APCAM 2015

14th Annual Auditory Perception, Cognition, and Action Meeting

Thursday, November 19th
Astoria Room, 3rd Floor
Hilton Chicago Hotel

Chicago, Illinois

Program sponsored by

WASHBURN UNIVERSITY

Welcome to APCAM 2015

Let us be the first to welcome you to (the Hilton Chicago Hotel in) Chicago, Illinois, site of the fourteenth annual Auditory Perception, Cognition, and Action Meeting (APCAM 2015). From its inception APCAM has pursued a unique mission: ". . . to bring together researchers from various theoretical perspectives to present focused research on auditory cognition, perception, and aurally guided action". We believe it to represent one of the only meetings where within a single session you will find a mixture of both basic and applied auditory research, reflecting different types of theoretical models, varying levels of processing accounts, and all manners of stimuli (including speech, music, and environmental noises). The fact that APCAM continues to flourish is a testament to the openness of its attendees to hear other perspectives, a principle characteristic of scientific progress.

Successful preparation of this year's APCAM would not have been possible without generous contributions of time and money from several sources. Primary among these is the Psychonomic Society, which, for several years now, has continued to cover all the expenses associated with meeting rooms, A/V equipment, and poster displays. Elimination of this major expense is the principle reason that we are able to provide APCAM as a free event. The society continues to cover room and equipment costs for its satellite meetings because it is believed that those meetings represent added value to the larger society conference. Thus, it is hoped that you also will be sure to attend the subsequent meeting of Psychonomic Society and enjoy its packed program as well. You should feel free to pass along gratitude to society leadership for helping to make APCAM available at no cost. We also want to express our gratitude to Washburn University, which, for several additional years, has absorbed the responsibility and costs associated with formatting and printing APCAM conference programs. Likewise, the committee extends its thanks to Kristopher (Jake) Patten for his help in reviewing abstract submissions again this year.

It should be clear that it takes a lot of people to arrange this event each year, and it is our hope that their efforts translate into a positive and rewarding meeting for you, its attendees. Ultimately, however, its success depends upon the strength of the program and ensuing discussions that you helped to generate. We hope that you concur that this year's program delivers a collection of novel and thoughtful work. Thank you to all presenters for choosing to share your work with us.

APCAM's vitality has depended largely on attendees sharing information about the conference with their colleagues by word of mouth. There is some evidence that this approach may be working to gradually foster growth of the meeting. For example, this year we received greater than 1.6 times the number of submissions compared to last year's submission totals. While such an increase likely reflects a number of contributing factors (including, for example, differences in the convenience of travel to conference sites), it is clear that the program continues to be enriched each passing year by the infusion of perspectives from first-time attendees, many of whom traditionally have become regular APCAM contributors. We would like to see this remain a consistent trend. We therefore kindly ask that if you enjoy your APCAM experience, then please pass that information along to other colleagues and bring them to our next meeting (slated for Boston, Massachusetts on November 17, 2016). In this way our shared meeting can remain vibrant and continue to grow.

Additionally, if there are issues that arise during the meeting, or thoughts that you have for further enriching the program or its execution in the future, then please do not hesitate to share those concerns or thoughts with any of us on the committee at any point. We welcome your feedback. For now, have a pleasant and productive day at APCAM.

Sincerely,
The APCAM 2015 Organizing Committee
Michael D. Hall (Chair)
Devin McAuley
John Neuhoff (Founder)
Peter Q. Pfordresher
Mike Russell

APCAM 2015 Schedule

8:00	**Registration – Astoria Room, 3rd Floor, Chicago Hilton**	
8:25	**Opening Remarks**	
	Multi-Sensory Stimulation, Attention, & Change Deafness (abstracts pages 10 – 13)	
8:30	The elephant in the road: High auditory perceptual load causes inattentional blindness in drivers	**Gillian Murphy* Ciara Greene**
8:50	Methodological considerations and alternative explanations for demonstrations of change deafness	**Michael D. Hall* Rachael B. Peck Jeremy Gaston Kelly Dickerson Heather Daly**
9:10	Predicting change deafness in natural auditory scenes using perceptual auditory similarity spaces	**Brandon Perelman* Kelly Dickerson Jeremy Gaston**
9:30	Testing the stability of the pitch-size and pitch-height cross-modal correspondences	**Laura Getz* Daniel Shanahan Michael Kubovy**
9:50	Metaphorical priming of music concepts	**Ryan Brigante* Bart Rypma**
10:10	**Break (20 mins)**	
	Music (abstracts page 14 – 15)	
10:30	Synchronization among performing musicians: Effects of leadership, spontaneous rates, and tempo flexibility.	**Caroline Palmer* Mark Elliott Dominic Ward Ryan Stables Alan Wing**
10:50	Effects of accompaniment during vocal pitch imitation reflect use of forward internal models	**Malak Sharif* Peter Pfordresher**
11:10	Sensory consonance and the perception of change in polyphonic melodies	**George Seror III* W. Neill**

11:30	The sixth momentum: Musical succession and physical motion	**Timothy Hubbard***
Poster Session (12 noon – 1:20 PM) Salon D (located on the Lower Level) Abstracts located on pages 24 – 40		
Lunch (1:20 – 2:00 PM)		
Invited Address (abstract page 17)		
2:00	***Groove's ecology: Sound, structure, and action***	***Richard Ashley***
Symposium: Perceptual biases coupled to natural regularities in auditory scenes (abstracts pages 18 – 20)		
2:30 to 3:10	Why do eeks sound high and ohs sound low? Patterns of speech and scat songs confirm a functional relationship between timbre and pitch	**K. Jakob Patten* Michael McBeath R. Chandler Krynen**
	Raising fundamental frequency when yelling is a natural regularity throughout the animal kingdom	**Michael McBeath* K. Jakob Patten R. Chandler Krynen Zachary Wilkinson**
	A natural regularity for a correlation between speech rate, intensity, and fundamental frequency	**Richard Krynen* Michael McBeath K. Jakob Patten**
3:10	**Break (20 min)**	
General (abstracts pages 21 – 22)		
3:30	Spectral TOJ: Suggested mechanism for non-temporal responses	**Leah Fostick* Harvey Babkoff**
3:50	Listening to act: Comparisons of temporal estimates in response to natural and artificial sound patterns	**Valeriy Shafiro* Brian Gygi Anatoliy Kharkhurin**

4:10	Auditory context and speech recognition in children	**Karen Banai* Wadeah Jadaon Rachel Yifat**
4:30	Intentional and spontaneous interpersonal synchronization in dyslexia	**Alexander Demos* Stephanie Del Tufo Kerry Marsh Rachel Theodore Roger Chaffin**
Discussion (abstract page 23)		
4:50	***Considerations for Increasing APCAM's Internet Presence***	**Michael D. Hall Devin McAuley John Neuhoff Peter Q. Pfordresher Mike Russell**
5:20	**Closing Remarks**	

Posters (abstracts located on pages 24 – 40)		
1	**Student's second-language grade may depend on classroom listening position**	**Robert Ljung* Anders Hurtig Patrik Sörqvist**
2	**Spatial fusion of auditory and visual stimuli in motion**	**David Hartnagel* Alain Bichot Lionel Pellieux Corinne Roumes Patrick M.B. Sandor**
3	**The effect of key distance on recognition of non-diatonic melodies**	**Abigail Kleinsmith* W Neill**
4	**Systematic listening exposure influences implicit knowledge of a Turkish musical scale**	**Timothy Justus* Nart Bedin Atalay Nazike Mert Charles Yates Meagan Curtis**
5	**Automatic processing of the semantic content of non-significant and neutral irrelevant sound: Evidence from a semantic deviation effect**	**Katherine Labonté Michaël Lévesque-Dion Nick Perham John Marsh François Vachon***
6	**Stimulus and familiarity factors in judgments of musical tempo**	**Justin London Birgitta Burger Marc Thompson Petri Toiviainen**
7	**The influence of major and minor tonality of music on an associative color-sound perception**	**Olena Anisimova***
8	**Eyes have ears: Pupillary response to auditory deviants reflects attentional capture during active visual tasks**	**Alexandre Marois* Vsevolod Peysakhovich Maxime Legendre Gabrielle Lebron-Paradis François Vachon,**
9	**The validation of a new online questionnaire for assessing spatial-hearing abilities**	**Christophe Micheyl Adriana Goyette* Sridhar Kalluri**

10	**Classifying auditory stimuli: A survey of perception research in leading journals**	**Michael Schutz***
11	**Beauty and the beast: WAVs invoke less negativity than MP3s in listeners**	**Joshua Sites* Edgar Jamison-Koenig Robert Potter**
12	**Acoustic cues and world knowledge impact listeners' perception of confidence**	**Jennifer Roche* Schea Fissel**
13	**Top-down effects on the association between numerical magnitude and auditory pitch**	**Steve Scheid* Michael Kubovy**
14	**An examination of auditory experience and change deafness to natural scenes**	**Rachel Boraca Melissa Gregg**
15	**Hemispheric differences in change deafness**	**Kacy OHaver* Melissa Gregg**
18	**Examining the time course of sound-class categorization: Insights from acoustic features**	**Mattson Ogg* L. Robert Slevc William Idsardi**
16	**Studying the effect of foreign accent on serial recall through error analysis**	**Kit Ying Chan* Brady Dailey Daroon Jalil**
17	**Artificially natural: Creating carefully-controlled acoustic cue continua from natural speech**	**David Saltzman* Ariane Rhone Bob McMurray Joseph Toscano**
18	**Examining the time course of sound-class categorization: Insights from acoustic features**	**Mattson Ogg* L. Robert Slevc William Idsardi**
19	**Measuring phonetic convergence and acoustic properties of speech with engaging, naturalistic experimental tasks**	**Tifani Biro* Joseph Toscano Navin Viswanathan**

20	**Speech testing using token-level error thresholds: Comparison with pure-tone audiograms**	**Alexandra Tabachnick* Beach Brooks Jont Allen Joseph Toscano**
21	**Characterization of short-term and long-term spectral variation in real-world auditory backgrounds**	**Jitwipar Suwangbutra* Ashley Foots Kelly Dickerson Jeremy Gaston Timothy Mermagen**
22	**The neglected aspect of auditory space: Perception of occlusion**	**Michael Russell* Stephanie Brown**
23	**Formal music education alters perceived musicality of pitch sequences**	**Mrinmayi Kulkarni* Katherine Potkonjak Richard Randall Adam Greenberg**
24	**Transformation under cover: The emotional power of pop song variation and its ability to enhance visual interpretation**	**Cheryl Bates***
25	**Investigating the individual resonant properties of the human skull**	**Michael D. Hall* Jitwipar Suwangbutra Rachael B. Peck Jeremy Gaston Ashley Foots Michael S. Gordon**
26	**Sorting excerpts of Western classical music based on perceived similarity**	**Rachna Raman* Michael Kriegsman Hervé Abdi W. Jay Dowling Barbara Tillmann**
27	**Memory for musical melodies in affective contexts**	**Alejandro Ataucusi Michael S. Gordon***
28	**Prelayed and delayed auditory feedback for sight-reading musicians influences gaze**	**Michael S. Gordon* Andrew Lucila Benjamin Ciccarelli Franklin Roque Michael Morgan**

29	**Interval discrimination and melodic dictation as implications of cognitive processing**	**Dorothy Musselwhite* Brian Wesolowski George Engelhard**
30	**Sustained theta (4-7 Hz) and alpha (8-12 Hz) synchronization in the electroencephalogram during auditory processing: Effects of listening difficulty**	**Matthew Wisniewski***
31	**Auditory-verbal sequence learning: The role of streaming**	**Robert Hughes John Marsh***
32	**Gradient categorization of speech sounds helps listeners recover from lexical garden paths**	**Efthymia Kapnoula* Jan Edwards Bob McMurray**

Oral Presentations

8:30

The elephant in the road: High auditory perceptual load causes inattentional blindness in drivers.

Gillian Murphy* *University College Cork*
Ciara Greene *University College Dublin*

Perceptual load (i.e. the amount of information to be processed in a given task) has been shown to affect awareness, with numerous studies demonstrating higher levels of inattentional blindness and deafness under high perceptual load. However, there is disagreement as to whether load in one modality can affect performance in another. This is a crucial question for applied settings as most everyday attention tasks have, at the very least, auditory and visual components. In the current study, 18 drivers drove a route in a driving simulator while actively listening to a traffic update on the radio. The audio task imposed either low load (listen for when the speaker changes gender) or high load (listen out for an update on the N248). High auditory perceptual load significantly reduced awareness for large, unexpected stimuli (an elephant or gorilla at the roadside), with just 23% of drivers reporting awareness under high load, compared to 71% under low load. High auditory load also affected other measures of driver awareness such as obeying yield signs and recalling what vehicle had just passed, as well as driving performance itself (speed, lane position, reaction times to hazards). This research suggests that perceptual load can have cross-modal effects on attention when driving, even to the extent of failing to report awareness of a 30-foot tall elephant encountered during a suburban route. That this has been found using a simple, naturally occurring task such as listening for a traffic update on the radio suggests that auditory load may be an important, often overlooked contributor to driver distraction and inattention.

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8:50

Methodological considerations and alternative explanations for demonstrations of change deafness.

Michael D. Hall* *James Madison University*
Rachael B. Peck *James Madison University*
Jeremy Gaston *US Army Research Laboratory*
Kelly Dickerson *US Army Research Laboratory*
Heather Daly *James Madison University*

Several recent investigations have been claimed to demonstrate change deafness as the auditory analog to change blindness (e.g., Snyder & Gregg, 2011; Neuhoff, Schott, Kropf, & Neuhoff, 2014), where listeners cannot detect above-threshold changes in auditory events or scenes. Our continuing cross-laboratory investigations have sought to address challenges to establishing change deafness, including distinguishing it from problems in encoding or increased stimulus uncertainty, as well as ensuring listeners can identify changed events. We additionally assert that some demonstrations represent ―inattentional deafness‖, where change deafness reflects attentional misdirection due to task instructions. A new paradigm provides more analogous conditions to change blindness demonstrations. Changes to a target event were flickered or continuously oscillated within virtual spatial arrays composed of the same four events; listeners identified targets as rapidly as possible. An initial test distributed events evenly across 120° of azimuth, with listeners identifying the oscillating event (moving 60°). Flicker conditions produced substantially fewer change-detection errors than are commonly reported. Furthermore, response times were faster when arrays were extended (3s v. 1s) prior to the change, revealing the impact of encoding. Only a continuous condition (with gradually moving targets) provided some evidence of change deafness, and a subsequent experiment further revealed that response times in this condition did not critically depend upon the rate of movement (from 8-80°/s). We have extended this approach to frequency-based timbre manipulations (narrow-band filtering around a target's spectral centroid) to permit a corresponding evaluation for perceptually dominant dimensions. Preliminary data indicate faster responses than for spatial arrays, but also a corresponding condition-specific distribution of response times. Thus, continuous changes to events again produced some evidence of change deafness. Finally, a task variant will be provided that enables evaluations of change deafness and inattentional deafness using identical stimuli. Methodological and theoretical implications for future investigations will be discussed.

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9:10

Predicting change deafness in natural auditory scenes using perceptual auditory similarity spaces

Brandon Perelman* *US Army Research Laboratory*
Kelly Dickerson *US Army Research Laboratory*
Jeremy Gaston *US Army Research Laboratory*

In natural environments, auditory scenes are often comprised of multiple sound sources and changes to those scenes can be easy to miss. The phenomenon Change deafness describes the inability to detect these changes, and can impair performance in natural environments. One factor that seems to mediate change deafness for environmental sounds is similarity among scene stimuli. Similarity is often operationalized as inter-stimulus distance in mappings generated using multidimensional scaling (MDS). Approaches typically attempt to map physical acoustic features onto MDS dimensions, but subjective dimensions such as sematic similarity may also account for patterns of change deafness performance (e.g. Gregg & Samuel, 2009). The goal of this study was to use perceptual similarity to predict change deafness errors. Using a set of 25 environmental sounds, 12 listeners discriminated changes between successive 1 sec scenes in a change deafness task. A separate group of 34 listeners made perceptual similarity ratings for pairs of the same 25 sounds for three instruction manipulations: (1) without instructions, or with (2) acoustic or (3) semantic instructions. These ratings were used to construct 2D MDS spaces using (1) non-metric and (2) metric MDS algorithms. These solutions were compared to patterns of change deafness to predict the magnitude of change errors. Acoustic instructions produced the lowest stress MDS solution, while the control solution contained the most stress. Qualitatively, the metric MDS solutions produced tight clusters of stimuli whereas the non-metric solutions approximated circumplexes. The non-metric solutions provided superior fits for performance, with the control ratings producing the highest explained variance, though both MDS algorithms and all three instruction conditions produced significant linear models. This study represents one step toward establishing current best practices for using similarity spaces to predict change deafness.

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9:30

Testing the stability of the pitch-size and pitch-height cross-modal correspondences

Laura Getz* *University of Virginia*
Daniel Shanahan *Louisiana State University*
Michael Kubovy *University of Virginia*

One of the main problems of the human perceptual system is deciding when and how multi-modal inputs should be combined into a single percept; this problem is commonly referred to as multisensory integration or the binding problem. Cross-modal correspondences, i.e., the consistent matching between sensory features across two modalities, have been proposed as a reliable solution to the binding problem. For example, people tend to match auditory pitch and visual size in a way that reflects the statistics in the environment; large objects make low-pitched sounds and small objects make high-pitched sounds. People tend to match auditory pitch and visual height in a way that reflects semantic overlap; the same words—low and high—are used to describe stimuli that vary in pitch and stimuli that vary in visual elevation. There is evidence that matching congruent endpoints (e.g., large/low and small/high) results in faster and more accurate processing than reversed endpoints (e.g., large/high and small/low). Here I show the fragility of the pitch-height correspondence. Using several converging operations, including conceptual and direct replications, I have failed to find fusion between auditory pitch and visual size. This is not due to my methodological choices: preliminary results on a similar test of the pitch-height correspondence do show automatic fusion between auditory pitch and visual elevation. I will present a plan for future research aimed at addressing differences in stability for different types of correspondences, which may have implications for how reliable a solution cross-modal correspondences can be in solving the binding problem. Further, this work adds to the current debate regarding the modularity of perception from the influence of higher-order cognition.

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9:50

Metaphorical priming of music concepts

Ryan Brigante* *University of Texas at Dallas*
Bart Rypma *University of Texas at Dallas*

Studies of grounded cognition have examined the possibility that concept representations are interlinked across modalities, and concepts from one modality can be understood in terms of another modality. This is particularly relevant in music cognition, where auditory concepts are often understood in terms of visual metaphors. For example, pitches are understood as heights (high and low pitch), timbre is understood as brightness (bright and dark tone), and melodies are understood as trajectories (ascending and descending note sequences). An unresolved question is whether metaphorical concepts are merely associated with each other at an abstract level, or whether they can causally influence each other at the perceptual level. Here we examine the hypothesis that metaphorical concepts can prime each other. We conducted two experiments that examined the cross-modality mappings of BRIGHTNESS -> PITCH, BRIGHTNESS -> TIMBRE, and SPEED -> TEMPO. Specifically, we tested whether perceptual priming of a visual dimension can influence judgments about a metaphorically-related auditory dimension. In Experiment 1, musically trained and untrained participants rated the pitch and brightness of tones and chords while viewing colors of varying brightness levels. In Experiment 2, participants estimated the musical tempo of rhythmic stimuli while viewing a moving stimulus of varying speeds. We found evidence for metaphorical priming in both cases. In Experiment 1, brighter colors elicited higher pitch ratings and higher brightness ratings for musical chords (but not for individual tones). In Experiment 2, faster-moving animations elicited greater tempo estimates (controlling for actual tempo). In both experiments, priming effects were greater among untrained participants. It might be that musically trained participants have more literal representations of music concepts, and thus they are less influenced by metaphorical priming.

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10:10 Break (20 mins)

10:30

Synchronization among performing musicians: Effects of leadership, spontaneous rates, and tempo flexibility.

Caroline Palmer* *McGill University*
Mark Elliott *University of Warwick*
Dominic Ward *Birmingham City University*
Ryan Stables *Birmingham City University*
Alan Wing *University of Birmingham*

Temporal synchronization is critical for musical ensembles. We investigate factors that influence performers' adjustments to tempo fluctuations during violin trio performances. We compared asynchronies between violinists' tone onsets with differences in violinists' endogenous rhythms, as measured by each performer's spontaneous musical tempo (Zamm et al, EBR, 2015). We also compared asynchronies with individual measures of rate flexibility, based on measures of asynchrony during performance with a metronome. Finally, we tested whether designation of a musical leader is reflected in the timing corrections (Wing et al, Roy Soc Interf, 2014) of each performer being weighted toward the leader. Three trios of student violinists from a symphony orchestra were tested. In the first session, each violinist played a familiar tune in solo performances, as measures of their spontaneous musical rate (SMR). Large SMR differences were obtained across violinists, but consistent rates within violinist. Next, they performed with a metronome at rates surrounding their SMR; asynchronies became more negative (performer anticipating metronome) for rates slower than the SMR and more positive for rates faster than the SMR. In the second session, violin trios performed the piece with instructions that the Leader was responsible for the tempo. Tone onsets were extracted from audio recordings, and asynchronies calculated from pairwise differences of tone onset times between performers. Results suggest that the amount of asynchrony is predicted by SMR differences (Leader - Followers). A linear phase correction model fit to the asynchronies suggested that leadership assignment influenced the estimated correction gains between performers. Findings are discussed in terms of the roles of individual performance measures.

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10:50

Effects of accompaniment during vocal pitch imitation reflect use of forward internal models

Malak Sharif* *University at Buffalo, The State University of New York*
Peter Pfordresher *University at Buffalo, The State University of New York*

It is commonly assumed that vocal imitation can be guided by auditory error correction, as in the case when a poor singer is seated next to a stronger singer in a choir. We explored how the augmenting of auditory feedback affects vocal imitation of pitch in two experiments. In the first experiment, participants vocally imitated four-note melodies by singing and were either unaccompanied or were accompanied by augmented feedback (a correct performance) that could be used for online error correction. We measured the absolute difference between a participants' imitation and the target melody in cents. Whereas augmented feedback had negligible effects for accurate singers, it in fact disrupted production of poorer singers when augmented feedback was relatively loud and heard over speakers rather than headphones (thus mimicking the choir scenario above). The second experiment explored the effect of intensity further. After first running a scaling study to find matching intensity levels across headphones and speakers, we manipulated the intensity of the augmented feedback such that the participants heard melodies with augmented feedback of five intensity levels (65dB, 70dB, 73dB, 75dB and 80dB). Here, we found that singers made fewer errors as the intensity of augmented feedback increases compared to when the intensity is lower and the disruptive effect of augmented feedback on poor singers increased with its intensity. We conclude that these results reflect deficient forward models of the auditory-vocal system in poor singers. As a result, poor singers have trouble associating auditory feedback with motor plans. This leads to problems distinguishing their own feedback from the augmented feedback source, particularly when the augmented source is loud.

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11:10

Sensory consonance and the perception of change in polyphonic melodies

George Seror III* *University at Albany, The State University of New York*
W. Neill *University at Albany, The State University of New York*

Polyphonic melodies appear to be encoded as separate auditory streams while at the same time retaining a gestalt like quality created by the interaction of tones as harmonic intervals. The current study examines several factors contributing to the perception of change between standard and comparison melodies. Participants rated pairs of polyphonic melodies as —same‖ or —different‖. In the different condition, melodies were altered by changing the final tone in either the upper or the lower voice by one or two semitones. Changes in comparison melodies were either within the key defined by the preceding melodic context or outside of the key. The harmonic interval resulting from a change also varied in sensory consonance. Changes could thus vary in sensory consonance (consonant vs. dissonant interval) and musical consonance (in key vs. out of key), and could occur in the upper or the lower voice. We found that 1 semitone changes resulting in dissonance were detected more easily than 2 semitone changes resulting in consonance, and these changes were detected more easily in the upper voice than in the lower voice. Further, the results suggested that consonance had a larger effect on out of key vs. in key changes. We compare these behavioral data with EEG data using Mismatch Negativity (MMN) to examine unattended melodic changes.

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11:30

The sixth momentum: Musical succession and physical motion

Timothy Hubbard*

Metaphors involving physical motion have for millennia influenced ideas about the nature of music. Larson (2012 [Musical Forces: Motion, Metaphor and Meaning in Music, Bloomington, IN: Indiana University Press]) suggested physical motion provides a potent metaphor for understanding musical succession, and he posited that the representation and experience of musical succession included analogues of physical forces that influence the motion of objects in the physical world; these analogues are referred to as musical forces, and three such musical forces are musical gravity, musical magnetism, and musical inertia. Larson‘s suggestion that musical inertia is similar to representational momentum is examined, and properties of representational momentum and of musical inertia are compared. Although appearing to share many properties, representational momentum and musical inertia operate on different time-scales, and it is suggested that musical inertia might be more closely related to other momentum-like effects such as behavioral momentum and psychological momentum that operate on longer time-scales than does representational momentum. Properties of behavioral momentum and of psychological momentum are compared with properties of musical representation. Many similarities are noted, and it is suggested that some aspects of musical representation exhibit momentum-like effects. As momentum is the product of mass and velocity, speculation regarding the musical analogues of mass and velocity is provided. It is also suggested that thinking about musical processing as capable of exhibiting momentum-like effects sheds new light on musical phenomenology and connects cognitive and psychological studies of music with literatures on a wide range of human behaviors.

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Poster Session (12:00 noon – 1:20 PM)
Salon D (located on the Lower Level)
Abstracts located on pages 24 – 40

Lunch (1:20 – 2:00 PM)

2:00

Invited Address

Groove's ecology: Sound, structure, and action

Richard Ashley *Northwestern University*

What gives rise to music's groove—that feeling that we want to move with the music? These questions drive one aspect of my group's current research program. In this talk my focus will be on funk drum lines as played by master drummers, including Clive Stubblefield (James Brown) and Dave Garibaldi (Tower of Power). I will discuss these drum parts in three ways. I will first address the acoustic and psychoacoustic structure of the parts, dealing with relational timbres in the drum kit and on the ways in which these timbres relate to musical pitch structures in tonality and to sound structures in speech. Second, I will discuss these drum lines' sequential timbral structures, represented as probabilistic (Markov) grammars and the way in which these manipulate rhythmic forces and the feeling of groove. I will then discuss these drum parts' relationships to human action, both as perceived (entrainment and feeling of groove) and as produced (analogous to a phonotactics of drumming).

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Symposium: Perceptual biases coupled to natural regularities in auditory scenes

K. Jakob Patten* **Michael McBeath** **R. Chandler Krynen**

Michael McBeath, Chandler Krynen, and Jakob Patten's individual abstracts all focus on recently discovered perceptual biases that couple to acoustic natural regularities and enhance Auditory Scene Analyses. We propose a symposium-style talk series with the three bodies of work presented sequentially. McBeath introduces the finding that the correlation between f0 and intensity, previously observed in humans (Scharine & McBeath, 2009), also exists for animal calls. He argues that the natural regularity for the acoustic dimensions of f0 and intensity to change together reliably extends throughout the animal kingdom, which supports that the bias of listeners to assume such a correlation is a functional adaptation. Krynen confirms the finding for a human production of a correlation between f0 and intensity in the speech domain, and extends the pattern of findings by confirming a related increase in speech rate correlated with both f0 and intensity. This correlation has previously been observed in the domain of percussive music (Johnson, McBeath, & Patten, APCAM 2014), but this is the first study to explicitly confirm the full three-way production correlation. Finally, Patten introduces and testsnatural regularities of timbre production, specifically correlations between phonetic vowel sounds with f0 and intensity in the domain of speech. . He establishes a continuum, comprised of f0 and intensity-matched phonetic vowel sounds, arranged by pitch height, and then confirms a relationship between the phonetic vowel sound pitch continuum and observed f0sin scat music and speech. The data confirm that vowels sounds with a higher pitch height are produced with greater intensity and at a higher f0 than lower pitch height sounds. The overall pattern of findings supports there are a variety of interrelated perceptual biases coupled to reliable natural correlations in the environment, which help listeners to optimally parse and track acoustic objects in their analyses of scenes.

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2:30 – 3:10

Why do eeks sound high and ohs sound low? Patterns of speech and scat songs confirm a functional relationship between timbre and pitch

K. Jakob Patten* *Arizona State University*
Michael McBeath *Arizona State University*
R. Chandler Krynen *Arizona State University*

Auditory scene analysis (ASA) is the process through which humans parse and organize their auditory environment into relevant auditory objects. ASA functions by exploiting natural regularities in the structure of auditory information. Natural auditory regularities include the reliable co-occurrence of domains of sound, such as simultaneous increases in intensity and fundamental frequency (f0) while vocalizing or playing music. The current study investigates timbre color (shape of the spectral envelope) of vowel phoneme sounds and tests if they exhibit a relationship with intensity and f0. Experiment 1 assesses the perceived differences in pitch height of twelve intensity- and f0-matched vowel phonemes (i.e. a pure spectral envelope manipulation). From this data, a two-dimensional scaling solution reveals the extreme difference in perceived pitch height lies between the phonemes ow (as in go) and i (as in we). Experiment 2 examines 20 instances of singing (scat and yodeling), public speaking, and animal vocalizations to measure the strength of the relationship between produced f0 and the phonetic-pitch continuum determined in Experiment 1. The findings reveal that the ow phonemes were vocalized significantly lower than the average f0 of the total performance, while i phonemes were vocalized significantly higher than the average, validating the occurrence of a natural regularity in which f0 and the phonetic-pitch continuum are correlated. The findings support that timbre be added to the acoustic dimensions of intensity and f0 as ones that exhibit natural regularities to be systematically related to each other in a manner that can be perceptually exploited to improve parsing and tracking of acoustic objects and optimize Auditory Scene Analysis.

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2:30 – 3:10

Raising fundamental frequency when yelling is a natural regularity throughout the animal kingdom

Michael McBeath* *Arizona State University*
K. Jakob Patten *Arizona State University*
R. Chandler Krynen *Arizona State University*
Zachary Wilkinson *Arizona State University*

Perceptual biases that are coupled to regularities of nature can help observers better predict and more accurately parse scenes into relevant objects. In the domain of audition, changes in the principal acoustic dimensions of intensity, fundamental frequency (f0), timbre, and rate, may exhibit reliable relationships with each other that can be functionally exploited to enhance tracking of individual acoustic objects. Documented auditory perceptual biases include the presumption that loudness, pitch, and tempo all change together in contexts of music and speech. These, in turn, have led to verification of natural regularities for correlated changes in the physical dimensions of acoustic intensity, f0, and percussive rate in human-produced sounds. For example, when people yell, intensity and f0 reliably rise together. The current study examines if the natural regularity to raise f0 with intensity is a generic biological pattern across other species. We examine calls of 21 different species including insects, birds, amphibians, and mammals and verify that the vast majority (88%) in the animal kingdom raise and lower f0 of their calls when they respectively increase and decrease intensity. The findings confirm the existence of a generic biological natural regularity for a correlation between changes in acoustic intensity and f0, and confirm that corresponding listener percepts of change in these acoustic dimensions are reliably exaggerated in the expected direction consistent with the natural pattern. The findings support the functionality of a listening bias to expect the perceptual dimensions of loudness and pitch to change together when listening to generic biological calls. This research provides a further example of perceptual biases that are coupled with natural regularities in the auditory domain, and supports a framework for understanding perceptual biases as functional adaptations that help perceivers more accurately anticipate and utilize reliable natural patterns to enhance scene analyses in real world environments.

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2:30 – 3:10

A natural regularity for a correlation between speech rate, intensity, and fundamental frequency

R. Chandler Krynen* *Arizona State University*
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Past research confirms a perceptual bias for listeners to hear faster percussive sequences as louder and slower sequences as quieter (Johnson, et al, APCAM 2014). This could be a functional bias if there is a generic natural regularity for faster acoustic sequences to have higher intensities. Listeners could then use rate as a predictive variable to help better track auditory sources. The present study examines whether human speech production exhibits a consistent regularity for rate and intensity to be related, which could enhance tracking and perception of speech. Here we test if the acoustic regularity for a correlation between rate and intensity as speakers transition from whispering to talking and, finally, yelling. In addition, we test if rate and intensity are related to fundamental frequency in a speech context. Participants counted from one to ten under three randomized conditions of intensity (whisper, talk, shout). We compared rates of speech between the different conditions and found a positive correlation between intensity and rate. This confirms that a natural regularity between intensity and rate exists in the domain of speech. Furthermore, consistent with previous research findings, fundamental frequency was also found to increase with intensity. It is possible that when whispering, speakers may tend to be more careful to enunciate words and hence speak more slowly for enhanced listener perception, given the lower intensity that is potentially more difficult to understand. Our results confirm that speaking rate, intensity, and fundamental frequency are all correlated, and support that there is a natural regularity for these three dimensions to be related in the domain of speech. Our findings support a general perception-action theory that intensity, fundamental frequency, and rate are all tied and change together during speech production such that listeners can generically employ the correlation to internally optimize the parsing and tracking of acoustic sources.

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3:10 Break (20 mins)

3:30

Spectral TOJ: Suggested mechanism for non-temporal responses

Leah Fostick* *Ariel University*
Harvey Babkoff *Ashkelon Academic Center*

Spectral temporal order judgment (TOJ) is a commonly used paradigm to compare the auditory temporal processing of healthy individuals with that of a variety of sub-populations. Two short tones of different frequencies (e.g., high and low) separated by short inter-stimulus intervals (ISI) are presented and participants are required to reproduce the order of the tones (high-low, or low-high). Researchers have related to performance on this task as reflecting the individual's ability to use the temporal cues provided by the ISI. The results of spectral TOJ have been used as evidence of deficit in auditory temporal processing by dyslexic readers, elderly individuals, and by various sub-populations relative to young, healthy controls. However, in an unpublished meta-analysis of 425 participants obtained from 16 of our studies we have shown that ~50% of participants succeed in reproducing the order of the tones (Duration=15msec) when almost no interval separates them (ISI < 5msec). These responses suggest that participants with thresholds of ISI < 5msec do not use temporal cue but a non-temporal one. We hypothesize that since spectral TOJ involves the presentation of tones of different frequencies (as opposed to spatial/dichotic TOJ), the order of the tones in each pair provides for a forward versus backward masking paradigm which makes the tone pairs sound different and thus provides non-temporal perceptual cues associated with the order of tone presentation. More specifically, since low frequency tones are more efficient maskers of higher frequency tones and forward masking is more efficient than backward masking, the order of the low frequency tone vis-à-vis the high frequency tone will affect how the tone pair is perceived. Each masking pattern sounds different, therefore, providing the additional cue for discriminating the low-high from the high-low pairs.

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3:50

Listening to act: Comparisons of temporal estimates in response to natural and artificial sound patterns

Valeriy Shafiro* *Rush University Medical Center*
Brian Gygi *United States Department of Veterans Affairs Northern California Health Care Systems*
Anatoliy Kharkhurin *American University of Sharjah*

Temporal dynamic behavior of objects in real-world environments is bound by their physical properties. Listeners often exploit these consistencies to guide their actions. Our previous work [Gygi et al., 2015, JASA, 138,457-466] demonstrated that listeners can accurately predict from sound pattern alone dynamic behavior of a bouncing object after hearing preceding sounds, while relying primarily on temporal cues. The present study further investigated the role of temporal structure (natural bouncing patterns vs. artificially reversed bouncing patterns) and sound event type (ball bouncing sounds vs. tone bursts). After listening to a sequence of 2 to 5 bounces or bursts, listeners pressed a bar when they expected the next sound to occur (without hearing it). Results replicate previous findings of high accuracy in predicting the timing of natural bounce patterns regardless of event type. Surprisingly, patterns of natural bounces produced somewhat less accurate responses than tone bursts, even in the absence of amplitude cues. Overall, accuracy was substantially poorer when pattern timing was reversed. Nevertheless, even for reversed patterns, listener accuracy improved when they heard more preceding bounces (or tones) before responding. The ability to substantially improve accuracy for reversed sound patterns demonstrates that listeners can quickly optimize their response strategy based on the timing of preceding sound events even for arbitrary but predictable timing patterns. However, more common and familiar event timing patterns that characterize behavior of real world objects, such as natural bouncing patterns, are responded to more accurately than unfamiliar timing patterns.

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4:10

Auditory context and speech recognition in children

Karen Banai* *University of Haifa*
Wadeah Jadaon *University of Haifa*
Rachel Yifat *University of Haifa*

Although the contribution of auditory processes to language skills in infancy is well recognized, the role of perception in linguistic processing beyond infancy is not well understood. Of interest here is auditory context because previous studies suggest that sensitivity to auditory context is associated with individual differences in language skills in children and in adults. In those studies, context was induced by across-trial stimulus repetition. We now ask whether repetition of identical stimuli is required to create context or whether across-trial similarity is sufficient. To address this question, we assessed the effects of context induced by the repetition of a Semitic word pattern on speech recognition in quiet (Experiment I) and in noise (Experiment II). Experiment I: Syllable recognition was tested in 61 preschool children using two conditions in which stimuli either shared a single word pattern or two different patterns. Mean identification was significantly better in the single-pattern condition than in the two-pattern condition, an effect that characterized two thirds of the individual children. Furthermore, the context effect accounted for 9-15% of the variance in vocabulary and phonological awareness scores. Experiment II: Word recognition in noise was assessed in 30 primary-school children in three conditions – a baseline condition in which 60 different pseudo-words comprised of six different word patterns; a pattern repetition condition in which 60 different words all shared a single word pattern and an item repetition condition in which 6 words, each of a different pattern were repeated 10 times each. Both types of repetition resulted in lower recognition thresholds, but item repetition induced a stronger effect than pattern recognition. These data suggest that both similarity and repetition can induce auditory context and that both are associated with language skills. Therefore current findings support the idea of continued associations between auditory processing and language even beyond infancy.

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4:30

Intentional and spontaneous interpersonal synchronization in dyslexia

Alexander Demos* *University of Illinois at Chicago*
Stephanie Del Tufo *University of Connecticut*
Kerry Marsh *University of Connecticut*
Rachel Theodore *University of Connecticut*
Roger Chaffin *University of Connecticut*

The primary etiology of dyslexia has long been considered to be deficit of phonological awareness. However, recent evidence points to a more general auditory deficit, which may stem from hypersensitivity to natural sounds. We examined the relationship between reading ability and the ability to shake a maraca in time with a metronome, music, and the sound of another person shaking a maraca. Compared to typical readers, dyslexic readers were no different at synchronizing with the metronome, worse with music, and better with another person. In the maraca condition, synchrony was stronger in pairs with similar reading abilities. Our results suggest that dyslexia stems from hypersensitivity to the acoustic variability in natural sounds. This hypersensitivity leads to dyslexia by making it difficult to map speech sounds onto phonetic categories. The same hypersensitivity is an advantage when synchronizing maraca-shaking with another person and a disadvantage when the natural relationship between sounds and the movements that create them are disrupted, as when shaking a maraca to recorded music.

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4:50

Discussion: Considerations for Increasing APCAM's Internet Presence

Michael D. Hall *James Madison University*
Devin McAuley *Michigan State University*
John Neuhoff *The College of Wooster*
Peter Q. Pfordresher *University at Buffalo, The State University of New York*
Mike Russell *Washburn University*

The organizing committee will serve as panelists and moderators for a meeting-wide discussion concerning a proposal to develop online resources in conjunction with other improvements and expansions to the APCAM website. Potential resources could include, but are not limited to, lists of links to the laboratory sites of contributors as well as their affiliated graduate training programs. Expected benefits of such additions, including the identification of possible future research assistants and other collaborators for individual attendees while also serving as a source of continued promotion of APCAM, will be reviewed. Concerns regarding initial development, as well as long-term maintenance and oversight of information, also will be discussed.

5:20 Closing Remarks

Poster session (12 noon – 1:45 PM)
Salon D (located on the Lower Level)

1

Student's second-language grade may depend on classroom listening position

Robert Ljung* *University of Gävle*
Anders Hurtig *University of Gävle*
Patrik Sörqvist *University of Gävle*

The aim the present experiment was to explore whether listening positions (close or distant location from the sound source) in the classroom, and classroom reverberation, influence students' score on a test for second-language listening comprehension (i.e., comprehension of English in Swedish speaking participants). The listening comprehension test administered was part of a standardized national test of English used in the Swedish school system. A total of 125 high school pupils, 15 years old, participated. Listening position was manipulated within subjects, classroom reverberation between subjects. The results showed that second-language listening comprehension decreased as distance from the sound source increased, whilst classroom reverberation had no discernible effect. The difference was most pronounced for the comparison between the condition with short reverberation time and a close distance between sound source and receiver and the condition with a long reverberation time and a far distance between sound source and receiver. The results indicate that listening comprehension scores—and hence students' grade in English—may depend on students' classroom listening position.

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2

Spatial fusion of auditory and visual stimuli in motion

David Hartnagel* *IRBA*
Alain Bichot *IRBA*
Lionel Pellieux *IRBA*
Corinne Roumes *IRBA*
Patrick M.B. Sandor *IRBA*

Audio and visual information can be fused together when they are displayed with a spatial disparity. This phenomenon called AV fusion or ventriloquism varies with eccentricity relative to straight ahead but depends on head and eye position (Hartnagel et al. 2007). Previous data showed that AV fusion is obtained for large disparity in elevation (>20°), this effect was explained by a poor auditory localization accuracy in elevation. As sound localization depends on ITDs and ILDs, a sound in motion (oscillation) is supposed to give more spatial information and then should be better localized. AV spatial fusion has been investigated mainly with synchronous static stimuli, here we report for the first time, a spatial fusion experiment using audio and visual stimuli in motion. Then, if AV fusion depends on auditory accuracy, a sound in motion is supposed to reduce AV spatial fusion. To move a sound without using virtual sound we designed a prototype to play a sound moving with almost no mechanical noise. The movement was an oscillation of 3Hz (over 5°) in vertical or horizontal dimension. The oscillation of the sound source was real or simulated by two real sound sources. Visual part was provided by a green motorized laser in darkness. The AV stimulus was displayed not moving, moving in phase or moving in opposite phase. Disparity between auditory and visual part of the bimodal stimulus was tested in azimuth and elevation. First analysis showed no difference between moving and static bimodal stimuli even when A and V parts are oscillating in opposite phase. Oscillations at 3 Hz extended on 5° should be too quick and/or on a too short space for the perceptive system to catch the differences.

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3

The effect of key distance on recognition of non-diatonic melodies

Abigail Kleinsmith* *University at Albany, SUNY*
W Neill *University at Albany, SUNY*

In previous research, Kleinsmith et al. (Psychonomics, 2013) and Kleinsmith & Neill (Psychonomics, 2014) demonstrated an effect of key distance on memory for melodies: the more distant in physical frequency a given melody is from the key of a previously studied target melody, the more difficult it is to identify it as the target melody in a different key on a subsequent recognition memory test. In our 2013 procedure, subjects were familiarized with one diatonic target melody presented in two physically close keys (C and D). Recognition memory was better for a target melody in a physically closer key (C#) than in a more distant, but more harmonically related, key (G). This same key distance effect was demonstrated when subjects were familiarized with a diatonic target melody presented in two physically distant keys (C and F#), as evidenced by better recognition of a target melody in a physically close key (C# and G, respectively), than in a more physically distant key (D#). In 2014, we extended this finding to nondiatonic melodies in physically close keys. The present set of experiments investigates the impact of key distance on recognition of quarter-tone and whole-tone melodies in physically distant keys. The results replicate our previous findings and demonstrate that physically closer transpositions are recognized better than more distant transpositions, even when subjects are unable to rely on information about musical key to inform recognition. Our results demonstrate that this key distance effect is generalizable to both diatonic and nondiatonic melodies, and suggest that it may not be necessary for a melody to strongly establish a musical key in order for that melody to be recognized at the time of test.

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4

Systematic listening exposure influences implicit knowledge of a Turkish musical scale

Timothy Justus* *Pitzer College*
Nart Bedin Atalay *TOBB University of Economics and Technology*
Nazike Mert
Charles Yates *Pitzer College*
Meagan Curtis *Purchase College*

Both passive perceptual learning and formal performance training likely contribute to the development of musical schemata, including representations of musical scales and modes. Previously, we investigated the relative contributions of enculturation and training by asking American and Turkish musicians and nonmusicians to perform a task of musical short-term memory (Justus et al., submitted). Participants heard seven-tone melodies drawn from either the Western major scale or Turkish rast makam, and determined whether subsequent probe tones had been presented. Here, we report the results of twelve additional participants recruited from Turkish classical and folk music clubs, all of whom listened to these genres on a daily or weekly basis. Following major melodies (comprising C, D, F, G, A, and either E-natural or B-natural), participants tended to accept natural probe tones (E-natural and B-natural) over both half-flat probes (E-half-flat and B-half-flat) and full-flat probes (E-flat and B-flat), which were inconsistent with both scales. These effects were observed for both the presented scale degree as well as the missing scale degree, suggesting top-down perceptual inferences based on knowledge of the Western major scale. Following rast melodies (comprising C, D, F, G, A, and either E-half-flat or B-half-flat), participants tended to accept natural probe tones as well as half-flat probes over full-flat probes. These effects were again observed for both the presented and the missing scale degree, suggesting top-down activation from both the major scale and rast makam following rast contexts. The present data are more consistent than those observed with previously tested Turkish musicians who had more musical training but less systematic listening exposure to traditional genres than the present group. We suggest that sensitivity to culture-specific scales and modes may be influenced more by systematic listening exposure within the relevant musical genres, than by passive enculturation or formal performance training emphasizing other genres.

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5

Automatic processing of the semantic content of non-significant and neutral irrelevant sound: Evidence from a semantic deviation effect

Katherine Labonté *Université Laval*
Michaël Lévesque-Dion *Université Laval*
Nick Perham *Cardiff Metropolitan University*
John Marsh *University of Central Lancashire*
François Vachon* *Université Laval*

The infrequent occurrence of a sound that differs from the auditory context in which it is embedded is known to capture attention and interfere with cognitive functioning. This ‗deviation' effect is caused by the discrepancy between the incoming sound and an automatically-created mnemonic representation of recent auditory past, the so-called neural model. While there is a clear consensus about the automatic processing of the acoustical properties of sound, the preattentive processing, hence inclusion of its semantic properties within the neural model is still subject to debate. This study sought to determine whether an unexpected change in the semantic content of non-significant and neutral unattended auditory information could attract attention. In Experiment 1, participants recalled the serial position of visually-presented digits while ignoring spoken words drawn from the same semantic category (e.g., animals) for all trials. On some rare trials, the insertion in the auditory sequence of a (deviant) word drawn from a different category (e.g., tools) resulted in a decrease in recall performance, revealing that an unexpected change in the semantic content of an auditory stimulation can catch attention. This semantic deviation effect suggests that the semantic context is automatically recorded within the neural model. In Experiment 2, the semantic content of the auditory sequence was changed on every trial in order to test how strong the mnemonic representation of the semantic context needs to be to observe the deviation effect. Recall was again disrupted by semantic deviants, indicating that only a few events are required to build up a sufficiently strong ‗semantic' neural model. Overall, these findings establish that attentional capture by irrelevant semantic information is not limited to personally-significant or high-arousal stimuli (e.g., taboo words) and provide novel evidence for the existence of preattentive semantic processing.

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6

Stimulus and familiarity factors in judgments of musical tempo

Justin London *Carleton College*
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Levitin & Cook (1996) showed listeners remember the "absolute tempo" of well-known songs in a melody reproduction task. Drake, Gros, & Penel (1999) found that beat rate (BPM), note density, and listener background affected tempo perception. Three experiments assess the effects of familiarity, BPM, spectral flux, dynamics, and listener background on tempo judgments. Matched pairs of six classic R&B songs (low vs. high flux) at 105, 115, and 130 BPM were the stimuli. BPM was further manipulated via time stretching (±5%) and dynamics via EQ (original vs. +7db). Participants rated the tempo on a 7-point scale. Exp1 presented the original vs. time stretched stimuli, Exp2 added dynamic contrast, and Exp3 involved participants with backgrounds in either swing or modern dance. In Exp1 a 3x3x2 (BPM x Time Stretch x Flux) ANOVA found MEs for BPM ($F(1.65, 42.83) = 80.80$, $p < .001$, $\eta p2 = .757$) and Stretch ($F(1.99, 51.84) = 201.35$, $p < .001$, $\eta p2 = .886$), but not Flux. In Exp2, ANOVAs showed MEs for BPM ($F(1.667, 31.671) = 37.443$; $p < .001$, $\eta p2 = .663$), Flux ($F(1, 19) = 22.783$; $p < .001$, $\eta p2 = .545$), and dynamics ($F(1, 19) = 17.469$; $p < .001$, $\eta p2 = .479$). Exp3 found a ME for dance background ($F(1, 20) = 8.894$, $p = .007$, $\eta p2 = .308$), modern dancers giving faster ratings. In sorting out the relative tempo of original versus time-stretched versions of each song, participants confused absolute (BPM rate) versus relative (time-stretch) aspects of tempo, the latter taking precedent (see Fig. 1). The effect of flux is dependent upon tempo and loudness, and listener background may also influence tempo judgments. The effects reported here depend on stimuli with clear musical identities, emphasizing the importance of using real musical stimuli in studying tempo perception.

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7

The influence of major and minor tonality of music on an associative color-sound perception

Olena Anisimova* *Institute for Musicology and M*

It has been investigated correlation of audio-visual perception, among others the influence of major and minor tonality on an associative color-sound perception. The goal of this investigation is finding of common tendencies of correlation between auditory perception and visual associations. The obtained results can be used for audio-visualization in the field of new media, arts and medicine. Materials and Methods: it has been developed and conducted the test for this studying. 110 respondents were tested, they had not the phenomenon of synesthesia. The test was developed based on the cognitive features of auditory and visual perception. The audio-visual associations during music perception were investigated in the test. Along with other audio-visual associations, were researched the influence of major and minor music on the occurrence of audio-visual associative correlations during the music perception. Results and Discussion: one of the part of the test has investigate regularity between major and minor tonality of music and emerging of chromatic and achromatic color associations. The following tendencies were found: music in minor tonality associates with cool, secondary and passive chromatic colors which have a low level of lightness, while music in major tonality associates with primary, active and bright chromatic colors. The associated colors during perception of major musical examples relate to seven main colors of ancient philosophy. The minor examples associates with middle - dark achromatic colors, while a major musical examples associates with middle - light achromatic colors. In addition it has been found correlation between the tempo of music and arising colors. Perception of music is a complex process of cognitive psychology. The results showed that the formation of associative links is based not only under the influence of external factors (culture and society) but has also physiological and psychological origin with certain tendencies and regularities at the majority of respondents.

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8

Eyes have ears: Pupillary response to auditory deviants reflects attentional capture during active visual tasks

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Maxime Legendre *Université Laval*
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The rare occurrence of a sound deviating from the auditory background tends to trigger attentional orienting and produces a group of sympathetic physiological responses (e.g., increase in cardiac and electrodermal activities). Pupil dilation, another sympathetic-associated response, is known to be influenced by environmental factors such as luminance or eye movements, and by cognitive workload. Yet, pupil diameter can also be modulated by auditory properties such as stimulus probability. The goal of this study was to determine whether a pupillary response can be triggered by deviant sounds and, hence, serve as a psychophysiological index of auditory attentional capture. Given the pupil‘s sensitivity to changes in luminance and gaze position, this test took place in the context of visual tasks. We used a paradigm in which deviant sounds were occasionally embedded within a to-be-ignored auditory sequence composed of the repetition of a standard sound while participants performed a visual reading task, which promotes gaze displacement and produces no overall luminance change (Exp. 1), and a visual serial recall task, which causes local changes in brightness and required a fixed gaze (Exp. 2). In each experiment, analyses showed that the deviant sounds produced larger pupillary responses than steady-state standard sounds. Such finding suggests that pupil dilation can index the orienting response toward deviant sounds. That this pupillary response to deviant sounds took place in spite of the concurrent requirement to process visual stimuli suggests that the variation in pupil size is a robust index of auditory attentional capture even in a context in which luminance and gaze position are varying.

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9

The validation of a new online questionnaire for assessing spatial-hearing abilities

Christophe Micheyl *Starkey Hearing Technologies*
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Sridhar Kalluri *Starkey Hearing Technologies*

Questionnaires are often used by clinicians and researchers to assess the difficulties experienced by hearing-impaired individuals in real-life situations. This study validated a new online questionnaire designed to assess spatial-hearing ability. This questionnaire facilitates experiential recall by including images related to the situations depicted in the questions and through the use of ecologically valid situations. Our hypotheses was that a spatial-hearing questionnaire that included images and ecologically valid questions would be more sensitive to detect the effect of hearing loss and amplification on spatial-hearing disabilities. 76 participants, including individuals with normal hearing, unilateral, asymmetric, or symmetric hearing loss, hearing-aid wearers and non-wearers, completed this new online spatial-hearing questionnaire and the spatial subscale of the Speech Spatial and Qualities of Hearing Questionnaire (SSQ; Gatehouse and Noble, 2004). Statistical analyses were completed to understand the relative effectiveness of each questionnaire. Data analyses using the Item Response Theory (IRT) model showed: (a) statistically significant correlations between spatial-hearing abilities inferred across the two questionnaires, even after taking into account the limited precision of inferences at the individual level; (b) statistically significant differences in inferred spatial-hearing abilities between the normal-hearing group and other participant groups with impaired hearing; some of these group differences were expected based on previous findings. Importantly, the patterns of group differences were not the same for the different spatial abilities, which was expected due to the fact that different spatial cues (monaural spectral cues, inter-aural time and level differences, etc) will impact different localization skills (left-right localization, distance perception, etc). Spatial hearing abilities were significantly correlated across the two questionnaires with a few exceptions. In particular, clearer differences among the normal-hearing and hearing-impaired groups were observed for spatial selective attention for the new questionnaire, compared to the spatial subscale of the SSQ; conversely, for distance perception, the spatial SSQ subscale was more discriminant than the new questionnaire. In conclusion, the new online questionnaire seems to be a valid and useful tool with a principled method of analysis that should be considered for use in research that investigates spatial hearing ability.

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10

Classifying auditory stimuli: A survey of perception research in leading journals

Michael Schutz* *McMaster University*

My team is engaged in a project exploring the sounds used in auditory research, inspired by our earlier survey of the sounds used in articles published in the journal Music Perception (Schutz & Vaisberg, 2014). The full project is ongoing, and to date we have surveyed hundreds of experiments on a variety of tasks and paradigms. We are interested in organizing this information into a large-scale taxonomy to provide a classification system of use in consolidating and interpreting this research. Thus far, we have grouped hundreds of stimuli into three categories with respect to their amplitude envelope structure, those with: (1) those with time varying amplitude envelopes such as musical instruments, animal calls, natural scenes, etc. (2) sustained amplitude envelopes such as ―flat tones‖ with linear or cosine shaped onsets/offsets, and (3) abrupt sounds with very short amplitude envelopes, such as clicks, pulse trains, and transients. Each of these primary classifications include sub-classifications – for example time varying sounds include subcategories for referential (originating from a natural events such as a hand clap or a musical note) vs. non-referential (tone bursts, tones with ―flat‖ amplitude envelopes, etc.) We are now interested in gathering feedback on this project to refine our thinking, with an ultimate goal of publishing a framework useful in classifying a broad range of auditory stimuli.

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11

Beauty and the beast: WAVs invoke less negativity than MP3s in listeners

Joshua Sites* *Indiana University*
Edgar Jamison-Koenig *Indiana University*
Robert Potter *Indiana University*

The topic of lossy file formats, such as MP3, is a contentious one in the music industry. While they are much more portable than their lossless file format counterparts, such as WAV, they are thought to provide inferior music listening experiences due to data reduction techniques. We conceptualize music as a form of communication. According to Lang's (2006) Limited Capacity Model of Motivated Mediated Message Processing, activation of the appetitive (positive) and aversive (negative) motivational systems occur independently--and the extent to which they are activated at any one moment impacts message encoding. If MP3s and WAVs have inherently different impacts on these motivational systems it could not only affect self-reported perceptions of the music but dynamic emotional and cognitive response. This would impact future considerations of file format choice into the message creation and consumption process. This study represents the first step in the process of evaluating MP3s in their efficacy as a means of communication. It examines audience members' self-reported reactions across multiple dimensions of both MP3s and WAVs. Additionally, the era in which the music was created was taken into account. For example, a song recorded prior to the advent of digital audio could not possibly be designed or produced for the MP3 file format. However, music recording created after the advent of MP3s may be better suited for the MP3 file format as it is pervasive among music consumers. Participants were not made aware of the differing file formats or the nature of the research, and reported increased levels of negativity in MP3s compared to WAVs, while positivity was not significantly different. The activation of the aversive motivational system in response to MP3s as opposed to WAVs suggests that the quality of the digital file has the capacity to influence the listening experience regardless of whether the music was produced in an era in which audience members were likely to listen to the song in lossy digital formats.

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12

Acoustic cues and world knowledge impact listeners' perception of confidence

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The expression and perception of confidence broadly represents identification and/or demonstration of certainty, and are thought to reflect one's general knowledge state (Lempert, Chen & Flemming, 2015). Given the diverse social-communicative utility of confidence, determining the nature of the relationship between confidence and knowing in speakers and listeners is critical. Acoustic cues (including speaking rate, vocal intensity, and rising intonation) have been identified as particularly salient in their respective contributions to listeners' perception of speaker confidence and intellect (Roche, Fissel & Duchi, in preparation; Schroeder & Epley, 2015). However, the identification of confidence in a speaker requires more than just processing of acoustic cues. Listeners must integrate acoustic cues with their own world knowledge in order to make decisions about another's relative ―knowledge state‖ as she is speaking. The current study extends previous research examining the relationship between confidence and knowing by exploring the relationship between acoustic cues, and world knowledge on listeners' perception of confidence. Acoustic cues were experimentally manipulated using a low-pass filter. World knowledge was manipulated by providing, or not providing listener access to the speaker's question. We found converging evidence that acoustics alone do not predict a listener's ability to predict speaker confidence. Generally, listeners are better predictors of confidence when the acoustics interact with knowledge ($p < .05$). Predictions of confidence also depended specifically upon the acoustics produced ($ps < .05$, at least, e.g., rising intonation), whether the talker controlled their acoustic variability ($p < .05$), talker's perception of question difficulty ($p < .01$), and degree of alignment of perceived difficulty between the talker and listener ($p < .001$). The main finding suggests that listeners were better able to determine confidence when the listener had more information and was more knowledgeable about the concept than simply relying on the acoustic cues alone ($p < .001$).

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Top-down effects on the association between numerical magnitude and auditory pitch

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In a series of experiments, we investigated a cross-modal (CM) effect on the perception of numerical value and auditory pitch. CM correspondence is a general term describing a perceptual phenomenon where perception of one class of stimulus can be facilitated or disrupted by the simultaneous presentation of another task-irrelevant stimulus. In our investigation, we developed a new experimental paradigm to test for cross-modal effects between high and low pitch and large or small numbers. Unlike the standard experimental design in CM research in which only one modality is relevant to the task, our design requires participants attend to both modalities on every trial. To achieve this, on each trial we present a random cue, telling participants whether to base their response on number or on pitch, seen only after the stimuli have been removed. Participants were given one of four sets of instructions: to select either the larger or smaller digit on number trials and either the higher or lower tone on pitch trials. We found a strong effect of instructions on CM correspondences. When the instructions require participants to respond to both larger numbers and higher pitches (or the inverse), we observe a strong congruency effect that links higher numerical value with higher pitch. However, when the instructions do not coincide with the CM association (e.g., —indicate the larger number or the lower pitch‖), we found no congruency effect. These results suggest that there may be a top-down effect of instruction that acts in addition to any perceptual effect. When the top-down effect of instructions aligns with the underlying perceptual association, the effect of stimulus congruency emerges. Conversely, when the top-down instructions run counter to the CM association, the congruency effect is suppressed.

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An examination of auditory experience and change deafness to natural scenes

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Change deafness is the remarkable inability of listeners to detect changes occurring in their auditory environment. Demonstrations of change deafness imply that our experience of the world is not as detailed as our subjective impressions would suggest. The purpose of this study was to determine if specialized listening experiences affect the ability to detect auditory changes; specifically we compared change detection performance of a group of non-musicians with change detection performance of a group of musicians with specialized training in melodic, rhythmic, and harmonic dictation. Both groups made a same/different judgment on two consecutive auditory scenes that had the same sounds or one differing sound. The number of sounds in each scene was varied (2, 4, or 6), as well as the type of sound (recognizable environmental sounds, unrecognizable, scrambled versions of the environmental sounds, noise rhythms, and pure tone rhythms). We predicted that the musicians would be more likely to hear changes in the noise and tone rhythms than non-musicians and that both groups would be equally likely to miss changes in the recognizable and unrecognizable environmental sounds. These findings would indicate that although change deafness occurs in both groups, musicians with specialized rhythmic training have an increased capacity to detect and process changes in auditory scenes, and that such improvement in auditory change detection can be a learned skill.

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Hemispheric differences in change deafness

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Change deafness is the finding that listeners are often remarkably poor at detecting changes to auditory scenes. We determined the extent to which change deafness is due to differences in holistic versus piecemeal processing of naturalistic auditory scenes. It is well-established that the left hemisphere processes fine details, while the right hemisphere processes more global properties of scenes. The purpose of the present study was to determine if change deafness is due to using the wrong hemisphere, i.e., relying on the right hemisphere in a change detection task would cause changes occurring in the details, i.e., individual objects, in the scenes to be missed. On each trial, listeners made a same-different judgment to four-object scenes presented consecutively. When changes occurred, the change was either to a sound from a different category (e.g., a dog changed to a piano tune) or the change was to a sound from within the same category (e.g., a small dog barking changed to a large dog barking). Sounds were presented dichotically, with two sounds presented to the right ear (i.e., the left hemisphere) and two sounds presented to the left ear. (i.e., the right hemisphere). The change occurred in the left ear (right hemisphere) on half of the trials and to the right ear (left hemisphere) on the other half of change trials. The results indicated more change deafness to changes from within the same category, as well as hemispheric differences in processing the auditory scenes. Implications for why perceptual errors occur in naturalistic auditory situations will be discussed.

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Studying the effect of foreign accent on serial recall through error analysis

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The current study examined how foreign accent affects phonological encoding, word recognition, and serial recall through analyzing the types of errors made across serial positions (SPs) in three serial recall experiments. Lists of native-English and Cantonese-accented words were presented with an inter-stimulus interval (ISI) of 1500 ms in an auditory mode in Experiment 1 and in a bimodal mode in Experiment 2; only Cantonese-accented words were presented in the auditory mode with a 4000 ms ISI in Experiment 3. Recall errors were categorized as either order errors (words recalled in an incorrect SP) or item errors (all other errors). Experiment 1 showed that foreign accents induce an overall decline in recall performance across all SPs. There were more item and order errors for accented words than native words. There were more item errors for accented words with low intelligibility than those with high intelligibility, suggesting that foreign accents induce identification difficulty. With a synchronized visual display to aid accented word recognition in Experiment 2, item errors for accented words decreased granted that there were still more item and order errors for accented words. Recall performance for accented words were still worse than native words in the middle SPs, implying that foreign accents exert other detrimental effects on memory in addition to identification difficulty. Lengthening the ISIs in Experiment 3 had no impact on recall of accented words in the early SPs. However, it greatly reduced item errors in the middle SPs, implying that extra time is required for phonological encoding and identification of accented words to be completed. Longer ISIs reduced order errors in the last two SPs only, suggesting that the extra time allows the indexical information of the final items to be processed and stored in echoic memory.

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Artificially natural: Creating carefully-controlled acoustic cue continua from natural speech

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Two methodological challenges in speech perception concern stimulus naturalness and control over the acoustic properties of stimuli. Ideally, researchers would like to maximize these properties, allowing for controlled experiments that investigate listeners' use of acoustic cues in a way that represents real-world speech. Concern over these issues is especially important given work showing that listeners treat natural and synthetic speech differently. For example, research examining vowel length (VL) as a cue to word-initial voicing has found conflicting results depending on the naturalness of the stimuli (Miller & Liberman, 1979; Shinn, Jongman, & Blumstein, 1985). One solution is to use edited recordings of natural speech. However, commonly used procedures for creating acoustic continua from natural speech cause certain cues to covary in an unnatural way (Toscano & McMurray, 2012), which may bias listeners' responses. We investigated this challenge using word-final voicing as a framework. For this phonetic distinction, VL and several other cues provide information about voicing. However, existing methods for generating VL continua either create covarying cues, sound artificial (e.g., cutting from the end of the vowel), or introduce artifacts. We developed a new approach to address these issues. First, we rendered other cues (closure duration, closure voicing, and the release burst) ambiguous by setting their values to weighted averages of the values measured from minimal pairs. We then created VL continua by automatically removing pitch pulses from the vowel to set it to its desired length. This retains the natural contour of the amplitude envelope, prevents VL from covarying with other cues (e.g., formant transitions), and does not introduce artifacts. Categorization functions were obtained from 17 participants, demonstrating the expected effect of VL (Raphael, 1972). This method improves upon existing approaches and can be employed largely automatically for problems investigating listeners' use of temporal cues in speech.

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Examining the time course of sound-class categorization: Insights from acoustic features

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Humans have an impressive, automatic, capacity for identifying and organizing objects in their environment; a task that continues to challenge artificial intelligence and robotics developers. Despite how central identification and categorization are for everyday functioning, we still know very little about how these processes are carried out and the timescales they function on. To better understand the temporal dynamics of sound categorization, we conducted a go/no-go perceptual gating study where participants heard speech, musical instrument, and environmental action sounds that ranged from 12.5 up to 200 milliseconds in duration. Participants' task was to detect sounds belonging to a target category. Accuracy improved steadily as sound duration increased, up to 100 ms, where near-perfect performance leveled out for most categories. Instrument sounds showed a distinct processing advantage at the shortest durations (50ms and less) with improved accuracy compared to other categories. History of musical training also significantly improved the detection of musical instrument and speech sounds. We next investigated the extent to which these effects were a product of acoustic differences between sound categories. This expands on previous investigations of rapid, early auditory categorization, which adopt a high-level approach focused on the semantic categories of sounds (e.g., speech or music) leaving the role of basic acoustic features that may differ between these categories unclear. Thus, we use Bayesian Information Criterion, to compare models of participant accuracy based on the semantic target categories with models that also include indices of acoustic features such as log-attack time, spectral centroid, fundamental frequency variability and ratio of harmonic to noise energy. Models of target detection including acoustic features significantly outperformed models based on semantic categories alone. These data underscore the importance of analyzing acoustic features in sound discrimination tasks.

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Measuring phonetic convergence and acoustic properties of speech with engaging, naturalistic experimental tasks

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Interlocutors often show increased similarity in phonetic cues during conversational speech (phonetic convergence), though the extent to which talkers converge is affected by a number of factors (Bradlow & Bent, 2008; Pardo, 2006) and may be difficult to measure using typical laboratory tasks (Olmstead, Viswanathan, Aivar, & Manuel, 2013). This points to a more general challenge in studying speech communication: researchers need tasks that elicit naturalistic language use in lab settings (Toscano, Buxó-Lugo, & Watson, 2015). We addressed this issue using a game-based approach that provides an engaging, yet experimentally controlled, task. Pairs of participants worked together to complete puzzles in the computer game Minecraft. Some puzzles consisted of mazes, with the correct route being determined by minimal pairs displayed on signs in the maze. If a participant needed to determine whether they should go left (as indicated by a sign with the word bear) or right (as indicated by the word pear), they would receive the correct direction from their partner. Thirty word-initial voicing minimal pairs were used as stimuli, and the degree to which participants' voice onset time (VOT) values converged over the course of the one-hour experiment was measured. We found that some subjects showed phonetic convergence, whereas others diverged. Overall, subjects who successfully communicated with their partner and completed the experiment more quickly were less likely to converge. We also examined the overall distribution of VOT values, comparing them with previous measures for English (Lisker & Abramson, 1964). Mean VOT values for voiced and voiceless stops were longer than what has been previously reported (voiced VOT: 25 ms; voiceless VOT: 101 ms). Together, these results suggest that engaging, naturalistic tasks may yield results that more accurately reflect real-world phonetic variation than traditional laboratory experiments.

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Speech testing using token-level error thresholds: Comparison with pure-tone audiograms

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Tests that specifically measure speech recognition would be extremely useful for assessing hearing loss. However, speech tests have been largely unsuccessful in practice. One reason may be that existing tests only consider listeners' average performance. In contrast, recent work has shown that error rates vary across consonants (Trevino & Allen, 2013) and that speech sounds in noise have token-dependent error thresholds (Toscano & Allen, 2014; Zaar & Dau, 2015). Thus, if a speech test uses a constant signal-to-noise ratio (SNR) across tokens, some errors will be produced not because of a hearing loss, but because certain tokens are presented below their threshold. Moreover, if results are averaged across tokens, we cannot identify nuanced deficits. The present study investigated the utility of a token-specific speech test by comparing listeners' performance on the test with their audiograms. Fourteen self-reported normal-hearing listeners (24 ears) heard 48 consonant-vowel pairs (2 repetitions) balanced across consonants by talker (6 female; 6 male) and vowel context (4 vowels), and indicated which consonant they heard (/b,d,g,p,t,k,f,v,s,z,m,n/). Stimuli were presented at token-specific SNRs, such that normal-hearing listeners should select the correct consonant 90% of the time (Toscano & Allen, 2014). Participants then completed a computerized pure-tone audiometry test. The results show that listeners' average performance obscures consonant-specific deficits. While error rates were ≈10% overall, performance on individual consonants spanned a wide range, with errors ≥50% for at least one consonant for many listeners. In addition, listeners with higher hearing thresholds at high frequencies made errors on specific consonants (/b,f,s,m/), suggesting that they are missing critical high-frequency acoustic cues for these sounds. Overall, these results indicate that speech tests using tokens with well-defined SNR thresholds can reveal specific deficits that correspond to higher hearing thresholds at certain frequencies,

opening the door to more accurate testing in the future.

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Characterization of short-term and long-term spectral variation in real-world auditory backgrounds

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Environmental sound perception research has typically used short pre-recorded samples of sounds presented in isolation, free from any contextual information. Conversely, everyday auditory experiences are substantially influenced by changes in the ambient auditory background. The spectral-temporal dynamics of common acoustic backgrounds are complex and can vary widely based on location and time of day. Despite potential relevance to perception in the real-world, the distributional characteristics of real-world ambient auditory backgrounds are largely under-specified. This research presents novel methods for capturing and analyzing short-term and long-term environmental sound recordings. Recordings were collected from three distinct outdoor environments (cityscape, suburban park, & strip mall parking lot). Three hour long recordings were collected at each site for each of three matched times-of-day (morning, midday, evening). Long-term recordings were then divided into one minute segments, and submitted to 1/3-octave band analysis. The 1/3-octave analysis revealed significant differences in average long-term and short-term spectra across all locations and times-of-day. To further characterize each of the ambient backgrounds within and across recording sessions, the spectra for each one minute segment was input to the Auditory Detection Model (ADM; MIL-STD 1474E), along with the spectra of several target sounds. The ADM makes a number of simplifying assumptions to predict aural detection distances for target sound sources. Two of the important input parameters of this model are the ambient background spectra and the spectra of the to-be-detected sound source. The ADM output suggest that long-term and short-term changes in the background spectra produce significant variability in predicted detection ranges. We discuss the implications of this significant variability for perception in the real-world.

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The neglected aspect of auditory space: Perception of occlusion

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When considering the space within which individual perceive and act, investigations have traditionally been limited to a target and the observer‘s perception of that target. Such a framework is Euclidean in nature. With regard to what we know about the auditory perception of space, research has essentially been limited to the perception of distance, azimuth, and elevation/altitude. Ecologically speaking, space involves much more than the target and actor/perceiver. It is argued here that an accurate and complete understanding of our ability to perceive the world around us must acknowledge the existence of clutter (what James J. Gibson referred to as the ―furniture of the world‖), the effect of clutter on spatial perception, and, just as importantly, the detection of that clutter. The current study examines the ability of individuals to: (1) perceive the presence/absence/extent of occlusion, (2) create occlusion to varying degrees, and (3) actively create a situation of disocclusion. The findings of the present study will be discussed with respect to the ability of individuals to accurately perceive occlusion (or the lack thereof) as well as to the significance and role that occlusion plays in our understanding of space. It will be argued that the detection of occlusion, in all aspects, is as (if not more) important as detecting the position of sound sources.

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Formal music education alters perceived musicality of pitch sequences

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It is widely accepted that music training is positively correlated with non-musical abilities such as reading proficiency (Corigall & Trainor, 2011), speech perception and IQ (Schellenberg, 2015). However, relatively little is known about differences in the perception of melodies between musicians and non-musicians. The present study aimed to understand how level of formal music training affects listeners' perceived musicality of melodies. Participants were classified into three groups (low-, medium- and highly-trained) based on their responses to a survey which assessed the level of music training through a variety of measures (e.g. formal music education, sheet music reading ability, perfect pitch presence, etc.). Stimuli comprised 100 randomly generated pure tone sequences, all coming from a one octave, Major, diatonic scale, presented in 16 blocks with 20 seconds of rest between each block. Following presentation of each stimulus, participants rated each sequence's perceived musicality using a five-point Likert scale (1 = not musical; 5 = very musical). We found a high degree of consistency across all subjects as to which sequences were rated most musical and which were rated least musical. Examining the differences in z-scored ratings between groups revealed that a subset of our stimuli were particularly diagnostic in differentiating between low-trained musicians and either of the other two groups. However, the vast majority of melodies were rated very similarly by the medium- and highly-trained participants. Additionally, a Principle Components Analysis (PCA) applied to the sequences revealed components that correlated with structural measures of the stimuli (mean interval, key, contour, etc). PCA on participants yielded components that differentiated low training from all others. Taken together, these data suggest that any formal music training may cause changes in auditory perception (and associated neural mechanisms) such that trained musicians perceive auditory objects differently, compared to those without music training.

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Transformation under cover: The emotional power of pop song variation and its ability to enhance visual interpretation

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The incorporation in film and television of pop culture music has become a standard practice that first originated with the interpolation of popular songs of the day in early Broadway musicals. Generally, the standard version of the song by its original performer is chosen for the soundtrack due to its immediate recognition factor and its ability to either reinforce or contrast the emotions being portrayed in a scene. When an artistic decision to use a specific cover version of a song rather than its original performance in a film or television episode occurs, the effects on the mood and meaning of the scene can create unexpected and even transformational results. This paper will explore how this process has occurred, reveal compelling examples of such cover songs through film and video clips, and, illuminate specific detailed musical elements and their ability to influence emotions found in recent film and television productions of the music of the chameleon of pop culture music, David Bowie.

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Investigating the individual resonant properties of the human skull

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This project was designed to investigate the different resonance patterns of human skulls. The skull creates a resonant cavity that affects spectral properties of incoming sounds for a listener. The resonances of 30 participants' skulls were captured to better understand how their acoustic properties differ. Broadband white noise produced by a portable audiometer was presented through a bone oscillator to the temporal bone; the several-second output was recorded from an experimental microphone secured on the center of the forehead. Participants were given sensory measurements with aural and bone-conduction audiograms. The recordings were spectrally analyzed by looking the energy contained within 1/3-octave bands from 25 to 5,000 Hz using custom MATLAB software. Substantial individual differences were observed, (e.g., a range of 9.33 dB around 1,250 Hz). There also were similarities across the individual skulls clustered at 50-125 Hz; across skulls, there also were observed average peak resonances within the 400, 1,250, and 4,000 Hz bands. These patterns also were visualized via FFT, which revealed a 20 dB average range across skulls within measured frequency bands. Ongoing efforts are using the FFT data to permit filter manipulations of audio recordings according to individualized resonance patterns. In this way, it should be possible to evaluate the impact of skull resonances on listening preferences (e.g., to musical material). Implications and applications will be discussed.

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Sorting excerpts of Western classical music based on perceived similarity

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Sorting tasks can reveal the underlying intuitive structure of a collection of items, in this case musical excerpts. Sorting tasks can be used to compare experts and non-experts without relying on specialized vocabulary, and they tend not to fatigue participants (Chollet, Valentin, & Abdi, 2014). Here, we used the sorting technique with excerpts from the piano music of Bach, Mozart, and Beethoven. Experiment 1 involved sorting 21 MIDI-generated stimuli. Experiment 2 utilized 36 excerpts from recorded performances of four pianists (Arrau, Barenboim, Pirès, and Richter). Each experiment involved two parts: In Part 1, participants sorted excerpts freely into any number of clusters. In Part 2, participants sorted excerpts into three clusters according to whether a single composer could have written the pieces in the group. We divided participants into three groups based on music training. We investigated the effects of composer, pianist, and music training on sorting. To analyze the data, we applied DiSTATIS (Abdi, Williams, Valentin, & Bennani-Dosse, 2012), a recent adaptation of multi-dimensional scaling specifically adapted to reveal the perceived dissimilarity among items, as well as to investigate group differences. The results showed an effect of composer in both experiments; participants were able to strongly differentiate Mozart‘s excerpts from Beethoven‘s, with Bach falling in between those two. In Experiment 2, participants‘ sorting decisions were strongly influenced by pianists. Richter‘s performances of the three composers were clustered relatively close to the Mozart region of the solution, indicating their clarity and balance; in contrast, those of Barenboim were clustered in the Beethoven region, indicating their sumptuousness and passion. Experience effects were not strong and the highest and lowest expertise groups were differentiated only in the free sorting task of Experiment 2.

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Memory for musical melodies in affective contexts

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A set of studies were used to investigate the memory encoding of melodies as they might be influenced by affect. For the initial experiment, participants were presented a small set of instrumentally heterogeneous melodies accompanied by an emotional video. After a five-minute delay participants were tested on their recognition of the presented melodies. In these conditions, participants tended to recognize all of the melodies with few errors and no strong influence of affect. A second study was used to further investigate using a more difficult task. To reduce the ceiling effects, this test set incorporated a larger number of stimuli that were completely homogeneous in instrumentation (solo guitar). During the exposure phase participants heard stimuli with and without the accompaniment of an emotional video. Analyses were conducted to determine the influences of affect expressed in the music and in the video, in addition to the order of stimulus presentation and musical background/training by the participants. In contrast to the first experiment, participants had difficulty recognizing the stimuli particularly with the audiovisual context. More importantly, participants were found to have better recognition of the musical stimuli presented earlier in the presentation order, and with less distracting accompaniment. These results seem to suggest some of the constraints for encoding musical stimuli, and the specific contributions of affect for musical encoding.

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Prelayed and delayed auditory feedback for sight-reading musicians influences gaze

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Musicians are tasked with coordinating auditory, visual, and motor activity to effectively sight-read music. When the auditory feedback that they receive is delayed (occurs after production) or prelayed (occurs prior to production) it has been found to increase error rates and cause decrements in the accuracy of their timing. We investigated this disruption by asking expert pianists to sight-read novel compositions. During the sight-reading tasks the musicians were presented an auditory recording of the composition that was synchronous, delayed, or prelayed relative to their performance. Errors in timing and accuracy were tracked in addition to gaze fixations during the sight-reading task. Of interest is the influence of prelayed and delayed auditory feedback on the number of visual search regressions and the duration of gaze fixations during this task. The use of asynchronous auditory feedback was found to increase gaze durations and regressions relative to the synchronous auditory condition. Results are discussed with respect to perception-action cycles.

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Interval discrimination and melodic dictation as implications of cognitive processing

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Sensory dimensions of musical sound are processed cognitively through a conceptual integration network consisting of the recognition, discrimination, and categorization of sound events (Bey & McAdams, 2002). Musicians tend to recognize patterns that form melodies through the identification of musical intervals between successive notes (Oxenham, 2013). Dowling (1978) emphasizes the idea that unfamiliar melodies are encoded by melodic contour attributed to an underlying scale as opposed to a sequence of intervals. The purpose of this study is to explore perceptual difficulty in the aural recognition of melodic intervals under isolated and contextual discrimination conditions. The study will be guided by the following research questions: 1. Can a hierarchy of interval detection difficulty be formed? 2. What is the strength of the relationship between isolated and contextual interval recognition? 3. Do patterns of difficulty emerge based upon sequential interval ordering? A total of 46 undergraduate music students participated in this study. Each subject participated in two discrimination tasks: (a) identification of an interval played sequentially; and (b) dictation of a melody. Student answers were coded dichotomously. A total of 98 items were collected: 20 for identification and 78 for dictation. The Many Facet Rasch (MFR) Rating Scale Model (Linacre, 1994) was used to evaluate the psychometric quality of items and persons. Similar methodology was used as a method for examining short-term memory in pattern-based discrimination IQ exercises in the Knox Cube Test (Wright & Stone, 1979). Results indicated good-model data fit to the MFR model. Calibrations of persons (i.e., achievement) and items (i.e., difficulty) will be discussed. Implications for the field of psychology and music education will be considered along with suggestions to improve the practice of interval training and dictation practices within the music classroom.

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Sustained theta (4-7 Hz) and alpha (8-12 Hz) synchronization in the electroencephalogram during auditory processing: Effects of listening difficulty

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Most auditory electroencephalographic studies examine transient phase-locked responses occurring within the first few hundred milliseconds post-stimulus onset (e.g., the event-related potential; ERP). Though these methods are informative, they cannot fully characterize processes occurring at time-points prior, and far exceeding sound onset (e.g., auditory working-memory; sustained attention). These may be better characterized by oscillatory dynamics of the electroencephalogram (EEG). This study tested: 1) whether or not such dynamics can be observed in an auditory delayed match-to-sample (DMTS) task, and 2) whether or not they relate to task difficulty. On each trial, two frequency modulated (FM) tones were presented consecutively and followed by a 2.5 second retention interval. Listeners' task was to indicate whether a third sound presented after the retention interval matched the first or second FM tone. Across trials, sounds could either be identical (Impossible), different in modulation rate at an individual's predetermined ~71% perceptual threshold (Hard), or different in modulation rate by a value well above threshold (Easy). There were clear increases in frontal midline theta (4-7 Hz) and posterior alpha (8-13 Hz) power during the retention interval. These modulations were strongest in the Hard condition, slightly weaker in the Impossible condition, and weakest in the Easy condition. Spatially fixed independent components (retrieved by independent components analysis; ICA) suggest that medial frontal networks drive the frontal midline theta effects. Posterior alpha is likely related to activity in parietal and/or occipital brain regions. That increases in theta and alpha power were highest in the Hard condition suggests that increasing listening difficulty requires increasing utilization of cognitive-control networks involved in working-memory and attention, as long as the task remains possible. Interestingly, these EEG features are present within a time-window in which the ERP revealed little. Sustained EEG dynamics have a relatively untapped potential to provide information about cognitive processes in audition.

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Auditory-verbal sequence learning: The role of streaming

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We investigated the role of auditory streaming in the long-term learning of a spoken sequence using the Hebb repetition paradigm in which such learning is witnessed in the form of improved recall of a list that is surreptitiously repeated across a block of short-term serial recall trials. In the present experiment, successive items in the to-be-recalled lists—including the critical repeating list—were presented in male (M) and female (F) voices (e.g., 461378 presented in the voices MFMFMF). If, for the final repetition of the critical list, the items were presented by voice (i.e., 417638), recall of this sequence still enjoyed an advantage over non-repeated lists. This transfer of learning did not occur if all items in the list had been presented in a single voice. These results suggest that obligatory perceptual organization is a key mechanism of auditory-verbal sequence learning: In the alternating-voices condition, non-successive item transitions had been learned as a by-product of streaming-by-similarity. However, we also found that such stream-based learning was only evident if participants were required to recall each repeating sequence, suggesting that sequence learning is dependent also on the resulting perceptual organization being acted upon.

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Gradient categorization of speech sounds helps listeners recover from lexical garden paths

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Introduction: Listeners appear to differ systematically in the way they categorize speech sounds; some are more sensitive to within-category differences showing more gradient responding, while others seem to disregard these differences and are primarily driven by linguistically significant, between-category differences (categorical listeners) (Kong & Edwards, 2011). Here we examine the consequences of such differences for spoken language comprehension. We hypothesize that maintaining within-category detail allows listeners to be more flexible in reconsidering erroneous interpretations (e.g., to change their mind about whether they heard a /b/ or a /p/ when new information arrives). Method: Following previous studies (Kapnoula, McMurray, Kong, Winn, & Edwards, 2014; Kong & Edwards, 2011), we used a novel method—the visual analogue scaling (VAS) task—to quantify these individual differences and classify listeners as categorical versus gradient. The VAS task is similar to a 2AFC task, except that listeners can more precisely report their continuous percept of a stimulus. Participants saw a line whose endpoints were labeled with two words (e.g,. ‗bin' and ‗pin') and they listened to stimuli that varied between the two words in ~7 msec increments of Voice Onset Time (VOT). Listeners clicked on the line to indicate where they thought the word they just heard falls on the line. This gave us a continuous measure of how ―bin-like‖ or ―pin-like‖ they perceived the word. We fit each listener's response function using a five-parameter logistic equation that allows us to extract a measure of how categorical or gradient a participant's response pattern is. These measures were related to eye-tracking data from a visual world paradigm (VWP) task assessing listeners' ability to recover from lexical garden paths (McMurray, Tanenhaus, & Aslin, 2009). In this task participants heard words that were temporally misleading, while their eye movements were recorded. Stimuli were words like ‗pumpernickel' and ‗bumpercar'. The VOT of the initial consonant was manipulated to create garden paths (e.g., ‗bumpernickel' when the target was ‗pumpernickel'). Participants' degree of commitment to correct and garden path items, as well as their recovery from the ambiguity, was assessed by recording their fixations to pictures of items' referents presented on a screen containing the target, a garden path competitor, and two unrelated items. From this we extracted measures of listeners' recovery from garden paths (e.g., how quickly they re-activated ‗pumpernickel' after hearing ‗bumpernickel'). Our hypothesis was that gradient listeners' access to within-category information would allow them to recover from lexical garden paths more efficiently. Results: We entered individuals' gradiency score (from the VAS task) as a predictor in a series of mixed-effects models with the following measures as the dependent variables: 1) garden path rate (i.e. proportion of trials in which participants looked to the competitor picture), 2) recovery rate (i.e. proportion of garden path trials from which the participant recovered), and 3) recovery latency (i.e. time it took participant to recover from a lexical garden path). Distance from target (in VOT steps) was also included as a predictor in all models. Distance from target was a significant predictor of all three measures (replicating McMurray et al., 2009). Individual participants' degree of gradiency did not significantly affect the probability of making a garden path interpretation, or how fast they recovered afterwards. However, in accordance to our hypothesis, gradiency was a significant predictor of the likelihood of recovering at all with more gradient participants showing higher recovery rates. Further, a marginally significant interaction between gradiency and distance from target suggests that categorical listeners were affected to a higher degree by the magnitude of the discrepancy between the auditory stimulus and the target word. Conclusion: Some listeners were more sensitive to within-category phonemic information and this seemed to make them more flexible in reconsidering previously rejected word candidates. We believe that this flexibility likely stems from the gradient (instead of all-or-none) activation of phoneme representations; all-or-none phoneme activation may lead to higher suppression of competing lexical items, which in turn makes it harder for them to be re-activated. In contrast, gradiency allows for only partial suppression of competing lexical items, which allows them to be more readily available when and if they are needed. This finding suggests that more gradient activation of phoneme categories may actually be a more optimal categorization strategy, at least in some listening contexts.

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