

# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Session Description** During COVID-19 lockdowns, many auditory scientists were forced to begin or expand their use of online data collection platforms. Three years later, what have we learned? How can psychoacoustics, and rigorous experimentation more broadly, be conducted online? What are the upsides and downsides of web-based data collection? Moving forward, what kinds of new opportunities are enabled by online experimentation? The goal of this symposium is to disseminate recent advances using online data collection, share methods for online research, and review potential pitfalls of online experimentation. Presenters will discuss different ways online experiments can be conducted, including one-on-one interactions, asynchronous data collection, and active behavioral measurement paradigms. By bringing together perspectives from clinical and basic scientists, we hope to explore how online experimentation can be used to augment a broad range of research programs for years to come.

**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

**In-Person Participation** I intend to participate in the MidWinter Meeting in-person for the entirety of the scheduled meeting.

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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\* Presenting Author

First Name	Last Name	Affiliation
Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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\* Presenting Author

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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REG<sub>r</sub>). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REG<sub>r</sub> are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REG<sub>r</sub> conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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\* Presenting Author

First Name	Last Name	Affiliation
Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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Meher *	Lad *	Newcastle University
Ester	Benzaquen	Newcastle University

Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online experiments using recruitment services (such as Prolific or Amazon Mechanical Turk) are becoming increasingly important in cognitive science. However, conducting online research in the auditory domain is particularly challenging: it requires participants to use certain hardware (headphones or microphone), be in a quiet environment, and provide complex behavioral responses, such as subjective ratings or reaction times with high millisecond-level precision. In this talk, I examine key challenges and recommendations when conducting online research in complex auditory modalities, such as recording participants' responses (tapping or singing) through the web browser with high temporal fidelity. I will then discuss how these challenges can be addressed by combining several useful techniques, such as economic pre-screen tasks, data quality monitoring online, motivational incentives, and feedback based on performance. Finally, I will show that by applying these recommendations researchers can now conduct large-scale online experiments that would be nearly impossible in the laboratory, reducing experimental costs while massively increasing the efficiency, scalability, and diversity of auditory research.

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\* Presenting Author

First Name	Last Name	Affiliation
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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

# Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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\* Presenting Author

First Name	Last Name	Affiliation
Nori *	Jacoby *	Max Planck Institut for Empirical Aesthetics

Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



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<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

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**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

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**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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\* Presenting Author

First Name	Last Name	Affiliation
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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REGr). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REGr are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REGr conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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\* Presenting Author

First Name	Last Name	Affiliation
Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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First Name	Last Name	Affiliation
Meher *	Lad *	Newcastle University
Ester	Benzaquen	Newcastle University

Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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**Individual Abstract** Online experiments using recruitment services (such as Prolific or Amazon Mechanical Turk) are becoming increasingly important in cognitive science. However, conducting online research in the auditory domain is particularly challenging: it requires participants to use certain hardware (headphones or microphone), be in a quiet environment, and provide complex behavioral responses, such as subjective ratings or reaction times with high millisecond-level precision. In this talk, I examine key challenges and recommendations when conducting online research in complex auditory modalities, such as recording participants' responses (tapping or singing) through the web browser with high temporal fidelity. I will then discuss how these challenges can be addressed by combining several useful techniques, such as economic pre-screen tasks, data quality monitoring online, motivational incentives, and feedback based on performance. Finally, I will show that by applying these recommendations researchers can now conduct large-scale online experiments that would be nearly impossible in the laboratory, reducing experimental costs while massively increasing the efficiency, scalability, and diversity of auditory research.

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First Name	Last Name	Affiliation
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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

## Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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\* Presenting Author

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Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Session Description** During COVID-19 lockdowns, many auditory scientists were forced to begin or expand their use of online data collection platforms. Three years later, what have we learned? How can psychoacoustics, and rigorous experimentation more broadly, be conducted online? What are the upsides and downsides of web-based data collection? Moving forward, what kinds of new opportunities are enabled by online experimentation? The goal of this symposium is to disseminate recent advances using online data collection, share methods for online research, and review potential pitfalls of online experimentation. Presenters will discuss different ways online experiments can be conducted, including one-on-one interactions, asynchronous data collection, and active behavioral measurement paradigms. By bringing together perspectives from clinical and basic scientists, we hope to explore how online experimentation can be used to augment a broad range of research programs for years to come.

**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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\* Presenting Author

First Name	Last Name	Affiliation
Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

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Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REGr). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REGr are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REGr conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

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Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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\* Presenting Author

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Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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First Name	Last Name	Affiliation
Meher *	Lad *	Newcastle University
Ester	Benzaquen	Newcastle University

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Helen	Nuttall	Lancaster University
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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

# Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Session Description** During COVID-19 lockdowns, many auditory scientists were forced to begin or expand their use of online data collection platforms. Three years later, what have we learned? How can psychoacoustics, and rigorous experimentation more broadly, be conducted online? What are the upsides and downsides of web-based data collection? Moving forward, what kinds of new opportunities are enabled by online experimentation? The goal of this symposium is to disseminate recent advances using online data collection, share methods for online research, and review potential pitfalls of online experimentation. Presenters will discuss different ways online experiments can be conducted, including one-on-one interactions, asynchronous data collection, and active behavioral measurement paradigms. By bringing together perspectives from clinical and basic scientists, we hope to explore how online experimentation can be used to augment a broad range of research programs for years to come.

**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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\* Presenting Author

First Name	Last Name	Affiliation
Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

### Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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\* Presenting Author

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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REGr). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REGr are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REGr conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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Meher *	Lad *	Newcastle University
Ester	Benzaquen	Newcastle University

Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online experiments using recruitment services (such as Prolific or Amazon Mechanical Turk) are becoming increasingly important in cognitive science. However, conducting online research in the auditory domain is particularly challenging: it requires participants to use certain hardware (headphones or microphone), be in a quiet environment, and provide complex behavioral responses, such as subjective ratings or reaction times with high millisecond-level precision. In this talk, I examine key challenges and recommendations when conducting online research in complex auditory modalities, such as recording participants' responses (tapping or singing) through the web browser with high temporal fidelity. I will then discuss how these challenges can be addressed by combining several useful techniques, such as economic pre-screen tasks, data quality monitoring online, motivational incentives, and feedback based on performance. Finally, I will show that by applying these recommendations researchers can now conduct large-scale online experiments that would be nearly impossible in the laboratory, reducing experimental costs while massively increasing the efficiency, scalability, and diversity of auditory research.

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\* Presenting Author

First Name	Last Name	Affiliation
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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

# Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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\* Presenting Author

First Name	Last Name	Affiliation
Nori *	Jacoby *	Max Planck Institut for Empirical Aesthetics

Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

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<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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First Name	Last Name	Affiliation
Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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\* Presenting Author

First Name	Last Name	Affiliation
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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REG<sub>r</sub>). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REG<sub>r</sub> are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REG<sub>r</sub> conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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\* Presenting Author

First Name	Last Name	Affiliation
Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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Meher *	Lad *	Newcastle University
Ester	Benzaquen	Newcastle University

Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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\* Presenting Author

First Name	Last Name	Affiliation
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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

# Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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Nori *	Jacoby *	Max Planck Institut for Empirical Aesthetics

Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Session Description** During COVID-19 lockdowns, many auditory scientists were forced to begin or expand their use of online data collection platforms. Three years later, what have we learned? How can psychoacoustics, and rigorous experimentation more broadly, be conducted online? What are the upsides and downsides of web-based data collection? Moving forward, what kinds of new opportunities are enabled by online experimentation? The goal of this symposium is to disseminate recent advances using online data collection, share methods for online research, and review potential pitfalls of online experimentation. Presenters will discuss different ways online experiments can be conducted, including one-on-one interactions, asynchronous data collection, and active behavioral measurement paradigms. By bringing together perspectives from clinical and basic scientists, we hope to explore how online experimentation can be used to augment a broad range of research programs for years to come.

**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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\* Presenting Author

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Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

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First Name	Last Name	Affiliation
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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REGr). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REGr are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REGr conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

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Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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First Name	Last Name	Affiliation
Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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Meher *	Lad *	Newcastle University
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Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online experiments using recruitment services (such as Prolific or Amazon Mechanical Turk) are becoming increasingly important in cognitive science. However, conducting online research in the auditory domain is particularly challenging: it requires participants to use certain hardware (headphones or microphone), be in a quiet environment, and provide complex behavioral responses, such as subjective ratings or reaction times with high millisecond-level precision. In this talk, I examine key challenges and recommendations when conducting online research in complex auditory modalities, such as recording participants' responses (tapping or singing) through the web browser with high temporal fidelity. I will then discuss how these challenges can be addressed by combining several useful techniques, such as economic pre-screen tasks, data quality monitoring online, motivational incentives, and feedback based on performance. Finally, I will show that by applying these recommendations researchers can now conduct large-scale online experiments that would be nearly impossible in the laboratory, reducing experimental costs while massively increasing the efficiency, scalability, and diversity of auditory research.

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\* Presenting Author

First Name	Last Name	Affiliation
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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

## Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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\* Presenting Author

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Nori *	Jacoby *	Max Planck Institut for Empirical Aesthetics

Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Session Description** During COVID-19 lockdowns, many auditory scientists were forced to begin or expand their use of online data collection platforms. Three years later, what have we learned? How can psychoacoustics, and rigorous experimentation more broadly, be conducted online? What are the upsides and downsides of web-based data collection? Moving forward, what kinds of new opportunities are enabled by online experimentation? The goal of this symposium is to disseminate recent advances using online data collection, share methods for online research, and review potential pitfalls of online experimentation. Presenters will discuss different ways online experiments can be conducted, including one-on-one interactions, asynchronous data collection, and active behavioral measurement paradigms. By bringing together perspectives from clinical and basic scientists, we hope to explore how online experimentation can be used to augment a broad range of research programs for years to come.

**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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\* Presenting Author

First Name	Last Name	Affiliation
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Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

### Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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\* Presenting Author

First Name	Last Name	Affiliation
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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REGr). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REGr are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REGr conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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\* Presenting Author

First Name	Last Name	Affiliation
Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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\* Presenting Author

First Name	Last Name	Affiliation
Meher *	Lad *	Newcastle University
Ester	Benzaquen	Newcastle University

Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

## Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

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Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

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**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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\* Presenting Author

First Name	Last Name	Affiliation
Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

### Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Neuropsychological testing is essential for both clinical and basic stroke research; however, the in-person nature of this testing is a limitation. Virtual testing overcomes the hurdles of geographic location, mobility issues, and permits social distancing, yet its validity has received relatively little investigation, particularly in comparison to in-person testing. We present results assessing virtual versus in-person administration of language and communication tasks with 48 left-hemisphere stroke patients (21F, 27 M; mean age =  $63.4 \pm 12$ ; mean years of education =  $15.3 \pm 3.5$ ) in a quasi-test-retest paradigm. Each participant completed two testing sessions: one in their home and one in the research lab. Participants were assigned to one of eight groups, with the testing condition (fully in-person, partially virtual), order of home session (1st, 2nd), and technology (iPad, Windows tablet) varied across groups. Across six speech-language tasks that utilized varying response modalities and interfaces, we found no significant difference in performance between virtual and in-person testing. However, our results reveal key considerations for successful virtual administration of neuropsychological tests, including technology complications and disparities in Internet access.

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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REGr). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REGr are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REGr conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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Roberta *	Bianco *	UCL Ear Institute
Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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Ester	Benzaquen	Newcastle University

Emma	Holmes	UCL
Kate	Slade	Lancaster University
Helen	Nuttall	Lancaster University
Christopher	Plack	University of Manchester
Timothy	Griffiths	Newcastle University

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online experiments using recruitment services (such as Prolific or Amazon Mechanical Turk) are becoming increasingly important in cognitive science. However, conducting online research in the auditory domain is particularly challenging: it requires participants to use certain hardware (headphones or microphone), be in a quiet environment, and provide complex behavioral responses, such as subjective ratings or reaction times with high millisecond-level precision. In this talk, I examine key challenges and recommendations when conducting online research in complex auditory modalities, such as recording participants' responses (tapping or singing) through the web browser with high temporal fidelity. I will then discuss how these challenges can be addressed by combining several useful techniques, such as economic pre-screen tasks, data quality monitoring online, motivational incentives, and feedback based on performance. Finally, I will show that by applying these recommendations researchers can now conduct large-scale online experiments that would be nearly impossible in the laboratory, reducing experimental costs while massively increasing the efficiency, scalability, and diversity of auditory research.

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\* Presenting Author

First Name	Last Name	Affiliation
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Manuel *	Anglada-Tort *	Max Planck Institute for Empirical Aesthetics
Peter M. C.	Harrison	University of Cambridge
Nori	Jacoby	Max Planck Institute for Empirical Aesthetics

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**Signature** Manuel Anglada-Tort

# Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

**Affiliation** Max Planck Institut for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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\* Presenting Author

First Name	Last Name	Affiliation
Nori *	Jacoby *	Max Planck Institut for Empirical Aesthetics

Frank	Hoger	Max Planck Institute for Empirical Aesthetics
Peter	Harrison	Cambridge University

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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\* Presenting Author

First Name	Last Name	Affiliation
Malinda *	McPherson *	Department of Brain and Cognitive Sciences, MIT
Josh	McDermott	MIT

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**Signature** Malinda J. McPherson



# Online Experimentation in Audition: Recent Advances and Future Directions

<b>Submission ID</b>	3003148
<b>Submission Type</b>	Symposia
<b>Topic</b>	Psychoacoustics
<b>Status</b>	Submitted
<b>Submitter</b>	Nori Jacoby
<b>Affiliation</b>	Max Planck Institut for Empirical Aesthetics
<b>Participant(s)</b>	Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

## SUBMISSION DETAILS

**Session Description** During COVID-19 lockdowns, many auditory scientists were forced to begin or expand their use of online data collection platforms. Three years later, what have we learned? How can psychoacoustics, and rigorous experimentation more broadly, be conducted online? What are the upsides and downsides of web-based data collection? Moving forward, what kinds of new opportunities are enabled by online experimentation? The goal of this symposium is to disseminate recent advances using online data collection, share methods for online research, and review potential pitfalls of online experimentation. Presenters will discuss different ways online experiments can be conducted, including one-on-one interactions, asynchronous data collection, and active behavioral measurement paradigms. By bringing together perspectives from clinical and basic scientists, we hope to explore how online experimentation can be used to augment a broad range of research programs for years to come.

**Target Audience:** We believe this symposium will be of interest to all auditory scientists and clinicians working with human participants, including those who work with clinical populations, and those who do basic research and psychophysics.

**Presenter Diversity** In designing this symposium we (co-chairs Nori Jacoby and Malinda McPherson) made every effort to invite a broad range of academics. Our Symposium will be majority female (4/7). Presenters and chairs are from all career stages, including three trainees (Malinda McPherson, Manuel Anglada Tort, and Meher Lad), two early career independent researchers (Nori Jacoby and Roberta Bianca), and two senior academics (Lori Holt and Julie Fiez). We recruited presenters from institutions from both sides of the Atlantic, including three institutions in the USA, one in England, one in Germany, and one in Italy, and the nationalities of the presenters include American, British, Italian, Israeli, and Catalan. We also recruited one senior researcher who normally does not attend ARO (Julie Fiez), but whose perspectives will be relevant to the community, as well as a trainee who will be attending ARO for the first time (Manuel Anglada Tort).

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**Signature** Nori Jacoby

# Online Experimentation in Audition: Recent Advances and Future Directions

## Breaking Auditory Psychophysics Out of the Laboratory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Lori Holt

**Affiliation** Carnegie Mellon University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** The methodologies of auditory psychophysics tend to rely on strongly sound-attenuated environments, finely calibrated equipment, and small numbers of expert or highly trained listeners who are motivated and compliant with task demands. This high level of ‘auditory hygiene’ is important: seemingly minute differences in stimulus delivery and timing, background noise levels, or participant engagement during an arduous task can dramatically affect experimental results. Laboratory disruptions due to COVID-19 inspired unexpectedly successful innovations in porting auditory research from well-controlled laboratories to participants’ home offices and living rooms, using only the internet bandwidth, computers, and headphones at participants’ immediate disposal. We will share three success stories in online auditory psychophysics, and convey lessons that can carry forward to facilitate future post-pandemic research. The first is that robust and efficient human auditory psychophysics is possible with inexpert online listeners using only their home equipment, even for tasks that would seem to demand high control. We demonstrate that online measures are effective even for highly finicky paradigms like tone-in-noise threshold estimation, and frequency-selective attention measured using the probe-signal tone detection in noise paradigm. The second lesson is that studying samples of convenience who tend to be ‘WEIRD people’ from Western, educated, industrialized, rich and democratic backgrounds sometimes leads us to the wrong conclusions about auditory processing. We share examples from our research for which some effects replicate cleanly across in-laboratory university students versus online citizens of the world, and – interestingly – some do not. The third lesson is that gamifying online testing can be highly useful in engaging special populations, or in testing targeted research questions, but that even more typical (dull) psychophysics tasks can succeed online with attention to participant engagement. Finally, we conclude with opportunities and challenges for carrying online testing forward to hasten and democratize future auditory psychophysics research, even beyond the COVID-19 pandemic.

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Lori *	Holt *	Carnegie Mellon University
Sijia	Zhao	University of Oxford
Christopher	Brown	University of Pittsburgh
Casey	Roark	University of Pittsburgh
Frederic	Dick	University College London

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**Signature** Lori L Holt

## Online Experimentation in Audition: Recent Advances and Future Directions

### Comparing the Reliability of Virtual and In-Person Post-Stroke Neuropsychological Assessment with Speech and Language Tasks

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Julie Fiez

**Affiliation** University of Pittsburgh

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

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First Name	Last Name	Affiliation
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Erin	Duricy	University of Pittsburgh
Corrine	Durisko	University of Pittsburgh
Michael	Dickey	University of Pittsburgh
Julie *	Fiez *	University of Pittsburgh

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**Signature** Julie Fiez

## Online Experimentation in Audition: Recent Advances and Future Directions

An online, Reaction-Time based, Longitudinal Study on Long-Term Auditory Memory

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Roberta Bianco

**Affiliation** UCL Ear Institute

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Longitudinal studies are fundamental for understanding auditory memory and plasticity. One major challenge of in-lab approaches is that participants must commit to coming to the lab on a regular basis, often for only brief memory recall sessions. This could be even more problematic for populations with reduced mobility (e.g., ageing or clinical). Online testing can overcome this limitation allowing one to test diverse large samples remotely and with efficiency. We demonstrate the feasibility of online approaches with an auditory memory paradigm based on a reaction times (RTs), tested on young and old participants.

Auditory memory for tone patterns was tested online with a paradigm previously used with young participants in the lab. This test requires participants to listen to rapid tone-sequences and to quickly respond to regularly repeating patterns (REG) emerging from random sequences. Unbeknownst to them, a few different patterns reoccur every ~3 minutes (REG<sub>r</sub>). RTs to novel REG are taken as a measure of the amount of information held in short-term memory until the pattern is detected; RTs to REG<sub>r</sub> are expected to decrease with exposure indicating long-term memory formation of previously heard patterns. Old and young adults (N = 191; aged 60-70 and 20-30 years) were recruited online and performed the test on day 1 (20 min) and a recall test 8 days later (5 min, 1 dropout). Participants were excluded based on an initial headphone check (Milne et al., 2020) and attention checks interspersed in the main task (i.e., absent or slow responses to simple tone changes) (final N = 132). RTs to simple tone changes were further used as a measure of individuals' RTs to simple changes to distil the computation time required to detect the patterns. The results from the online young sample replicated the pattern of RTs to REG and REG<sub>r</sub> conditions observed in lab. Furthermore, we found age-related impairments in both short- and long-term memory measures, but preserved long-term memory in both groups as assessed on day 8. Short- and long-term memory effects were not linked with visual-spatial memory or processing speed

measures.

Overall, there is an exciting promise of online longitudinal studies for tracking how auditory memory changes over long-time periods in populations which would be difficult to repetitively bring to the laboratory. Sensitive measures such as RTs can be reliably collected online, but at the cost of excluding a large number (~30%) of participants failing audio-equipment and attention checks.

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First Name	Last Name	Affiliation
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Maria	Chait	UCL Ear Institute

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**Signature** Roberta Bianco



# Online Experimentation in Audition: Recent Advances and Future Directions

## Online Auditory Experimentation in Ageing and Clinical Disorders

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Meher Lad

**Affiliation** Newcastle University

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online research has allowed scientists to greatly expand the scope of questions they ask and the range of participants they include in their studies. However, this comes with its costs. Online experiments can create different contextual effects, there are limitations on the kind of experiment one can perform and the type of participant one includes in their study. These are increasingly important to consider with older participants and those with cognitive impairments.

In this talk, I will present some successful studies that we have performed, in older participants with and without cognitive impairment, studying auditory perception and range of auditory cognitive processes from scene analysis to auditory memory. I will discuss some of the challenges we faced and some efforts we made to overcome these. Finally, I will present scenarios that we are yet to overcome with patient populations.

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**Signature** Meher Lad

# Online Experimentation in Audition: Recent Advances and Future Directions

## Running Online Auditory Experiments in Complex Production Modalities

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Manuel Anglada-Tort

**Affiliation** Max Planck Institute for Empirical Aesthetics

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Online experiments using recruitment services (such as Prolific or Amazon Mechanical Turk) are becoming increasingly important in cognitive science. However, conducting online research in the auditory domain is particularly challenging: it requires participants to use certain hardware (headphones or microphone), be in a quiet environment, and provide complex behavioral responses, such as subjective ratings or reaction times with high millisecond-level precision. In this talk, I examine key challenges and recommendations when conducting online research in complex auditory modalities, such as recording participants' responses (tapping or singing) through the web browser with high temporal fidelity. I will then discuss how these challenges can be addressed by combining several useful techniques, such as economic pre-screen tasks, data quality monitoring online, motivational incentives, and feedback based on performance. Finally, I will show that by applying these recommendations researchers can now conduct large-scale online experiments that would be nearly impossible in the laboratory, reducing experimental costs while massively increasing the efficiency, scalability, and diversity of auditory research.

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**Signature** Manuel Anglada-Tort

## Online Experimentation in Audition: Recent Advances and Future Directions

Extending the Possibilities of Auditory Psychophysics with Massive Online Experiments

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Nori Jacoby

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**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

### SUBMISSION DETAILS

**Individual Abstract** Experiments conducted online can significantly increase the scale and scope of experimental research. Here I introduce PsyNet (<https://www.psynet.dev/>), a new Python package for developing online behavioral experiments. PsyNet streamlines the development of highly complex experiment paradigms, ranging from adaptive psychophysics to iterated learning to cultural evolution over social networks. It also streamlines experiment deployment, taking care of server provisioning, participant recruitment, data-quality monitoring, and participant payment. As a result, every experiment can be replicated by using only one terminal command. This presentation illustrates how PsyNet can be used to study classical questions in auditory perception such as pitch and consonance perception, and how we can apply it to significantly increase the number of stimuli, participants, and control experiments in a single study, as well as the diversity of the participants in auditory psychology.

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**Signature** Nori Jacoby

## Online Experimentation in Audition: Recent Advances and Future Directions

### Online Auditory Psychophysics Enables New Psychoacoustic Paradigms

**Submission ID** 3003148

**Submission Type** Symposia

**Topic** Psychoacoustics

**Status** Submitted

**Submitter** Malinda McPherson

**Affiliation** Department of Brain and Cognitive Sciences, MIT

**Participant(s)** Nori Jacoby (Chair), Malinda McPherson (Co-chair), Malinda McPherson (Presenter), Lori Holt (Presenter), Roberta Bianco (Presenter), Manuel Anglada-Tort (Presenter), Julie Fiez (Presenter), Meher Lad (Presenter), Nori Jacoby (Presenter)

#### SUBMISSION DETAILS

**Individual Abstract** Recent work has illustrated how traditional psychoacoustic experiments can often be implemented successfully using online crowdsourcing. While online data collection sacrifices precise control over sound quality and participant environment, it enables experiments when in-person activities are limited, and thus gained converts during the pandemic. However, online experiments are more than a fallback. In particular, they facilitate data collection on a scale that is difficult to attain in the laboratory. In this talk I will describe several results from experiments that were only feasible because of online recruitment. For example, we have measured individual differences in pitch discrimination judgments across hundreds of participants. Individual sessions in these experiments lasted up to two hours, analogous to typical in-person experiment durations, and the measured pitch discrimination judgments were comparable to those obtained in tightly controlled laboratory conditions. However, online recruitment enabled us to enroll the large numbers required to assess, and to replicate, individual differences (>700 participants) - sample sizes that would have been impractical to obtain in the lab. I will also describe several experiments whose design required participants to complete only a single trial per condition. Such experiments again require very large samples to achieve adequate power, making them impractical for the lab. But such approaches can yield new insights and are readily possible when implemented online. We will argue that even outside of extreme circumstances such as a pandemic, the ability to recruit large numbers of participants make online experiments an attractive tool, and expands the range of psychoacoustic paradigms.

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**Signature** Malinda J. McPherson