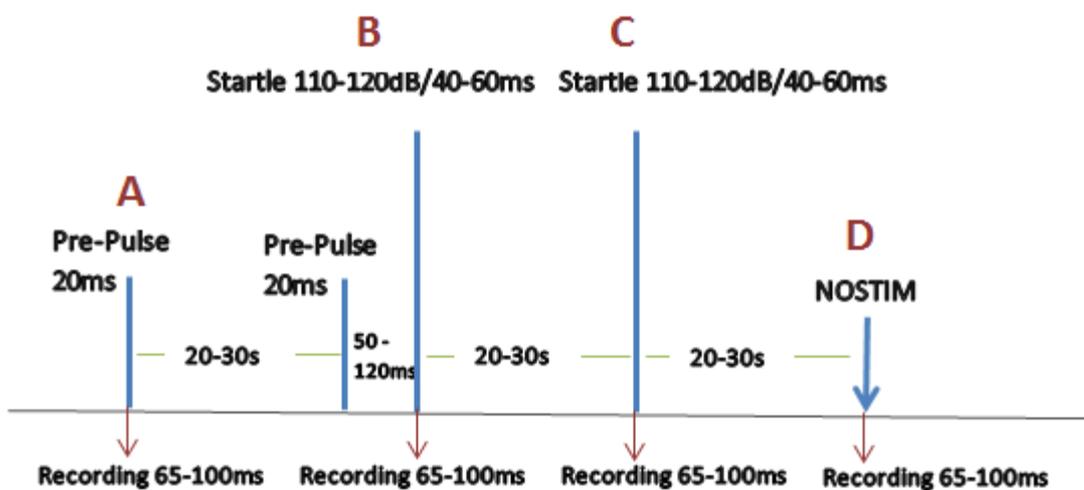

Fig.1. The different type of trials of the acoustic startle & pre-pulse inhibition test. A: pre-pulse alone (PP1, PP2, PP3 and PP4), B: startle preceded by pre-pulse (PP1_S, PP2_S, PP3_S and PP4_S), C: startle alone and D: NOSTIM.

5. Ensure that all apparatus are functioning correctly
6. Place each mouse onto the load cell platform inside the sound attenuated acoustic chamber and secure the door close.
7. Run the experimental session according to the experimental design described above.
8. Remove each mouse at the end of the experimental session and record its weight before returning it to the relevant home cage.
9. Wipe clean the animal holders and allow time to dry before loading another test cohort.
10. At the end of the experimentation, save the data for detailed analysis of acoustic startle and acoustic pre-pulse inhibition responses.

Data collection. The maximal peak amplitude is used to determine the acoustic startle response. Basal startle responses S and PP-S, are calculated respectively as the average responses to the pulses presented alone and the average responses to the combined pre-pulse-pulses. The amount of pre-pulse inhibition (PPI) is calculated as a percentage score for each acoustic pre-pulse trial type: % PPI= 100 x (S – PPi_S)/S.   The global level of PPI is also calculated as the mean %PPI for the different prepulse responses: 100 x [S—(PP1_S + PP2_S + PP3_S + PP4_S)/4]/S.

Notes

Illumination and noise levels in the holding room should be comparable to the housing suite during acclimation and testing to minimize their effects on behavioral outcome.

The maximal voltage change is to be used as the startle response over the recording interval. The background noise is on throughout the experiment and therefore between the prepulse and the startle.

The information about the date of the experiment, that is the date when the measurement is performed, is an important parameter which is to be submitted in the Experiment xml file (dateOfExperiment="2013-02-28").

Data QC

The calibration of the sound and the movement sensors are important for obtaining valid test results and therefore must be routinely calibrated, e.g. at least monthly. Each depends on the type of equipment used therefore follow manufacturer guidelines for effective calibration and provide that the sensitivity of the instrument be high enough to avoid inaccuracy on measures of prepulse inhibition.   It is recommended that the maximum signal peak of the startle response with a standard unit (e.g. male mouse C57) be in a range at about 800-1200 (higher is not a problem).

Parameters

	Version	Type	Increment	Option	Derived	Unit	Data Type
Response amplitude - BN IMPC_ACS_001_001	1.4	simpleParameter					FLOAT
Response amplitude - PP1 IMPC_ACS_002_001	1.3	simpleParameter					FLOAT
Response amplitude - PP2 IMPC_ACS_003_001	1.4	simpleParameter					FLOAT
Response amplitude - PP3 IMPC_ACS_004_001	1.3	simpleParameter					FLOAT
Response amplitude - PP4 IMPC_ACS_005_001	1.4	simpleParameter					FLOAT
Response amplitude - S IMPC_ACS_006_001	1.4	simpleParameter					FLOAT
Response amplitude - PP1_S	1.4	simpleParameter					FLOAT

	Version	Type	Increment	Option	Derived	Unit	Data Type
IMPC_ACS_007_001							
Response amplitude - PP2_S IMPC_ACS_008_001	1.4	simpleParameter					FLOAT
Response amplitude - PP3_S IMPC_ACS_009_001	1.4	simpleParameter					FLOAT
Response amplitude - PP4_S IMPC_ACS_010_001	1.5	simpleParameter					FLOAT
% Pre-pulse inhibition - PPI1 IMPC_ACS_033_001	1.7	simpleParameter			IMPC_ACS_006_001 IMPC_ACS_007_001 - IMPC_ACS_006_001 / 100 *	%	FLOAT
% Pre-pulse inhibition - PPI2 IMPC_ACS_034_001	1.7	simpleParameter			IMPC_ACS_006_001 IMPC_ACS_008_001 - IMPC_ACS_006_001 / 100 *	%	FLOAT
% Pre-pulse inhibition - PPI3 IMPC_ACS_035_001	1.7	simpleParameter			IMPC_ACS_006_001 IMPC_ACS_009_001 - IMPC_ACS_006_001 / 100 *	%	FLOAT
% Pre-pulse inhibition - PPI4 IMPC_ACS_036_001	1.8	simpleParameter			IMPC_ACS_006_001 IMPC_ACS_010_001 - IMPC_ACS_006_001 / 100 *	%	FLOAT
% Pre-pulse inhibition - Global IMPC_ACS_037_001	1.6	simpleParameter			IMPC_ACS_006_001 IMPC_ACS_007_001 IMPC_ACS_008_001 + IMPC_ACS_009_001 + IMPC_ACS_010_001 + 4 / - IMPC_ACS_006_001 / 100 *	%	FLOAT

Metadata

	Version	Type	Increment	Option	Derived	Unit	Data Type
Light level in chamber IMPC_ACS_011_001	1.0	procedureMetadata		95		Lux	INT
Startle stimulus IMPC_ACS_015_001	1.2	procedureMetadata		110		dB	INT
Background noise IMPC_ACS_016_001	1.1	procedureMetadata		65		dB	INT

	Version	Type	Increment	Option	Derived	Unit	Data Type
Pre-pulse stimulus 1 IMPC_ACS_017_001	1.1	procedureMetadata		70		dB	INT
Pre-pulse stimulus 2 IMPC_ACS_018_001	1.1	procedureMetadata		75		dB	INT
Pre-pulse stimulus 3 IMPC_ACS_019_001	1.1	procedureMetadata		80		dB	INT
Pre-pulse stimulus 4 IMPC_ACS_020_001	1.2	procedureMetadata		85		dB	INT
Inter PP-S stimulus interval IMPC_ACS_013_001	1.0	procedureMetadata		50		ms	INT
Inter-trial interval IMPC_ACS_021_001	1.3	procedureMetadata		random 10-20		s	TEXT
Number of trials IMPC_ACS_022_001	1.0	procedureMetadata		105			INT
In-chamber adapt time IMPC_ACS_023_001	1.1	procedureMetadata		300		s	INT
Stimulus order IMPC_ACS_024_001	1.0	procedureMetadata		Pseudo-random			TEXT
Mouse chamber ID IMPC_ACS_025_001	1.1	procedureMetadata					TEXT
Equipment ID IMPC_ACS_026_001	1.0	procedureMetadata					TEXT
Experimenter ID IMPC_ACS_014_001	1.0	procedureMetadata					TEXT
Equipment manufacturer IMPC_ACS_027_001	1.0	procedureMetadata		O'hara Co. Ltd.			TEXT
Equipment model IMPC_ACS_028_001	1.0	procedureMetadata		SR-4020			TEXT
Software version IMPC_ACS_029_001	1.1	procedureMetadata		Animal Startle SR-9020			TEXT
Mouse chamber dimension IMPC_ACS_030_001	1.2	procedureMetadata		7.5 x 3.0		cm	TEXT
Sound generator manufacturer IMPC_ACS_031_001	1.1	procedureMetadata		O'hara Co. Ltd.			TEXT
Sound generator model	1.0	procedureMetadata		SR1040			TEXT

	Version	Type	Increment	Option	Derived	Unit	Data Type
IMPC_ACS_039_001							
Sound-proof box dimension IMPC_ACS_032_001	1.2	procedureMetadata		33 x 43 x 33		cm	TEXT
Date equipment last calibrated IMPC_ACS_038_001	1.2	procedureMetadata					DATE
Acoustic startle response measure IMPC_ACS_040_001	1.0	procedureMetadata		Peak-to-peak			TEXT