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FECHNER DAY 2019

Proceedings of the 35th Annual Meeting of the Society for
Psychophysics



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FECHNER DAY 2019 - October 30th - 2nd November 2019

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Welcome to Fechner Day 2019

It is an honour to host the 35th Annual Meeting of the International Society for Psychophysics: the Fechner Day for the first time in Turkey, here in Antalya. We are very happy to welcome you to the region where East and West converge and embrace in the many different cultures of Anatolia. This time, Turkey will eagerly embrace scientists from all over the world to discuss sensation, perception and psychophysics.

Antalya is one of the most beautiful Mediterranean cities situated on the southwest coast of Turkey. You may enjoy warm weather, beautiful nature and the archaeological sites of important, ancient civilizations. You may be skiing in the Taurus mountains, and one hour later, be swimming in the blue waters of Mediterranean Sea.

Annual meetings of the International Society for Psychophysics prove that science is universal and sharing scientific knowledge has no borders. The organization of Fechner Day 2019 was a product of a collaboration between Turkey and Ireland. As the co-chairs of Fechner Day 2019 Dr. Mark Elliott and I with the other organization committee members hope to provide a scientific atmosphere in a peaceful country within a beautiful nature.

The first day of the meeting will start with the keynote delivered by a distinguished member of the ISP, Prof. Jim Townsend at Akdeniz University. The day will continue with a reception in the Old Town where members of Psychophysics will be able to socialize and share their ideas informally. We have five keynotes signposting the meeting and each is amongst of the best in our profession: Representing Turkey are two successful Turkish scientists: Prof. Dr. Onur Güntürkün and Prof. Dr. Canan Başar Eroğlu. In addition, there are Prof. Jim Townsend and Prof. Ruth Litovsky from the United States and Prof. Yoshitaka Nakajima from Japan. We expect they will enlighten us with their expertise. This year there will be one special theme session on Psychophysics of Language. As well as many more free talks and posters.

To illustrate the depth of human experience in southern Anatolia, we aimed to visit the fascinating ancient city of “Thermessos”. This is the city Alexander the Great intended to capture but could not in 333 BC. Our excursion will be guided by an expert from the Department of Archaeology at Akdeniz University.

We would like to thank to all attendees for their contributions to the 35th Fechner Day. We would like to express our special thanks to Akdeniz University Rector’s Office and the Faculty of Letters for their support and hosting the meeting.

We hope the 35th Fechner Day will be a fruitful scientific meeting building new bridges among different cultures.

Welcome to Turkey, welcome to Antalya!

Assoc. Prof. Dr. Evrim Gülbetekin PhD

Joint meeting-chair of Fechner Day 2019

Head of Experimental Psychology Department

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Keynote Speakers

Invited Speakers

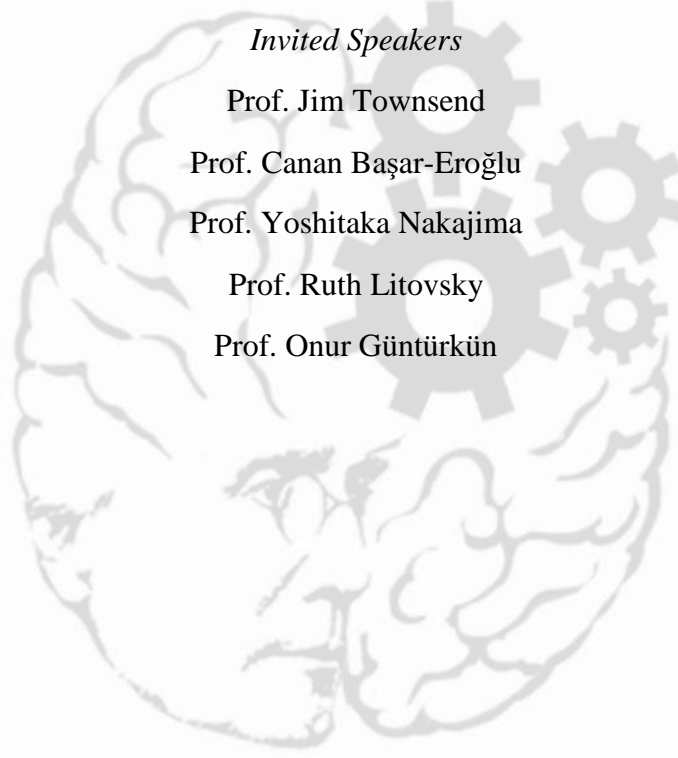
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Prof. Ruth Litovsky

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Fechner Day

Psychological systems theory (PST): Extending Fechner's psychophysics to elementary perception, cognition, and motor processes

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Abstract

My dream since grad school has been to construct a *psychological systems theory*. The aim is to formulate quite general ways with which to arrive at the type of lawfulness found in our society's father, Gustav Fechner's classical research. Such a theory would resemble a coin: On one side is the theory, which perforce embodies definitions, postulates, axioms and theorems about input-operations-output behavior. On the other side resides a suite of theory-driven methodologies that serve to whittle down the prospective theoretical explanations of given sets of observational data. We have sometimes used the term 'sieve approach' to describe the reduction of the class of potential explanations. Just as in general and dynamics systems theory (e.g., think Klir, Forster, Ashby, to some extent von Neumann, Wiener, Turing, McCulloch & Pitts, and so on), the ensuing metatheory strives to encompass important psychological concepts, structures and mechanisms, but rather than plumping for one position or the other, to derive behavioral and/or physiological assays to result in the aforesaid 'paring down' goal. This type of thinking led me (long, long ago it must be confessed) to begin with the kinds of properties being ascribed to things like search in short-term memory or a set of visual items. Over the decades, it has led to metatheories like *general recognition theory* and *systems factorial technology*. With apologies to the few in the audience (like my long-time friend and collaborator, Danny Algom) who are already experts in those topics, I will briefly review their fundamental constructs and how they assess critical properties such as *mental architecture*, *decisional stopping rules*, *workload capacity*, *perceptual separability*, *decisional separability*, and *dimensional or featural independence vs. positive or negative dependence*. I then lead up to their far-from-complete synthesis into a modest *psychological systems theory* wherein the ultimate goal is a set of experimental paradigms capable of simultaneously assessing the above characteristics within the same observational blocks of trials.

The impact of deafness on auditory processing and cognitive load in complex listening environments

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Abstract

Patients with bilateral deafness are eligible to receive bilateral cochlear implants (BiCIs), and in some countries, patients who suffer from single-sided deafness are receiving a cochlear implant (SSD-CI) in the deaf ear. In both the BiCI and SSD-CI populations there is a potential benefit from the integration of inputs arriving from both ears. One of the demonstrated benefits is improved sound localization. To understand the factors that are important for binaural integration we use research processors, delivering pulsatile stimulation to multiple binaural pairs of electrodes. Our novel stimulation paradigms are designed to restore both binaural sensitivity and speech understanding. A second known benefit is improved ability to segregate speech from background noise or competing maskers. Our recent studies are aimed at measuring both release from masking and release from cognitive load. In these studies, we use real-time pupil dilation as a means to assess listening effort while subjects listen to speech stimuli. We are interested in the extent to which bilateral hearing in BiCI patients, and in SSD-CI promote release from masking, and the corresponding cognitive load. By understanding the cost/benefit of integrating inputs to two ears, a more complete picture of the advantages of bilateral stimulation can emerge.

Acknowledgements

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Auditory psychology and phonology

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Abstract

Phonology is a field in linguistics that focuses on how speech sounds are separated from and related to one another. This field should be closely connected to auditory psychology, which deals with how sounds in the environment are organized perceptually, i.e., how perceived sounds are separated and related. These two areas, however, are not always connected systematically, and we are involved in two attempts to find connections.

In one attempt, we try to create a kind of phonology that works for non-linguistic sounds, and call this theoretical framework *Auditory Grammar* (Nakajima, et al., 2014). It is widely accepted that auditory organization is basically a process in which the auditory system forms perceptual units called auditory streams utilizing acoustic cues in the environment. An auditory stream is typically a chain of auditory events extending in time. Auditory Grammar assumes that the auditory system tries to convert the acoustic cues to perceptual elements, which we call *auditory subevents*. There are four types of auditory subevents: onsets, offsets, fillings, and silences. Auditory subevents forming an auditory stream should make a grammatical string. An onset should be followed either by a filling or by a silence, and a filling should be followed by an offset, for example. This theoretical framework is based on the idea that, if our auditory system should utilize phonological rules to perceive linguistic sounds, then a kind of phonology should be available even for the perception of non-linguistic sounds. This idea indeed works to explain a few illusory phenomena as the gap transfer illusion or the split-off phenomenon.

Our other attempt to connect phonology and auditory psychology is to develop a new research field which we tentatively call *acoustic phonology*. Linguistic functions of speech sounds are firstly revealed in syllable formation. To examine psychoacoustic natures of syllables should give a solid basis to understand how a speaker and a listener communicate with each other by sharing the same temporal structures. A key concept is *sonority* (Nakajima, et al., 2018). Sonority is supposed to be a phonological nature of speech sounds that is considered higher at or near syllable nuclei; typically, the highest sonority is given to vowels. A problem is that the concept of sonority is often derived from the syllabic structures of speech, and this concept is employed to explain how syllables are formed; there is a risk to lead to circular reasoning. It thus would be productive to connect sonority to acoustic analysis of speech. Our analysis of British English speech indicated that a spectral factor around 1000 Hz is closely related to what is assumed to be sonority. What de Saussure called *aperture* is also closely related to this spectral factor, suggesting strongly that this factor depends on the whole configuration of the articulatory organs (de Saussure, 1966). My colleagues and I found that

this factor appears as rhythmic aspects of speech getting clearer in the developmental process of infants' speech.

It should be productive to investigate how linguistic and non-linguistic sounds are perceived in the same phenomenological and psychophysical frameworks. Phonology-like rules seem to work also in the perception of non-linguistic sounds, and basic experimental methodology employed to investigate the perception of pure tones or clicks should be useful also to understand how speech syllables are perceived.

Acknowledgements

This study and the studies my students report with me in this conference are supported by the Grant-in-Aid for Scientific Research 17H06197 from the Japan Society for the Promotion of Science. The session my colleagues and I organize is also supported by the same Grant-in-Aid.

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What do we learn from brain oscillations?

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Hans Berger recorded the first Human EEG in 1929. The use of EEG reached a maximum within 10 years. However, 1960s EEG research became less attractive, since the development of CT and MRI became more interest for the neuroscientists. In 1998, Mountcastle has reported about the paradigm-changing by means of analysis methods in EEG research. He emphasized that using brain oscillations have become conceptual and analytical tools for the understanding of cognitive processes. Because of the different properties of frequency bands, we also emphasize the combined application of several analytical methods such as power spectra, wavelet decomposition, adaptive filtering of event-related potentials, and inter-trial coherence. These combined analyses procedure gives the most profound approach to understanding of EEG responses.

In the last decade, brain oscillations are considered as functional building blocks of sensory –cognitive processes. Our research team has investigated delta, theta, alpha, beta and gamma frequency bands in both healthy and patients with schizophrenia, bipolar disorder, and Alzheimer’s disease. According to our studies, psychopathologies have to be investigated in multiple oscillatory frequency ranges in multiple locations to understand the nature of disorders. Therefore, I would like to present examples from our studies that investigated neuropsychiatric disorders in such a way.

Schizophrenia is a complex mental disorder with impairments in integrating sensory and cognitive functions, leading to severe problems in coherent perception (Bařar-Erođlu, Schmiedt-Fehr, & Mathes, 2013). Based on our studies this impairment is accelerated during multistable perception (Bařar-Erođlu et al., 2016). Specifically, inter-trial coherence of frontal theta was impaired in patients with schizophrenia during visual perception. Bipolar disorder is a chronic illness with an unpredictable relapse and remitting course. Relapses are manic, depressive or mixed in nature. Neurocognition has been shown to be largely disturbed in bipolar disorder. Findings from our research group a selective decrease of the fast theta response to cognitive load. Also, a major break of alpha reaches beyond the alpha reduction already shown in other neuropsychiatric disorders is also a striking finding, indicated an important deficit in the main operator of the central nervous system in bipolar disorder (Özerdem et al., 2013). Alzheimer’s disease is the most common form of dementia a neurological disease characterized by loss of mental abilities severe enough to interfere with normal daily activities. One of our studies showed impaired frontal phase-locking in the theta frequency band in Alzheimer’s disease (Yener, Güntekin, Öviz, & Bařar, 2007). One of the most interesting results of our research group is the improvement of frontal theta phase-locking in Alzheimer’s disease following treatment of cholinesterase inhibitors.

As a summary, comparison of the results of the neuropsychiatric disorders may lead us to important conclusions related to the web of brain oscillations. Consecutively, we could gain new insights to approach brain function.

Acknowledgments

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Bicameral minds in humans and other animals: A mechanistic neuronal view

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Abstract

Although left-right differences of brain and behavior are ubiquitous, we have hardly any detailed insights on the neuronal of brain asymmetries. Using humans and pigeons as model organisms, my aim is to establish mechanistic explanations that bridge the gap between neurons and lateralized behavior. To this end, I will talk about four core questions: First, how widespread are asymmetries in the animal kingdom? Second, how do asymmetries pay in terms of evolutionary fitness? Third, how do they emerge in ontogeny? Fourth, how do we integrate complementary functions across our hemispheres?

Theme Session: Psychophysics of Language

Invited Speakers

Yoshitaka Nakajima

Daniela Czernochowski, Petra Ludowicy, Tina Weis, & Thomas Lachmann

Yuko Yamashita, Miharu Fuyuno, Yoshitaka Nakajima, Stanislava Antonijevic-Elliott, Mark
A. Elliott, & Sophia Arndt

Shimeng Liu, Yoshitaka Nakajima, Mark A. Elliott, Lihan Chen, Gerard B. Remijn,
Sophia Arndt, & Zhuoyue Pang

Stanislava Antonijevic-Elliott

Fechner Day

Psychophysics of language

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Abstract

Psychophysics typically represents a research paradigm to investigate the relationship between physical and subjective natures of the same phenomena. Psychophysical investigations are particularly relevant for two aspects of human linguistic communication. Firstly, the relationship between the physical natures of sounds and their phonological representations require systematic examination. The second aspect is related to the relationship between the mental representations of linguistic contents and the physical objects and events they represent. It is often difficult, however, to clearly separate these two aspects, which lead to development of a spectrum of different research methodologies. As speech sounds are not directly connected to objects and events they represent, it seems important to understand how sounds are perceived to mean something and related to what they mean as a whole inseparable process. Four attempts to promote this way of thinking are presented in this organized session.

Acknowledgements

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Is it still speech? Psychophysics of discriminating stimuli gradually changing from speech to non-speech and of subsequent feedback evaluation

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Abstract

We investigated speech processing by using stimuli gradually changing from speech (German vowels) to non-speech (spectral rotated versions of these vowels). Stimuli were presented in descending levels of vocalization blends, from pure speech to non-speech, through step-wise combinations, resulting in ambiguous versions of the sounds. Participants performed a two-alternative forced choice task: Categorization of sounds was made according to whether they contained more speech or non-speech. Performance feedback was presented visually on each trial. In several experiments we assessed discrimination performance as well as ERP and functional magnetic resonance imaging (fMRI) data during auditory and visual processing. A left lateralization of activation in the primary auditory cortex and the superior temporal sulcus predicted superior speech-non-speech discrimination. Subsequent feedback processing follows three distinct and successive stages, starting with initial screening for behavioral relevance, followed by a binary valence distinction, and a more detailed analysis.

A quantitative analysis to characterize verbal and non-verbal behavior in public speaking performance

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Abstract

The present study quantitatively explored verbal and non-verbal behavior in public speaking performance with English native speakers. Speech performances with 15 Irish native English speakers were audio- and video-recorded and analyzed. Their speech rate, duration of speech pauses, duration of speech units, the coefficient of variation of speech pauses, and the duration and frequency of eye contact were obtained as objective indexes. A principal component analysis revealed that total duration of speech pauses, the coefficient of variation of speech pauses, and the total duration of eye contacts are important to characterize speech performance.

Pause duration influences impressions of English speech style rated by native and non-native speakers

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Abstract

Influences of pause duration on speech style impressions of English speeches were investigated by means of rating scales and factor analysis. Excerpts from a university English textbook, along with sound materials collected from the compact disk attached to the textbook were used. First, all punctuated pauses were manipulated to have the same duration between 0.075-4.8 s. As a result, the same two factors indicating how the speech styles were perceived were obtained both from native ($n=19$) and from non-native, Chinese ($n=22$) or Japanese ($n=19$), speakers of English. These factors were interpreted as *naturalness of speech* and *speech rate*. Speech rate was basically higher when the pause duration was shorter. Naturalness of speech was highest when the pause duration was around 0.6 s. In a following experiment, pauses within sentences and pauses between sentences were varied separately in between 0.15-2.4 s. Original speech and speech without pauses were also included. Data from native ($n=18$) and non-native [$n=20$ (Chinese) and $n=20$ (Japanese)] English speakers were collected. Naturalness tended to be higher when the pauses between sentences were longer than those within sentences. However, setting all pauses to 0.6 s made the naturalness almost as high as the naturalness of the original speech. The present results revealed the importance of controlling pause duration to make speeches sound natural.

The psychophysics of language: Measuring grammatical knowledge

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Abstract

Sentence Repetition Task has been proven to measure morphosyntactic knowledge and comparable versions of the task in multiple languages have been used to compare morphosyntactic knowledge in multilingual speakers. However, cross linguistic influence and differences in morphosyntactic complexity of languages can influence the scoring and lead to incorrect judgement about language performance in individual languages of multilingual speakers. Possible ways of avoiding these pitfalls will be discussed.

Session I



The effects of context repetition and alternation on CSE without learning and memory confounds in a flanker task

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Abstract

Congruency effect is slower and more error-prone responses to incongruent trials than congruent trials in conflict-inducing tasks. Congruency Sequence Effect (CSE) which is considered as an indicator of cognitive control is a decrease in congruency effect after incongruent trials compared to congruent trials. In our previous study (Atalay & Inan, 2017) the contextual feature did not influence the CSE when there is a contingency between target- and distractor dimensions; but, when the contingency confound was removed, the differential effects of context on CSE was observed. The repetition of the target and distractor dimensions across the consecutive trials, the memory confound was also not removed so the differential effects of context on CSE was observed only when target-distractor repetitions exist in the absence of contingency. In the current study, contingency confound will be removed a-priori and target- and distractor dimension repetitions will be removed before analysis. The effects of context repetition/alternation on CSE will be investigated by using a Flanker task in which dynamic visual white noise will be the contextual feature. If contextual information can be used to retrieve control parameters, we expect to observe the CSE only in the context repetition condition but not in the context alternation condition. If contextual information cannot be used to retrieve control parameters, then we expect to observe the CSE in similar magnitudes in both context repetition or alternation conditions.

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Dissociating cognitive and affective uncertainty using a General Linear Classifier

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Abstract

A number of categorization models have been proposed that consider classification performance and uncertainty in terms of prototypes, category boundaries, and exemplars. Like other models of categorization, category boundary models (e.g., GLCs) only consider cognitive uncertainty while failing to consider affective uncertainty. Using a modified GLC, measures of affective uncertainty were obtained by combining exemplar-based information (e.g., response frequency) and categorical information (e.g., categorization accuracy) in varying proportions (0/100, 25/75, 50/50, 75/25, and 100/0). We provide evidence that categorical and exemplar-based representations likely inform affective uncertainty in simple categorization tasks.

Introduction

Uncertainty is a fundamental concept in information theory (Shannon, 1948) explicitly or implicitly informing many early models of cognition (Lachman, Lachman, & Butterfield, 1979). Uncertainty is typically understood in terms of confusability between multiple stimuli due to an absence of information or as the result of stimulus similarity. This reflects the cognitive dimension. Contemporary models of decision-making have considered affect in terms of an antecedent to information processing (e.g., Slovic et al., 2002). More recently, studies have attempted to dissociate cognitive and affective uncertainty (Burleigh & Schoenherr, 2014; Schoenherr & Burleigh, under review). In the present study, we examine whether a simple model of categorization based on General Recognition Theory (GRT; Ashby & Townsend, 1986) can be adapted to understand differences between cognitive and affective uncertainty rather than postulating separate response mechanisms. We examine three different computational methods for modelling affective uncertainty that incorporate categorical and exemplar-based information and contrast them against models that use a single source information (i.e., categorical or exemplar knowledge). We then consider, and reject, a Bayesian model of this phenomenon.

Cognitive and Affective Uncertainty in a Categorization Task

Categorization Models

A number of similarity-based categorization models have been proposed that assume that novel stimuli are classified based on their similarity to summary representations, instances, and category boundaries (for a review, see Pothos & Wills, 2011). Collectively, these models assume that participant will be uncertainty to the extent that a given exemplar shares features with an exemplar associated with a contrasting category. While recent categorization models have considered cognitive uncertainty (e.g., Paul et al., 2011), affective uncertainty has yet to be considered.

Uncanny Phenomena

In the context of engineering, Mori (1970) suggested that the extent to which an object (e.g., robot, mask, doll, prosthetic) was associated with negative affect ('eeriness') was a nonlinear function of the extent to which it shared features with humans, i.e., humanlikeness. The result is an "uncanny valley" (hereafter, referred to as the uncanny valley hypothesis, or UCV), or minima in a function describing positive affect along a continuum.

With considerable qualification, the UCV has received some support from a number of empirical studies (e.g., Cheetham, Suter, & Jäncke, 2011; MacDorman & Ishiguro, 2006). Studies that present participants with stimuli from human and nonhuman categories have found that stimuli containing characteristics from both categories are associate with greater decisional uncertainty which has been interpreted as affective uncertainty (e.g., Cheetham et al., 2011). However, these results must be qualified. In a study by Burleigh, Schoenherr, and Lacroix (2013), stimuli that deviated in terms of humanlikeness (e.g., facial morphology, the number of polygons) did not demonstrate an uncanny valley (Experiment 1). However, when human and nonhuman features were blended in novel stimuli, negative affect was observed (Experiment 2). These results can be taken as suggesting that the uncanny valley is not dependent on humanlikeness, but requires two contrasting category and exemplars that share features of each.

Evidence also suggests that the UCV can be understood in terms of categorization processes more generally. Burleigh and Schoenherr (2014; Schoenherr & Burleigh, under review) suggest that negative affect might be the result of uncertainty that arises from comparing novel stimuli that share features from two contrasting categories. The absence of familiarity with the novel exemplars relative to two or more well-known categories leads to negative affect. Thus, presentation frequency should be a key determinant of affect uncertainty.

Burleigh and Schoenherr (2014) obtained evidence to support this account using a unidimensional categorization task. In a training phase, participants were provided with exemplars selected from two nonhuman categories and were provided with feedback. In a transfer phase, participants categorized old and new stimuli (novel extrapolation items) and provided eeriness and typicality ratings. Burleigh and Schoenherr (Burleigh & Schoenherr, 2014; Schoenherr & Burleigh, under review) observed that cognitive uncertainty (errors) and affective uncertainty (eeriness ratings) are highest around the category boundary. Crucially,

they additionally observed that affective uncertainty (but not cognitive uncertainty) was also high for stimuli located far away from the category boundary that had not been presented during training (extrapolation items). They suggested that this finding can be accounted in terms of frequency-based effects in studies of preference (Bonanno & Stillings, 1986) and the mere exposure effect (e.g., Borenstein, 1989). Consequently, while categorization performance was determined by a categorical representation (i.e., a category boundary), ratings of negative affect were additionally affected by exemplar presentation frequency during the learning phase.

Present Study

The results of Burleigh and Schoenherr (2014) suggest that uncanny valley phenomena need not be the result of special kinds of knowledge or processes related to human categories, but might best be understood in terms of general categorization processes. If true, this means that computational models of categorization should be able to account for the patterns of results associated with the UCV. Following the suggestions of Burleigh and Schoenherr (2014), we consider an account of the UCV that uses a category boundary to classify stimuli from two contrasting categories. Given the widespread use of GRT (Ashby & Townsend, 1986) and category boundary models (e.g., Ashby & Gott, 1988), we used a previous implementation of this model (Alfonso-Reese, 2006) to simulate categorization performance using a General Linear Classifier (GLC). GRT assumes that stimuli are represented in multidimensional space and that categorization occurs by means of the adoption of a decision-boundary. Following the presentation of a stimulus, a GLC adjusts the location of the category boundary in multidimensional space until an optimal decision boundary is identified. The relative location of an old or new stimulus to the decision boundary will determine the category of the stimulus.

Beyond GRT, we additionally assume that participants retain knowledge of both a category boundary and specific exemplars (e.g., RULEX; Nosofsky, Palmeri, & McKinley, 1994). Exemplar-based information was modelled using the response frequency of the GLC, i.e., the *perceived* frequency of stimulus presentation. By pooling categorization accuracy and model stimulus response frequency, we examine possible measures of affective uncertainty.

Model and Results

The model was based on the GRT Toolbox (Alfonso-Reese, 2006) developed in MATLAB. We used the unidimensional variant of the General Linear Classifier (GLC) model (`lindiscrim1dvals.m`) to accommodate the single dimension used by Burleigh and Schoenherr (2014) and used a low-level of noise ($\text{noise} = 1$) due to the high level of performance of participants in that study. The category boundary was assigned to the mid-point of the stimulus distribution (i.e., Stimulus 8).

Stimulus sets were created in MATLAB to replicate those used by Burleigh and Schoenherr (2014). We examined 2 separate stimulus sets corresponding to two different kinds of training conditions. Corresponding to the equal frequency (EF) condition, the GLC was provided with 5 stimuli from each category (i.e., Stimuli 3-7 and 9-13) that were randomly sampled without replacement. Each of the 10 stimuli were presented 4 times in a block of trials.

In the unequal frequency (UF) condition, the same number of training stimuli (40) were provided to participants. However, the presentation frequency of each of the 4 stimuli (i.e., Stimuli 3-6 and 8-13) increased as a function of distance away from the category. Each successive position away from the stimuli resulted in a doubling of presentation frequency, such that the stimuli located close to the category boundary (Stimuli 6 and 8) were presented 2 times whereas as the most distant stimuli (Stimuli 3 and 13) were presented 8 times. In this way, the GLC becomes sensitized to extreme values along the stimulus continuum in the UF condition but receives unbiased training in the EF condition. The model was provided with 10 training blocks. Table 1 contains the distributions for the training blocks in the EF and UF conditions.

The test session proceeded in an identical manner for the EF and UF conditions. All 15 stimuli were presented to the model. In each of the two training blocks, the model received only 2 presentations of each stimuli.

Response Coding

Correct responses were determined by the assignment of a given exemplar to a region along a perceptual continuum, i.e., a category. Stimulus 8 was used as a mid-point and therefore it was neither correct nor incorrect. Stimuli 1-7 were assigned to Category 1 whereas stimuli 9-15 were assigned to Category 2. Responses were coded as correct if the appropriate category label was assigned to a stimulus.

Model Fit

Figure 1a provides the model output for the training phase wherein only a subset of stimuli were provided. Like Burleigh and Schoenherr, response accuracy is at the lowest at the category boundary, reflecting high decisional uncertainty. As Figure 1b demonstrates, participants were highly accuracy even with the two novel stimuli from each category. To this end both the GLC and human data suggest that a linear category boundary was used to categorize stimuli. A correlational analysis demonstrates the similarity between the human and model categorization data with a strong positive correlation, $r(14) = .980, p < .001$.

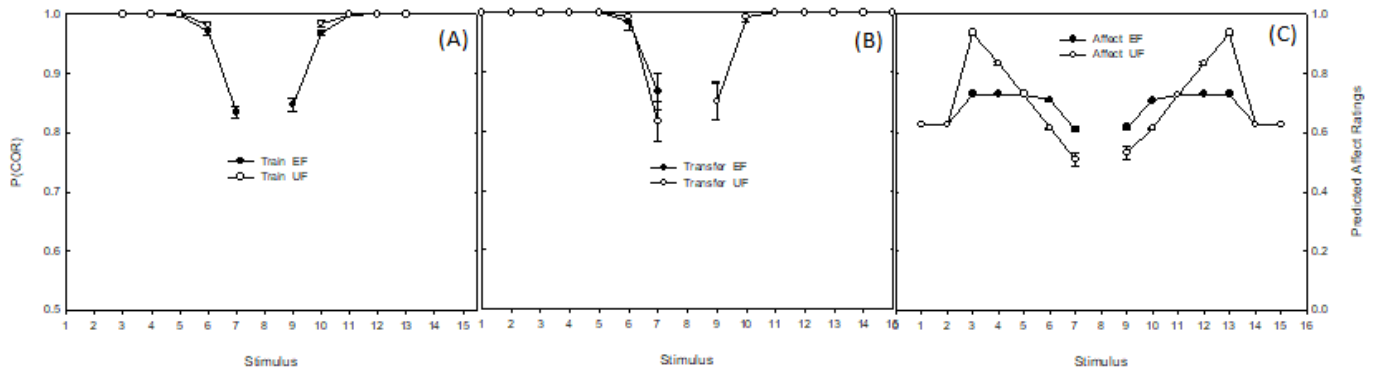


Fig 1. General Linear Classifier (GLC) predicted accuracy in the training (A) and transfer phases (B). GLC predicted negative affect in the transfer phase (C) using the 50:50 ratio for categorical and exemplar-based information.

Affective ratings were modelled using proportional combinations of two sources of information. Affective models were assessed that included only response accuracy or response frequency. Three additional possibility were also examined assuming that one source of information (categorization accuracy or training frequency) might exert a larger influence on affective ratings than another or whether they contributed equally. Table 2 provides the results.

Table 1. Correlations between models of affective responses and human data from Burleigh and Schoenherr (2014). The *p*-value is contained within parentheses.

	Categorical:Exemplar				
	100:0	75:25	50:50	25:75	0:100
Equal Freq.	-.120 (.68)	.014 (.96)	.151 (.61)	.219 (.45)	.245 (.40)
Unequal Freq.	.214 (.46)	.478 (.08)	.528 (.05)	.537 (.05)	.538 (.05)

As Table 1 demonstrates, despite the GLC providing an excellent fit to the categorization data, we did not find support that the GLC’s model of response accuracy provided a reasonable fit of the affective responses in either the EF or UF conditions. This supports our claim that cognitive uncertainty (accuracy) and affective uncertainty (negative affect ratings) are differentially influenced by separate sources of information.

The results provided in Table 1 suggest that if a GLC provides a reasonable means to understand affective ratings, the basis for affective ratings might be dependent on condition. Whether equal weight was provided to both categorical and exemplar-based information (50:50) or greater weight was assigned to exemplar-based information (25:75), or exemplar-based information was solely used (0:100), the model provided a reasonable fit to the data in the UF condition. This was not the case for the EF condition. Regardless of the measure used, the GLC did not provide a reasonable model for affective responses. However, this condition appeared to reflect stimuli categorization bias. As Burleigh and Schoenherr (2014) noted, participants in the EF condition appeared to have a bias to anchor their preferences to a particular response category. The possibility of modelling such bias was not examined here but could be explored using a GLC. It is still noteworthy that, even in this condition, the best fits

followed the same trend as the UF condition: the greater the influence of exemplar-based information, the better the affective model fit.

Discussion

In the current study, we obtained evidence that a general linear classifier (GLC; Alfonso-Reese, 2006) provides a good fit for uncertainty responses. While we do not claim that categorization, or the relationship between affect and cognition, can be adequately described by a GLC, we sought a parsimonious account to contrast against more complicated accounts of this relationship (e.g., MacDorman, & Ishiguro, 2006). In the case of the present study, our model used few parameters and, with the exception that response frequency influences affective responses, no additional assumptions were required beyond those of GRT (Ashby & Townsend, 1986). In terms of the categorization results, the GLC provided an excellent fit to the data with equivalent performance to that of the human data. With minor assumptions, the pattern of affective ratings was also captured. Measures that assumed affective uncertainty and cognitive uncertainty were equivalent, provided the poorest fits for the data. In contrast, we found that measures that assume exemplar-based representations inform affective responses produced the best fits.

The current study and GLC-based model of the uncanny valley can be contrasted with a Bayesian account (Moore, 2012). This account assumes the uncanny valley is a function of two factors: (1) *perceptual tension* near category boundaries based on uncertainty between perceptual cues (modeled by a displacement function), and (2) the relative frequency of each category. Being a Bayesian account, the key difference between category boundaries is the assumption that the non-human category's probability distribution has a broader spread than the human category's distribution. This differential spread is required to match the non-monotonicity of Mori's original *affinity* axis. Crucially, Moore's account begins with Mori's function and then works backwards to describe a set of probabilistic processes which could fit this function rather than describing specific elements of the data.

Consequently, Moore's account is lacking in two respects. First, like many early Bayesian accounts, they fail to consider how prior distributions are acquired through learning. Second, like other discussions of the UCV, this account conflates cognitive and affective uncertainty responses thereby assuming only a single learning and response system. In contrast, our results suggest that multiple stimulus representations or multiple learning systems are required to understand discrepancies between affect and categorization.

The findings presented here provide support for Burleigh and Schoenherr's (2014) explanation of UCV-like phenomena. Specifically, high cognitive and affective uncertainty is observed for stimuli located between the two categories due to stimulus ambiguity: stimuli located near the category boundary share more features with a contrasting category and are therefore more confusable. In contrast, stimuli located at the ends of the stimulus continuum are associated with low cognitive uncertainty because of their remoteness relative to the category boundary. Their high affective uncertainty must therefore be a response of infrequent exposure to stimuli during training. Thus, while these stimuli are unambiguously members of their respective categories, they are unfamiliar. This lack of familiarity results in negative affect.

In terms of a simple model of affective uncertainty, we found that using the outputs of a GLC in terms of 1) categorization accuracy and 2) response frequency can provide reasonable fits for the data obtained in experiments examining the UCV. Crucially, the GLC does this without invoking special learning and response mechanisms associated with “humanlikeness” (e.g., MacDorman & Ishiguro, 2006) as well as those that equate cognitive and affective uncertainty (e.g., Cheetham et al. 2011). We therefore suggest that UCV-like phenomenon simply reflect patterns that have been identified in discussed in the preference literature (e.g., Bonanno, & Stillings, 1986; Borenstein, 1989). In short, the special status that is typically ascribed to the “human” category in UCV studies is likely the result of increased high frequency of exemplars (humans) within the environment and cognitive uncertainty of stimuli that shared features from two contrasting categories.

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Procedural pain discrimination by neonates measured by behavioral and physiological parameters

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Abstract

Few studies have explored discrimination ability for different nociceptive procedures in neonates. This study evaluated 116 neonates using pain psychophysical parameters during baseline, reactivity and recovery for 10 different clinical nociceptive procedures. Two ratters blind-scored videos using PIPP, NFCS and EVENDOL pain scales. Skin conductance activity was measured by number of peaks (NP), amplitude (A), rise time (RT) and area under curve (AUC). Repeated-measures-ANOVA determined that pain reaction differed through time for PIPP and A ($p < .038$). Wilcoxon-test showed change between baseline and reactivity in all scales and electrodermal response ($p < .001$), though only PIPP and A detected change between reactivity and recovery ($p < .001$). PIPP differed significantly among procedures ($p = .050$). There were gender effects over NFCS and PIPP ($p < .050$); Apgar over NP ($p = .022$) and Weight at Birth over A ($p = .047$). Thus, neonate infants perceived nociceptive stimulation for all procedures and reacted differently to them. Being female, healthier or born with higher weight improved the effect.

The nociceptive response in newborn infants has been formally studied since Charles Darwin when he published, in 1872, his book “The Expression of the Emotions in Man and Animals”, in which he argued that all humans, and even other animals, show emotion through remarkably similar behaviours and this can be observed early in life. There is enough evidence to show that infants, even prematures, are capable of perceiving and reporting pain, though it was controversial for many decades (Stevens et al, 2007). This capacity relates both to their medical condition and to the clinical procedures they undergo, such as blood tests, endotracheal suction, surgery or other invasive procedures, especially in an intensive care unit (ICU) (Harrison et al 2006). Pain is defined by the International Association for the Study of Pain (IASP) as ‘an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in ‘pain is always subjective and is always a psychological state’ (Merskey & Bogduk, 1994; Anand & Craig, 1996). Nevertheless, researchers still face the challenge to understand how newborns are able to perceive pain and if they are able to discriminate different sources of pain.

Pain measurements in newborns involve physiological and behavioural assessment, although it is not always clear whether they are measuring pain or distress. Several one-dimensional (behaviour factors) or multidimensional (behaviour plus physiological factors) pain scales have been introduced to assess pain in infants (Bellieni, 2012). Changes in facial expressions, crying, and increases in motor activity are the most often used clinical indicators of pain in newborns and these behaviours compose the items of the majority of pain scales that have been validated for newborn infants (Jesus et al, 2015). Among physiological measures for pain, one often used is the electrodermal activity, which represents autonomic changes in the electrical properties of the skin. Applying an electrical potential between two points of skin contact and measuring the resulting current flow between them can quantify it. Skin

conductance responses results from sympathetic neuronal activity and has been considered an useful index of changes in sympathetic arousal that are tractable to emotional and cognitive states as it is the only autonomic psychophysiological variable that is not contaminated by parasympathetic activity (Braithwaite et al, 2015). However, few studies have explored discrimination ability for different nociceptive procedures in neonates comparing behavioural scales, one-dimensional and multidimensional, with electrodermal activity. The aim of this study was to register and compare the newborns' reactivity to nociceptive stimulation in natural context as in a neonatal hospital ward using three pain scales and skin conductance measures.

Method

This is an observational study, controlled by the individual, *before*, *during*, and *after* the painful event. The convenience sample studied consists of 116 painful events from a population of 89 clinically stable hospitalized newborns. They were selected based on convenience from the neonatal care unit at the University of Brasília Hospital, Brazil. Newborns excluded were those with metabolic, respiratory, cardiovascular, neurological or infectious diseases, third or fourth degree intracranial haemorrhage, with impaired skin integrity, and with cardiac, pulmonary, gastrointestinal, and neurological congenital malformations. Written informed consent from a parent was obtained before inclusion of the newborns in the study, which was performed in accordance with the Declaration of Helsinki (2010) and approved by the Research Ethics Committee of the University of Brasília.

Procedures

The selected invasive procedures happened at the convenience of the clinical staff and were monitored by the research team composed by three researchers on duty at the Neonatal Intensive Care Unit (NICU). Once the chief nurse announced the clinical procedure, the researchers triggered the equipment setting and connected the infant to the skin conductance algesimeter.

The newborns' behavioral and physiological responses were observed in three time periods, each lasting 15 seconds: before the nociceptive procedure (baseline), immediately after (considered to be the period during the nociceptive stimulation), and after the end of the period during (considered to be the recovery period). The facial and body movements of the baby were video recorded by a digital video camera (Sony DCR-SR47, Manaus, Brazil), located 1m from the neonate under natural ambient lighting and/or artificial white light. The images that were captured were sufficient to visualize the newborn. Later, two trained independent observers using a second-to-second stop-frame technique analysed the recorded images and scored the behavioral response. The scores were attributed accordingly to the protocols established for the scales: NFCS (Grunau & Craig, 1987), PIPP (Stevens *et al*, 1996), and EVENDOL (Fournier-Charrière et al, 2012).

Skin conductance response was measured using a skin conductance measurement system (SCMS, Med-Storm Innovation, Oslo, Norway) with an alternate current (AC) of 60 Hz, according to Storm guidelines (Storm, 2001). The SCMS uses a computer program that records the number of waves per second (NWps) and calculates the area under curve of peaks (AUC, Medstorm PC software, version 1.0.0.27), amplitude (A) and rise time (RT). The NWps is correlated with the rate of firing of the skin's sympathetic nerve system (SNS). The AUC contributes to understanding the physiology of the skin's sympathetic nerve response to a painful stimulus, showing how forcefully the SNS is firing, amplitude is related to the reaction intensity and rise time is the time taken from SCR onset to reach peak amplitude within the SCR (number = secs). To eliminate electronic noise, the minimum amplitude was set to 0.02

micro-Siemens (μS ; Storm, 2001; Storm, 2008). In each of the periods of observation, 15-s time intervals were also analyzed to determine the NWps and AUC.

Statistical Analysis

Descriptive analysis of categorical variables and position measurements of continuous variables were used. The Shapiro-Wilk test was used to test sample normality. To evaluate the equivalence of the two observers, the following tests were used: Weighted Kappa coefficient, with cut-off criterion $>.60$ for agreement, and the Intraclass Correlation Coefficient (ICC), to assess the agreement of both observers regarding the total score, where values above $.75$ are indicative of good reliability. In assessing homogeneity, Cronbach's alpha higher than $.70$ was considered for internal consistency. Spearman's coefficient was used to determine correlations between observers for the NFCS, NIPS, and COMFORT scales. Statistically significant differences between periods by the Wilcoxon's nonparametric paired test compared SCR levels and pain scale scores before, during and after the procedures. One-Way ANOVA Repeated measures (Greenhouse-Geisser correction) measured time effect considering baseline, reactivity and recovery values. To determine whether the clinical covariates and medication use of the newborn infants were related to the variables under study, Multiple Regression analyses was applied. The program Statistical Package for Social Sciences (SPSS IBM-V.24) was used.

Results

From a sample of 116 procedures, 27 were identified as outliers as they were under use of more than one type of medication. The final analyses considered 89 events distributed according the 10 types of procedures rearranged in five categories of clinical manoeuvres (Table 1). Selected newborns were within $36.3 (\pm 3.6)$ gestational weeks, average weight of $2686.7\text{gr} (\pm 926.5)$, Apgar at 5th minute of $8.1 (\pm 2.0)$, 57% female and 44.4% born through C-section. The procedures were from 10 different types of clinical nociceptive manoeuvres within first two weeks of life (Table 1). 59% procedures were done without use of medication, while one probe procedure used antihypertensive (1.2%), one heel lance case used reflux inhibitors (1.2%), one aspiration case and two catheter cases used analgesics (2.3%), four punctures cases and one heel lance of were under antibiotics (9.3%) and two cases of puncture used bronchodilators (2.3%). The sample passed Levine's homogeneity test for baseline values of behavioural and physiological measures.

Table 1. Frequency of types of clinical nociceptive manoeuvres by type of exam and collapsed in categories.

	Individual Procedure	N	%	Procedural Categories	N	%
Nociceptive Procedures	Blood Test	12	12.8%	Heel Lance	50	56.2%
	Glucose Curve	38	32.5%			
	Bladder Probe	2	2.2%	Probe	12	13.4%
	Nasal Probe	10	11.2%			
	Umbilical Catheter	1	1.1%	Catheter	3	3.3%
	Venous Catheter	2	2.2%			
	Tracheal Aspiration	5	5.6%	Aspiration	5	5.6%
	Lumbar Puncture	1	2.2%	Puncture	19	22.3%
	Venipuncture	14	15.7%			
	Arterial Puncture	4	4.5%			

Table 2 – Behavioural and electrodermal response to nociceptive stimulation and Wilcoxon Test comparing differences among the three periods (baseline, reactivity and recovery).

Measure	Periods						Periods Differences			
	Baseline		Reactivity		Recovery		B-D		A-D	
	M	SD	M	SD	M	SD	Z	p	Z	p
NFCS	.67	1.08	3.23	2.17	3.02	2.32	-7.68 ^b	.000	-1.20 ^c	.227
PIPP	2.29	1.03	3.42	3.15	2.89	3.06	-3.37 ^b	.001	-2.55 ^c	.011
EVENDOL	.97	2.31	4.49	3.78	4.07	4.20	-7.76 ^b	.000	-1.32 ^c	.184
AUC	73.79	245.05	49.34	169.25	331.78	848.16	-.98 ^b	.323	-4.90 ^b	.141
A (uS)	2.70	8.78	1.246	2.69	1.094	2.21	-.92 ^b	.354	-1.47 ^c	.000
NWps	.55	.62	.542	.54	.541	.60	-.31 ^b	.753	-1.33 ^c	.183
RT (sec)	-.08	.82	-.002	.81	-.004	.45	-.22 ^c	.819	-.16 ^b	.873

Notes: M= mean; *p*= significance asymptotic two tails; NWps= number of waves per second; AUC = area under curve of peaks; A = amplitude; RT = and rise time; sec= seconds; B-D= Before – During; A-D= After - During a. Wilcoxon test; b. based on negative cases; c. based on positive cases.

The scales scores and SCR reaction are described at Table 2 together with the differences between before and during and after-during values for all measures. Table 3 presents the values of infant’s reaction to nociceptive stimulation (during period) to different types of clinical procedure. Wilcoxon-test showed change between baseline and reactivity in all scales (*p* < .001), though only PIPP and A detected change between reactivity and recovery (*p* < .001). There were gender effects over NFCS and PIPP scales (*p* < .050) with females having higher pain scores; lower Apgar lowered NWps (*p* = .022) and higher Weight at Birth enhanced A (*p* = .047).

A repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean PIPP scores and SCR amplitude values were the only markers that differed statistically significantly between time points ($F_{(1.93;90.95)} = 3.796, p < 0.035$ and $4.463, p = .038$, respectively). Also PIPP was the only scale to significantly differed among procedures ($F_{(8;74)} = 2.017, p = .050$). Post-hoc analyses pointed to significant difference in infant’s reaction to the procedures between Venous Punction and Heel Lance (*p* < .50).

Table 3. Behavioural and electrodermal response to nociceptive stimulation comparing for type of procedure.

Nociceptive Procedures		Behavioural Scales				Electrodermal Response			
		NFCS	PIPP	EVENDOL	AUC	A(uS)	NWps	RT(sec)	
Heel Lance	M	4.00	4.74	6.15	22.62	1.52	.36	-.13	
	SD	1.80	3.03	4.15	56.51	2.89	.25	.72	
Puncture	M	1.92	1.54	2.00	17.80	.54	.84	-.00	
	SD	2.10	2.60	2.48	32.94	.77	1.18	.06	
Probe	M	3.57	3.57	5.14	32.78	1.07	.48	-.08	
	SD	2.44	2.99	3.53	53.43	1.51	.43	.33	
Aspiration	M	3.00	2.00	1.75	21.12	1.22	.29	.02	
	SD	1.41	1.82	1.70	35.29	1.70	.24	.03	

Regression models tested the effect of clinical variables as type of medication use alone and with other clinical variables over each one of the behavioural and electrodermal parameters. In both models the use of antibiotics, specifically Ampicillin, has decreased the number of peaks of skin conductance response and lowered PIPP scale scores ($p < .003$). The effect is bigger in neonates with lower weight at birth and that were born younger ($p < .018$), also these covariables had negative impact over amplitude of the skin conductance response.

Discussion and Conclusion

All scales and electrodermal markers were sensible to change in response from baseline and reaction to nociceptive stimulation, meaning the neonate infants perceived nociceptive stimulation changing in the intensity dimension of both categories of responses, behavioural and physiological. Though, only PIPP scale and skin conductance response in the marker Amplitude, the intensity dimension of electrodermal response, detected change to the recovery period. Being female, healthier or born with higher weight improved the effect of all findings. This pattern of expected reaction happened for all procedures and infants were able to discriminate between them and reacted differently, especially for Venous Puncture and Heel Lance.

However, part of the sample was making use of different medications and a significant effect of lowering the pain scales scores and number of waves per second was caused by the use of antibiotics, in this study the use of Ampicillin. The antibiotic-induced neurotoxic effects have been widely investigated as it can over-stimulate the parasympathetic system and, eventually, under-stimulating the sympathetic system. This effect shall be better investigated in newborn infants as it can change the pain management strategies in hospital facilities for infants under treatment (Grill & Maganti, 2011).

One important finding is the behaviour scale that better detected changes was the Premature Infant Pain Profile (PIPP), which is considered a promising multidimensional tool for comparison and testing of new technologies in newborn pain assessment studies since it may adhere to basic psychophysical parameters of intensity, direction, reactivity, regulation and slope described in analyses of physiological pain indicators as shown in previous study (Oliveira et al, 2011). Venables et al (1980) proposed the hypothesis that reaction of the emotional behaviour and skin conductance response could be considered as a measure of attentional 'openness--closeness' to the environment, being strong indicators of emotional and cognitive aspects of a pain measure. This study tested this hypothesis in a very early stage of life by examining the relation of SCR to behavioural response at the reactivity and recovery times, thus establishing a consistent multidimensional measure of attentional stance for pain perception.

Acknowledgments

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EEG patterns in older patients diagnosed with Alzheimer's disease: A review

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Abstract

Alzheimer is an incurable and chronic progressive disease that causes dementia, other psychiatric symptoms, and problems about the quality of life. Alzheimer's disease is one of the most significant public health problems for older people. Recent studies refer to the importance of the causes and developing factors of Alzheimer's disease by using electroencephalogram (EEG) in older patients. In this study, we aim to do a review of EEG studies on Alzheimer's disease in a sample of older patients. According to the findings, EEG pattern is like, fast frequencies decrease, and slow frequencies increase at posterior regions. At the fronto-central regions, the most noticeable change is to decrease responses of delta and theta frequencies, and there is a correlation between the increase of alpha3/alpha2 power ratio and hippocampal atrophy. For the next years, Alzheimer's disease will be a crucial health problem for older people because of this projection, understanding this disease with neuroimaging studies is noteworthy.

Session II

Invited Speakers

Evrin Gulbetekin, Seda Bayraktar, Ece Varlık Ozsoy, Deniz Kantar Gok, Enes Altun, Muhammed Nurullah Er, Arda Fidancı, Fehmi Bedirhan Surucu, & Recep Tayyip Cam

Jose L. Pardo-Vazquez, Juan R. Castineiras-deSaa, Mafalda Valente, Iris Damiao, Tiago Costa, M. Ines Vicente, Andre G. Mendonca, Zachary F. Mainen, & Alfonso Renart

Kazuo Ueda, Valter Ciocca, Gerard B. Remijn, & Yoshitaka Nakajima

Anuj K. Bharti, Sandeep K Yadav, & Snehlata Jaswal

Fechner Day

Effects of tactile stimulation on face perception

Evrım Gülbetekin¹, Seda Bayraktar¹, Deniz Kantar², Ece Varlık Özsoy¹, Enes Altun¹,
Nurullah Er¹, Arda Fidancı¹, Fehmi Bedirhan Sürücü³, Recep Tayyip Çam³

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Abstract

The aim of the study is to understand the effects of tactile stimulation on face perception. Twenty subjects (10 female, 10 male) participated the study. The subjects were randomly assigned to two conditions: (1) Tactile stimulation/TS (2) Control. In TS condition, the subjects observed faces while a robotic finger was touching on their faces simultaneously. In the control condition the subjects exposed to faces, but there was no tactile stimulation. In the acquisition stage, a fixation point was presented for 3sec, following a black screen for 4sec and a face was presented for 3sec. In TS condition, the robotic finger touched the subject's left cheek for 3sec while he/she was still observing the face. After the task, the subjects in both conditions were tested in a face recognition task. During the task and test phases, brain signals were recorded via 64 channel Actichamp EEG. We focused the signals of O1, O2, OZ, PO7, PO8, PO3, PO4, PO8, P4, P6, P8, P7, P5, P3, P1, PZ, P2, TP8, CP6 and CP4 electrodes. ERP components were identified and measured with respect to the average baseline voltage over the interval from -200 to 0 ms. We found a face-specific P100 response (150-200ms) at the occipital electrode sites (O1, O4, PO4, PO8) and P300 responses over the electrodes OZ, P4, P8, PO3, PO7, PO8 while the subjects were observing the faces. The amplitude was higher over the electrodes occipital and parietal regions during robotic finger stimulation. In addition to these regions we observed negative signals in frontal areas during tactile stimulation (Figure 1)

The subjects' correct response ratios for faces changed in respect to the condition. The response time (RT) was also different for the two conditions. The results indicated that tactile stimulation of one's own face has a significant effect on the perception of other faces.

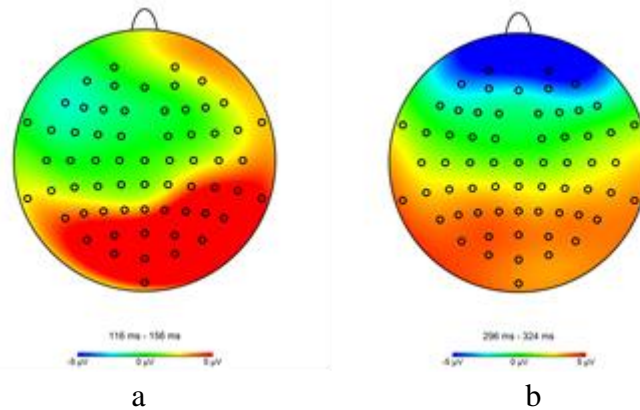


Fig. 1. Grand averages during (a) face processing and (b) face processing + tactile stimulation

The mechanistic foundation of Weber's Law

Jose L. Pardo-Vazquez, Juan R. Castiñeiras-de Saa, Mafalda Valente, Iris Damião, Tiago Costa, M. Inês Vicente, André G. Mendonça, Zachary F. Mainen, and Alfonso Renart*

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Abstract

We investigated Weber's law training rats to discriminate the relative intensity of sounds at the two ears at various absolute levels. These experiments revealed the existence of a psychophysical regularity, which we term time-intensity equivalence in discrimination (TIED), describing how the distribution of reaction times changes as a function of absolute level. Further experiments showed the TIED holds also for human subjects and for rats discriminating olfactory mixtures. As a mathematical constraint, the TIED is very stringent, enabling the specification of the computational basis of Weber's law. The resulting mechanism places strict requirements on how stimulus intensity is encoded in the stochastic activity of sensory neurons and reveals that discriminative choices must be based on bounded exact accumulation of evidence. We further demonstrate that this mechanism is not only necessary for the TIED to hold, but is also sufficient to provide a virtually complete quantitative description of the behavior of the rats.

Perceptual restoration of interrupted locally time-reversed speech: Effects of noise levels and segment duration

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Abstract

To elucidate the process involved in the perceptual restoration of temporally degraded speech, the intelligibility of Japanese sentences was measured for interrupted speech (I), locally time-reversed speech (LTR)—i.e., speech was segmented at regular intervals, and each segment was reversed in time—, and interrupted LTR speech (ILTR). Segment duration of LTR and ILTR was varied from 20 to 160 ms. The interposed pink-noise (for I and ILTR stimuli) had a level of -10, 0 or +10 dB re the speech signal. Nineteen native Japanese listeners were asked to transcribe sentences. Intelligibility was drastically reduced for ILTR compared to LTR with 40- and 80-ms segments. By contrast, when 40-ms silent gaps in ILTR were replaced by noise (0 and +10 dB conditions) intelligibility improved by about 30%. No improvement in intelligibility was observed with the lowest noise level (-10 dB). These results suggest that illusory continuity improves the use of contextual (across-segment) information for the recognition of temporally degraded speech.

Location modulates the effect of simultaneous but not sequential presentation on feature binding: An fMRI study

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Abstract

Feature binding is the process of combining different characteristics to perceive an integrated object. We aimed to study binding of colours and shapes using a change detection task and assessed activation in the associated brain regions using fMRI.

Feature binding is usually studied with simultaneous presentation. But simultaneous presentation involves proximity in time as well as space, and hence implies confound with location information. To unravel this confound, we orthogonally manipulated location with mode of presentation in these experiments, using unchanged and random locations from study to test for either simultaneously or sequentially presented stimuli.

Experiment 1, the behavioral study, used a repeated measures design with mode of presentation (simultaneous vs. sequential) and locations (unchanged vs. random) as the two independent variables and accuracy of colour-shape binding as the measure of interest. Change detection was higher with simultaneous presentation as compared to sequential presentation. Also, performance was better with unchanged locations as compared with random locations. Importantly, there was an interaction between mode of presentation and locations, such that performance with simultaneous presentation was much better when locations remain unchanged as compared to the other three conditions.

The fMRI experiment was designed to search activation in predefined regions of interest comparing the four experimental conditions yielded by crossing locations and modes of presentation analogous to Experiment 1. Results show no significant differential activation due to mode of presentation. But activation is more with random locations than unchanged locations in the bilateral parietal regions and right fusiform gyrus. The interaction between mode of presentation and locations is manifest in the left precentral gyrus and the right fusiform gyrus, these showing the least activity in the condition with simultaneous presentation and unchanged locations, as compared to the other three conditions.

Session III

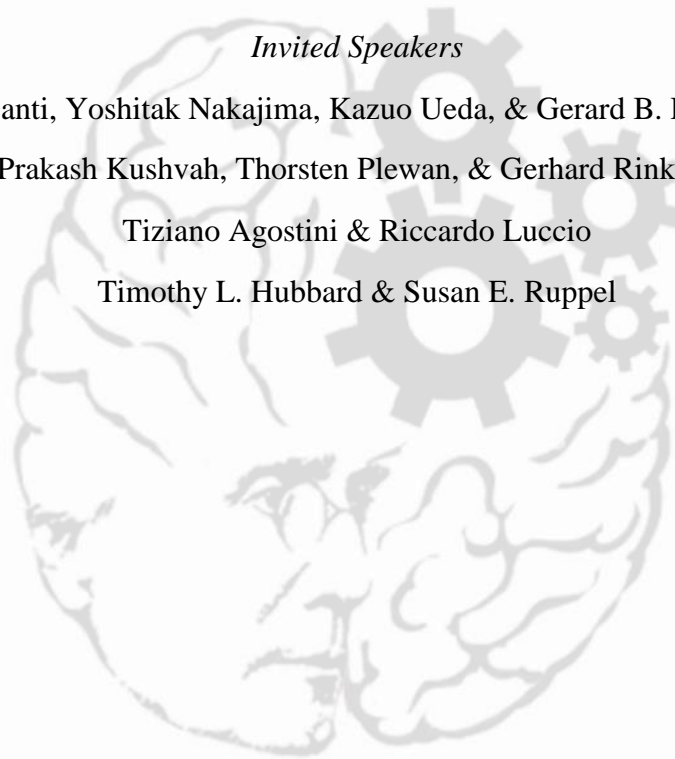
Invited Speakers

S. Santi, Yoshitak Nakajima, Kazuo Ueda, & Gerard B. Remijn

Jai Prakash Kushvah, Thorsten Plewan, & Gerhard Rinkenauer

Tiziano Agostini & Riccardo Luccio

Timothy L. Hubbard & Susan E. Ruppel



Fechner Day

Effects of compressing or stretching mosaic block duration on intelligibility of English mosaic speech

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Abstract

Mosaic speech (Nakajima, Matsuda, Ueda, & Remijn, 2018) is degraded speech in which the spectrogram of original speech is mosaiced into time-frequency blocks. This technique had been developed to measure temporal and frequency resolution of speech needed for linguistic communication, and it had been revealed that temporal resolution of ≤ 40 ms can make speech intelligibility almost perfect. In the present study, we were interested in what would happen if the mosaic blocks were compressed or stretched in time *after mosaicing*. Two original mosaic block durations (OMBDS), 20 and 40 ms, which were ≤ 40 ms, were used. Mosaic block duration (MBD) for presentation was either compressed (0.5 x OMBD), preserved (1 x OMBD), or stretched (2, 4, or 8 x OMBD). Twenty Indonesian speakers who speak English as a foreign language (EFL) participated. They typed what they heard after three repetitions of each speech sound stimulus. They were instructed to avoid guessing a correct answer. The intelligibility was obtained by counting the number of participants' correct answers with completing the Consonant-Vowel-Consonant (CVC)/Consonant-Vowel (CV)/Vowel-Consonant (VC) words. The results showed that when MBD was compressed, the intelligibility always decreased by about 20%. For preserved/stretched MBD, the intelligibility was not affected by OMBD, and was a function of MBD in the range 40-160 ms. The amount of information given to the listener must have changed when OMBD changed, but this did not affect the intelligibility if MBD remained the same.

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Effects of object shape, force related auditory feedback and age on hand-held object weight perception

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Abstract

The present study investigated whether the grip force related auditory feedback alters the perceived heaviness of differently shaped hand-held objects. Younger and older (n=22, each group) participants performed a two-alternative-force-choice task to discriminate the perceived heaviness of equally weighted objects but distinctively inclined surfaces (0°, +15° and -15°) and two auditory feedback conditions. Participants lifted the reference (0°) and weight-variable (using an adaptive staircase algorithm) test object sequentially and responded for test object heaviness. Force and movement related precision grip parameters and psychophysical measures were recorded. Results revealed overall aging effects on force rate, move rate and latency measures. Object shape variation modulated the PSE scores similarly in older and younger groups. Further, grip force-synchronized auditory feedback improvised the motoric execution of grip and lift by reducing the exerted force to grasp in both the groups. Contrarily, the feedback did not affect the weight perception while lifting differentially shaped objects.

What is (and what is not) simplicity in perception

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Abstract

The problem of simplicity in cognitive processes, and in particular in perception, has assumed a leading role in experimental psychology in the last century with the Gestalttheorie, and after a few years of relative silence it has found a new strong interest in recent years. If in the most classical research on perception, the problem has been seen above all in terms of the "principle of minimum", that is of the tendency, of the perceptual system to prefer the simplest solutions, in recent years there have been above all derivations from information theory and Bayesian models to keep the field. In all this is often said that the simple percepts are instances of Prägnanz, and that the simple percepts are "Occamian". This is misleading. When a prägnant percept can be anything but simple, Occam's razor applies to the choice of theories, not on their product.

What is a simple percept is something very difficult to define, so much so that someone has been tempted to apply to perceptual simplicity what Supreme Court judge Potter Stewart said about pornography: "I know it when I see it". But in reality, simplicity can be something very complicated. For Mach, the obligatory starting point for these discussions, the simplest perceptive object was the straight line (1896, Ch. 10, § 9): "The straight line in space therefore presents a *minimum of deviations from the mean of the depth sensations* as every point of a line represents the average of the homogeneous spatial values of the neighboring points ". He concludes for a *principle of economy*: The straight line is "seen with *the least effort*" (italics in Mach).

Let's make an example of how simplicity depends on the level in which the stimulus is analysed. Let's take the case of perceptual belongingness (Benary, 1924). In Figure 1a, the grey dashed lines of the cube on the left appears lighter than the grey dashed lines of the cube on the right (Agostini and Galmonte, 2002). The contrast on the dashed lines is induced by the colour of the corners of the cube to which the dashed lines belong. Indeed, by removing the belongingness relationships the effect is reversed in the direction of local contrast (See Figure 1b).

Gilchrist & Annan (2006) introduced a "more simple configuration" where they claim that the contrast effect is also due to perceptual belongingness (See Figure 2). Agostini, Murgia, and Galmonte (2014) slightly modified their configuration by reducing the size of the background (Figure 2 b-b'). The result is a perceptually multi-stable configuration. Independently from the perceptual solution, the gray in 3b appears lighter than that in 3b'. Replacing all the inducer elements with gray strips identical to the target (Figure 2 c-c'), the grays in 3c still appear lighter than those in 3c'. It must be noted that this configuration coincides with Helson's (1964) assimilation figure.

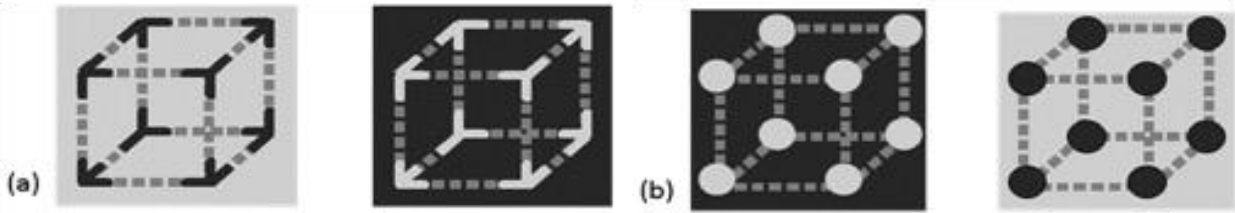


Fig. 1. a) The dashed lines on the left appear lighter than the dashed lines on the right, despite the fact that the former are on a light background and the latter on a dark background; b) control condition.

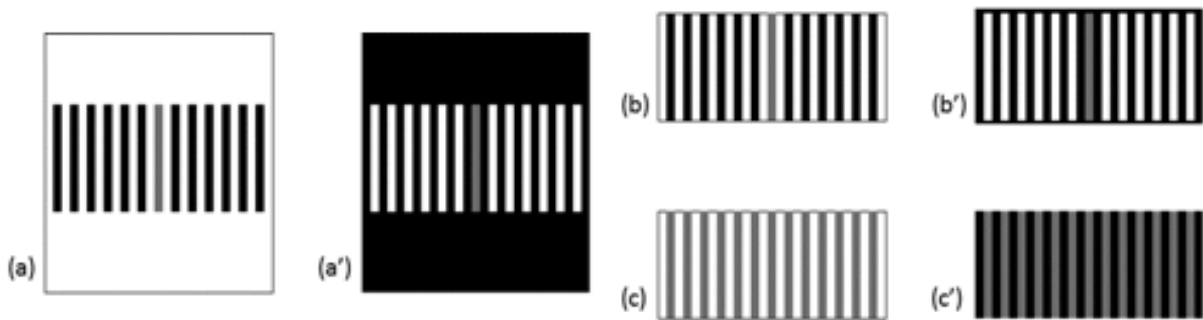


Fig. 2. Gilchrist & Annan's original configuration (a-a'); same configuration with reduced background (b-b') and with gray strips (c-c').

Going back to the history of the problem, let us just remember that after Mach this became a cornerstone of Gestalt psychology, and was one of the main arguments in the early formulations of the concept of *Prägnanz*, or figural "goodness". In Wertheimer (1922, 1923), the term *Prägnanz* is used to indicate a principle of organisation that act as precise laws, to which the process is forced to obey overall in the sense of maximum economy and simplicity.

This concept was further developed by Köhler and Koffka. According to Köhler (1920, § 250), "for if, for a given physical topography given as immutable, a material at the beginning (of our observation) possesses a certain grouping and at all points certain velocities, and if after a short or long time an immutable state is attained, then there will be some particular quality that is *prägnant* (*ausgezeichnet*), for whose sake the change in him comes to an end". Koffka (1935, p. 110) defines the "law of *Prägnanz*" as follows: "psychological organization will always be as 'good' as prevailing conditions allow. In this definition the term 'goodness' is undefined." We also have Koffka to thank for elaborating a concept that was to have a significant influence on subsequent developments in the debate: the concept of minimum and maximum simplicity (1935, p.171).

What appeared most interesting was the Köhler concept of tendency towards a minimum (in Köhler, minimum energy), and the Koffkian principle of minimum simplicity. And indeed, all subsequent theorizations have been expressed in terms of "tendency to the minimum": this is the case of Hochberg and MacAlister (1953), of Attneave (1954), and above all of the very influential work of Pomerantz and Kubovy (1986).

Now, while conceiving Prägnanz in terms of simplicity may indeed work in many cases, in many others (and perhaps in the majority) other factors emerge. Excellent examples of this are the cases of multistable figures: the factors that lead to the emergence of the figure with respect to the background thus appear to be the convexity of the contours, the symmetry, the equality of amplitude, the equality of the style, and so on, and what is seen as figure does not necessarily have to be simpler than that which appears as ground.

In reality, simplicity is only one aspect of Prägnanz. Rausch (1966), who developed this concept most masterfully (but, unfortunately, in German, in an monolingual English speaking world of psychology), sees this concept as having seven dimensions: 1) regularity or conformity to rules, as opposed to randomness or arbitrariness; 2) autonomy and independence, as opposed to derivation and dependency; 3) integrity and completeness, as opposed to lack and incompleteness; 4) structural simplicity as opposed to structural complexity; 5) complexity and structural richness, as opposed to structural poverty; 6) richness of expression as opposed to poverty of expression; 7) fullness of meaning as opposed to absence of meaning. Notice that among all these dimensions of Prägnanz only number 4) refers to simplicity, and the last three go in the opposite direction, focusing on richness, complexity, and meaningfulness. The fact is that if a tendency does exist in perception, it is towards the stability of the perceptual world, and to achieve this stability we obtain a world that is anything but constituted by simple and regular forms.

However, the idea that Prägnanz is a multidimensional construct, in which several coexisting factors contribute to a final perceptive solution, is also present in other authors. At this point, it is worth mentioning a paper which came from an unexpected source, and namely from Bayesian modeling. Froyen, Feldman and Singh (2015) recently proposed a Bayesian hierarchical model (BHG), according to which a percept is made up of a mixture of different elements, each of which requires, in a hierarchical order, a Bayesian inferential process. We think there are various reasons for being skeptical about this model. If nothing else, one of the typical characteristics of Prägnanz is the immediacy of the salience of the percept. If we had to face a series of inferential processes arranged into a hierarchy before the percept reaches us, we fear that there would be serious problems with decision times.

In any case, we have found a vulgate, in our opinion arbitrary, that Prägnanz is synonymous with simplicity. And this appeared particularly evident in the discussion, particularly lively in recent years, on Bayesian modeling in perception. We know that the Bayes rule says that

$$p(A_1 | B) \propto p(B | A_1) p(A_1). \quad (1)$$

The above formula are to be read as follows: Let us consider two families of possible events, A and B ; here, the event B is a single one, while there are several (or at least two) possible A s. We call $p(A_1 | B)$ an *a posteriori probability*: that is, given that B is true, the particular event A_1 of the family of the A s is also true. This is an *a posteriori probability* because it is calculated on the basis of the previous knowledge that we have about the *likelihood* that, given that A_1 is true, B is true as well, that is, that $p(B | A_1)$; in addition, we also need to know the probability that A_1 is true, irrespective of the state of B , and we call this an *a priori probability*, that is $p(A_1)$.

Now, in recent years Bayesian modeling (BM) has found a large flowering of contributions in the field of perception (see, among others, Ma et al., in press; Vincent, 2015). In our opinion, despite the enthusiasm that these have raised among many scholars, there are still substantial limits to their applicability (Luccio, 2019), but this is another story.

What interests us here is the translation of the BM, which is a substantially Helmholtzian theory of perception, based on likelihood, with another theory of perception, based on simplicity (or its inverse complexity; see in particular Chater, 1996; van der Helm, 2014, 2017). Now, classical information theory tells us that, given an event with probability p , its complexity corresponds to the quantity of information contained in it, today called *surprisal*, that is $\log \frac{1}{p} = -\log p$. After Rissanen (1978), which introduced the MDL principle (minimum description length principle), instead of surprisal we can use to measure complexity the *precisal* p , as $p = 2^{-I}$, where I represents descriptive complexity.

Let us now see how to proceed. In both cases, surprisals or precisals, given a possible event, we can formulate a hypothesis H a priori on its complexity in terms of description length, $I(H)$. If the event actually occurs, so if data D are present, we will have a conditional complexity $I(D | H)$. The a posteriori complexity will be given by

$$I(H|D) = I(H) + I(D|H), \quad (2)$$

where I represents descriptive complexity. We cannot go into the merits of this discussion here, since they are beyond the scope of this paper, but we shall merely say that (2) allows the use of Bayes rule. So, we must select H that minimizes the a posteriori.

The problem is however related to the code that is used for the description. From this point of view, many advances have been made especially by the Nijmegen school, with the structural information theory (SIT) initially proposed by Leeuwenberg (1968), but the results cannot be considered definitive. Particularly instructive from this point of view is the problem of amodal completion (see van Lier, van der Helm & Leeuwenberg, 1994). Whenever patterns were identified that could not be explained by the originally proposed code, the SIT authors proposed ad hoc adaptations, in a potentially infinite regression. It is possible that the SIT route is the right one, but the end of the tunnel still appears far away.

One last observation. More and more often, authors to describe simple percepts speak of "Occamian percepts". This is misleading. This is certainly not the place to discuss Occamian philosophy (but see Baudry, 1949; Pike, in press). It is certain that according to the *Venerabilis Inceptor* the final products of sensory perception (the *notitia intuitiva*) could not be the object of a discussion, but only the processes that led to it. The so-called "Occam's razor" is, also for contemporary epistemology, a criterion of choice between theories, not among the products of theories.

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Exploring the relationship of attentional momentum and representational momentum

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Abstract

In representational momentum, memory for the location of a previously viewed target is displaced in the direction of motion. In attentional momentum, detection of a target in the direction of an attention shift is faster than detection of a target in a different direction. Hubbard (2015, 2017) hypothesized that attentional momentum might be related to representational momentum. Two experiments collected measures of attentional momentum and representational momentum. In Experiment 1, attentional momentum (based on differences between detecting probes opposite or orthogonal to a cued location) negatively correlated with representational momentum (based on cursor-positioning). In Experiment 2, attentional momentum (based on facilitation in detecting a gap on a probe presented in front of the final target position) negatively correlated with representational momentum (based on probe judgment). Implications of the findings for the relationship of attentional momentum and representational momentum, and for theories of momentum-like effects more generally, are considered.

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Session IV

Invited Speakers

Joseph A. LaBarre & William Wren Stine

Deanna Anderlini

Metehan Irak, Can Soylu, Gozem Turan, Berna Guler, & Elif Guldemir

Irina Skotnikova



Fechner Day

The effects of motion adaptation and contrast polarity on motion-induced blindness

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Abstract

In Motion-induced blindness, a salient target stimulus perceptually disappears in the presence of a moving field of distractor elements, or mask (Bonneh, et al., 2001). We first replicated the coherence effect (Wells et al., 2011, 2014) where incoherent motion masks induce longer disappearances than coherently moving masks and then showed that motion adaptation occurs during our MIB sessions with coherently moving masks. Finally, we examined the effect of motion adaptation on total disappearance time using a coherent motion adaptation stimulus prior to each MIB trial, in which half of the MIB trials were mask motion congruent (same direction) to that of the adaptation stimulus, and the other half were mask motion incongruent (opposite direction) to that of the adaptation stimulus. Incongruent motion masks induced longer total disappearance than congruent masks. We argue that motion adaptation to the congruent motion renders the coherently moving mask less effective than motion adaptation to incongruent motion.

Motion-induced blindness (MIB) is a visual phenomenon in which salient target stimuli perceptually disappear (for up to several seconds) and reappear in the presence of a moving field of distractor elements, or mask (Bonneh, Cooperman, & Sagi, 2001; Grindley & Townsend, 1965). Bonneh et al. (2001) found that target disappearance increased with both increasing eccentricity and increasing target brightness, and that the influence of Gestalt features on disappearance suggested a winner-take-all process in which multiple targets disappear together, or not at all (Bonneh, et al., 2001). Bonneh et al. concluded that disappearance is not due to suppression (to eliminate conflicting visual information), local adaptation (a decrease in the response of neurons resulting from sustained stimulation), or a contrast-gain mechanism since increasing target brightness increased disappearance and small protection zones around targets where no mask elements appear had little effect.

Stine et al (2017) showed that increment and decrement targets and mask elements have differential effects on the timing of initial target disappearance during MIB, which may result from the function of retinal ganglion cells (RGCs) that are sensitive to local contrast differences, not absolute levels of illumination. Previous evidence has shown that ON- and OFF-channels remain segregated from the retina to visual cortex (Dacey, 2004; Xing, Yeh, & Shapley, 2010; Yeh, Xing, & Shapley, 2009). Furthermore, it has also been suggested that manipulating contrast as increments and decrements for the target dots on a gray neutral background should differentially stimulate ON- and OFF-channels (Dolan, & Schiller, 1994; Schiller, 1992; Schiller et al., 1986; Stine, Levesque, Lusignan, & Kitt, 2017; Zaghoul, Boahen, & Demb, 2003).

Wells et al. (Wells, Leber, & Sparrow, 2011; Wells & Leber, 2014) demonstrated that an inverse relationship exists between mask coherence and target disappearance, such that less coherence yielded more target disappearance. Wells et al. (2011) suggest that a coherent motion

mask may induce motion adaptation, thereby making the coherent motion stimulus less effective as a mask relative to that of the incoherent mask. Motion adaptation can be measured through the motion aftereffect (MAE), a visual phenomenon in which stationary objects are perceived in steady motion in a direction opposite to that of a previously viewed constant motion stimulus, such as flowing water (Addams, 1834; Ishihara, 1999; Keck, Palella, & Pantle, 1976; Wohlgenuth, 1911).

We examined the effects of motion adaptation and target contrast polarity on the total disappearance duration during MIB (Experiment III). Motion adaptation reduces the perceived motion of a stimulus in the direction of adaptation. We therefore hypothesize that a coherently moving mask, moving in the direction of motion adaptation (the *congruent* mask motion condition) will yield less disappearance than a coherently moving mask moving in the opposite direction of motion adaptation (the *incongruent* mask motion condition). We also predict that increment (brighter than the background) targets will be more easily suppressed by our decrement mask than decrement targets, resulting in more total disappearance than the decrement target (Stine et al., 2017). Using our stimulus configuration, we first replicate the mask coherence effect in MIB (Experiment I), and then demonstrate the presence of motion adaptation, measured using the MAE, (Experiment II) within our experimental context. If both hypotheses are correct, the least total disappearance time should occur for the congruent MIB mask motion with decrement target, whereas the greatest total disappearance time should result from the incongruent mask motion and the increment target.

Method

Participants were volunteers from the UNH community with normal or corrected to normal vision and signed informed consent forms and were debriefed consistent with University of New Hampshire Institutional Review Board policy.

Experiment I: MIB and Coherent/Incoherent Masks

Experiments were conducted in a darkened room. For experiment I, the stimulus was comprised of a fixation dot, a single target dot, and 64 randomly placed mask dot elements presented in a $5.54^\circ \times 5.54^\circ$ square on a gray screen of 107.5 cd/m^2 . Increment and decrement dot elements (200.0 cd/m^2 and 15.0 cd/m^2 respectively, giving Weber contrasts of $\pm 86\%$) were used, with increments for the fixation and target, and decrements for the mask element dots. The fixation dot was 6 arc minutes (arcmin.) in diameter and centered on the computer screen. The target dot was placed in the upper half of the visual field with an eccentricity of 2.19° of visual angle (arc) from the fixation dot and was 12 arcmin. in diameter. The position of the target dot was varied from trial to trial in order to prevent target dot afterimages. The mask (background comprised of 64 moving dots) was contained within a square frame region of side length 5.54° centered over the fixation dot. Each of the mask dots was 7.5 arcmin. in diameter, giving a density of 0.93-mask dots per degree. Thus, masking dots covered 0.018% of the stimulus. Two mask stimuli were used: in the *coherent* motion condition, all of the mask elements moved from left to right at a speed of $4^\circ/\text{s}$; in the *incoherent* motion condition, the individual mask elements moved in random directions (0% coherence) at a speed of $4^\circ/\text{s}$.

Each of 10 participants were seated in a darkened room with their head positioned 1 m from the computer screen with a forehead rest. After a 120 second adaptation period prior to each session, individual trials lasted for 20 seconds, with a pretrial adaptation screen appearing for 20 seconds before each trial to maintain adaptation. Fifteen trials were presented for each condition, in random order, per session. Participants performed 2 sessions each, yielding 30 trials per condition. Participants were instructed to indicate disappearance of the target dot by pressing the spacebar for the duration of the disappearance(s) during each trial. Space bar presses were sampled at 60 Hz.

Experiment II: Motion Adaptation and the Motion Aftereffect (MAE)

Experiment II measured motion adaptation with eight participants. The test stimulus was comprised of an increment fixation dot, an increment single target dot, and 64 randomly-placed, decrement static mask dot elements as before. There was a pretrial adaptation screen appearing for 20 seconds before each trial comprised of a static fixation dot and 64 decrement mask dot elements exhibiting coherent motion. There were 30 trials per session. Participants performed 1 session each. Otherwise, the stimuli were identical to those used in Experiment I for the coherent motion condition.

Procedure

There was a 120 second adaptation period prior to the session, during which participants adapted to the background of 64 dots moving coherently from left to right and a fixation dot. This was followed by a pretrial motion adaptation period of 20 seconds, which occurred prior to each trial. Trial durations lasted 20 s during which the test stimulus was presented. Participants were instructed to indicate perception of motion by pressing the spacebar for the duration(s) of the perceived motion. Otherwise, the procedure was identical to that used in Experiment I for the coherent motion condition.

Experiment III: The Effect of Motion Adaptation and Target Contrast Polarity on MIB

The MIB mask moved coherently either left to right or right to left during a trial. Initial adaptation and pretrial adaptation was identical to Experiment II. Otherwise, the stimulus configuration was identical to that in Experiment I, but with eight participants.

During the 120 s adaptation period and during the 20 s pretrial adaptation periods, the screen comprised a static fixation dot and 64 decrement mask dot elements exhibiting coherent motion from left to right as before. Trial durations lasted 20 s. Participants were instructed to indicate disappearance of the target dot by pressing the spacebar for the duration of the disappearance(s), as in Experiment I. Two independent variables were manipulated: target dot contrast polarity (positive vs. negative) and motion mask direction (left-to-right (*congruent*) vs. right-to-left (*incongruent*) motion) resulting in a 2 x 2 factorial repeated-measures design. Eight trials per condition were presented in random order during each of the four sessions, giving 32 trials for each condition overall. Otherwise, the procedure was identical to that used in Experiment I.

Results

Experiment I

Experiment I was designed specifically to replicate the coherence effect established by Wells et al. (2011, 2014) within our experimental context. As can be seen in Figure 1, participants exhibited the coherence effect.

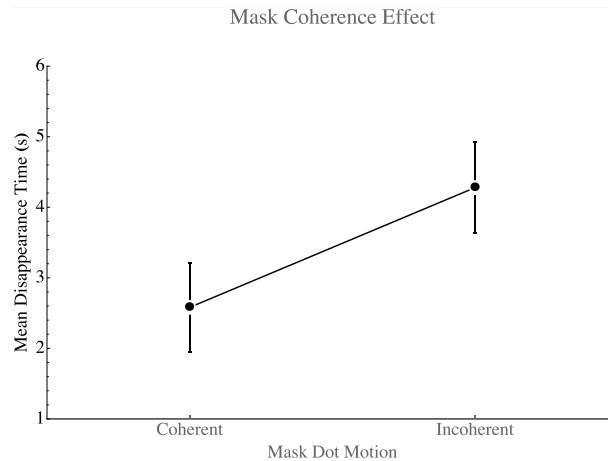


Fig. 1. Mean total disappearance times with standard errors for coherent versus incoherent mask conditions averaged over all participants from experiment I.

The data were analyzed in the context of a participant by mask coherence repeated measures analysis of variance (randomized block design with two levels; Kirk, 2013, Ch. 8). Residuals for disappearance time appeared normally distributed and consistent with no evidence that the effects of mask coherence varied systematically across participants (Tukey's test of non-additivity $F_{(1, 8)} = 0.0450$, $p = 0.837$, $MSRES = 0.478$; Kirk, 2013, pp. 300-303). Incoherent-motion masks engendered a longer disappearance time than coherent motion masks ($F_{A(1, 9)} = 33.7$, $p < 0.001$, $MSRES = 0.428$, partial $\omega^2_{Y|A.BL} = 0.621$). Participants also differed from one another in reported disappearance times ($F_{BL(9, 9)} = 18.0$, $p < 0.001$, partial $\rho_{I Y|BLA} = 0.630$). The coherence effect does replicate in our context.

Experiment II

Experiment II was designed to measure whether or not motion adaptation occurred in our protocol. We used the motion aftereffect as an indicator of adaptation. All participants exhibited the MAE, thus exhibiting adaptation. Figure 2 shows box and whisker plots exhibiting the range of MAE for each of the six participants. While the distributions do differ among our participants, all exhibit robust motion adaptation that dissipates during the 20-second interval.

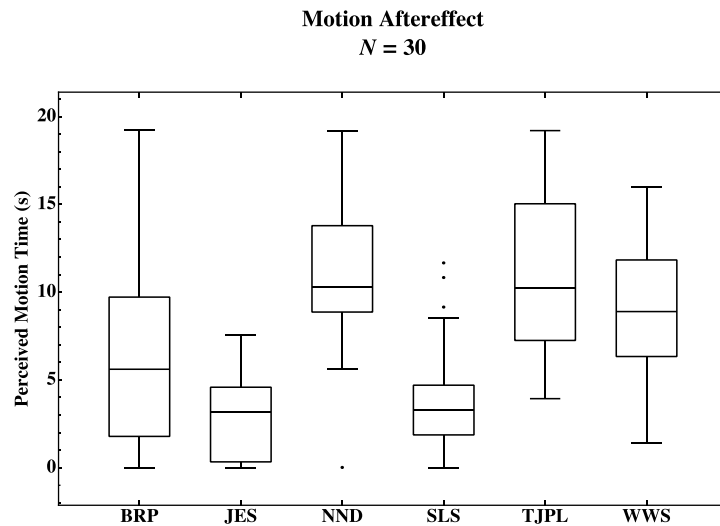


Fig. 2. Box and Whisker plot of all participants showing the range of MAE per trial from experiment II.

Experiment III

With experiments I and II showing the coherence and adaptation effects (respectively) are indicated by all participants in the current study, it was expected that a coherently-moving mask, moving in the direction of motion adaptation (the *congruent* mask motion condition) would yield less disappearance than a coherently moving mask moving in the opposite direction of motion adaptation (the *incongruent* mask motion condition). Further, we anticipated that increment targets (brighter than the background) would be more easily suppressed than decrement targets by our decrement mask, resulting in more total disappearance. However, the mean disappearance times across participants suggests an effect for congruent versus incongruent mask motion but not for the effect of bright versus dark target stimuli (Figure 3).

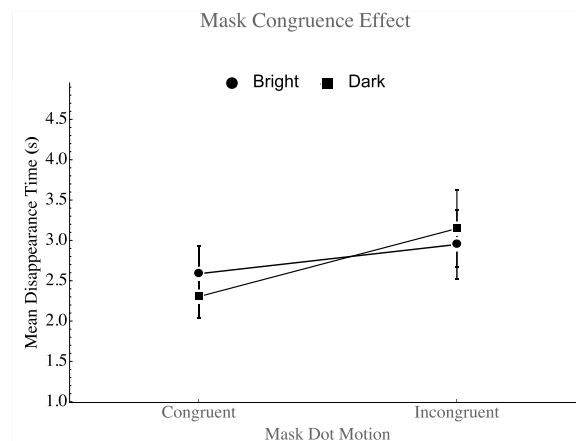


Fig. 3. Mean disappearance time across all participants with standard errors for experiment III.

The data were analyzed in the context of a participant by mask congruence by target polarity repeated measures analysis of variance (a 2 x 2 randomized block factorial design; Kirk, 2013, Sec. 10.5-10.9), Residuals for disappearance time appeared normally distributed but suggest that the combined effects of mask congruence and target contrast polarity may have

varied systematically across participants (Tukey's test of non-additivity $F_{(1, 20)} = 3.07$, $p = 0.0951$; Kirk, 2013, pp. 300-303). Further, the variance-covariance matrix appeared spherical (locally best invariant test $V_{(3, 8)}^* = 4.66$, $p > 0.25$; Kirk, 2013, pp. 310-314). Incongruent-motion masks engendered a longer disappearance time than congruent motion masks ($F_{A(1, 21)} = 2.90$, $p < 0.0415$, $MSRES = 0.616$, partial $\omega^2_{Y|A,AB,BL} = 0.104$). But, contrast polarity had no effect on disappearance time ($F_{B(1, 21)} = 0.0221$, $p = 0.883$). Further, the effect of mask motion congruence did not vary across target contrast polarity ($F_{AB(1, 21)} = 0.751$, $p = 0.396$). Participants differed from one another in reported disappearance times ($F_{BL(7, 21)} = 4.75$, $p < 0.00249$, partial $\rho_{IY|BL,A,AB} = 0.613$). So, a coherent motion mask moving in the direction of motion adaptation yields less disappearance than a coherent motion mask moving in the opposite direction of motion adaptation, but increment targets are not more easily suppressed than decrement targets by our decrement mask.

Discussion

The results of our first experiment demonstrated the coherence effect (Wells et al., 2011; 2014) where a mask comprised of coherently moving elements yielded less perceptual disappearance than a mask of elements moving randomly, accounting for 62% of the variance. Experiment II verified that our coherent motion mask used in Experiment I caused motion adaptation as measured by MAE. Our third experiment showed that a coherent-motion mask moving in the same direction as a coherently moving motion adaptation stimulus is less effective (yields less disappearance) than a mask moving in the opposite direction, accounting for 10% of the variance – a moderately strong association (Kirk, 2013, p. 135). We therefore conclude that motion adaptation contributes to the coherence effect, but there are, in all likelihood, other variables involved.

DePierro, LeBel, Hansen, Duggan, Meurer, Kitt, and Stine (April, 2017) failed to replicate the coherence effect on the threshold trial duration for disappearance using an analogue to the method of constant stimuli. Given that motion adaptation would increase over the time of a trial (Ishihara, 1999; Keck, et al., 1976), we examined time-to-first disappearance instead of total disappearance time, to find that the incoherent masks do not produce quicker disappearance than coherent masks ($F_{A(1, 9)} = 1.50$, $p = 0.252$, $MSRES = 2.40$; time-to-first disappearance exhibited positive skew and additivity - Tukey's test of non-additivity, $F_{(1, 8)} = 0.170$, $p = 0.691$, $MSRES = 2.64$; Kirk, 2013, pp. 300-303) – in agreement with DePierro et al. (April, 2017). The congruence effect also vanishes when time-to-first disappearance is analyzed ($F_{A(1, 21)} = 0.519$, $p = 0.479$, $MSRES = 2.31$; time-to-first disappearance again exhibited positive skew, additivity - $F_{(1, 20)} = 10.5$, $p = 0.00417$, $MSRES = 1.59$, and the variance-covariance matrix appeared non-spherical - locally best invariant test $V_{(3, 8)}^* = 6.83$, $p < 0.25$; Kirk, 2013, pp. 310-314). These results are consistent with the buildup of motion adaptation during a trial.

We also examined the effect of contrast polarity on total disappearance during MIB and failed to replicate the results of Stine et al. (2017). However, as mentioned previously, Stine et al. used a method of constant stimuli analogue to measure threshold trial duration for disappearance (the same method used by DePierro et al., April 2017). We repeated our analysis of the contrast polarity effect using time-to-first disappearance, to find that contrast polarity

had no effect on time-to-first disappearance ($F_{B(1, 21)} = 0.655$, $p = 0.427$) nor did the effect of mask motion congruence vary across target contrast polarity ($F_{AB(1, 21)} = 0.195$, $p = 0.664$), though the means are in the anticipated direction (Figure 8). Participants did differ from one another in reported time-to-first disappearance ($F_{BL(7, 21)} = 3.06$, $p = 0.0221$, partial $\rho_{IY|BLA,AB} = 0.505$).

As mentioned previously, it is possible that the method of constant stimuli analogue used by Stine et al. (2017), and DePierro et al. (April, 2017), is more sensitive to time-to-first disappearance due to a more precise measure of the timing and therefore can better address the differences in the processing between the ON and OFF pathways than the method employed in the present study. The method used in the present study is dependent on reaction time, and therefore subject to more inter- and intra-observer variability than that used by Stine et al. and DePierro et al.

Moreover, differences between ON and OFF channel processing may only be relevant for time-to-first disappearance, with little-to-no effect on total trial disappearance time. The difference in processing speed between the ON and OFF pathways should only affect early contrast processing differences. This difference would quickly decrease once stimulus processing has begun and would therefore have a negligible effect on total disappearance time (Dolan, & Schiller, 1994; Schiller, 1992; Schiller et al., 1986; Zaghoul, et al., 2003).

In summary, we have provided additional evidence in support of the coherence effect, initially exhibited by Wells et al. (2011; 2014), in motion-induced blindness. Random motion of mask elements yields more disappearance in MIB than does coherent motion of mask elements. In addition, we have shown the effect of motion adaptation as measured by motion aftereffect, such that a coherent-motion mask moving in the same direction (*congruent*) as a coherently moving motion adaptation stimulus yields less disappearance than a mask moving in the opposite direction (*incongruent*). We therefore conclude that motion adaptation contributes to disappearance in MIB via MAE and the coherence effect. However, it is very likely that other variables are involved.

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Impact of narrative on becoming a “Good” citizen

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Abstract

Why do Man-made tragedies occur over and over again? From the Holocaust to the Rwanda genocide, it seems either we can’t learn from the past or we are so “plastic” that we change under different circumstances.

Narrative is a powerful way to spread moral values. Works by Chaplin, Shakespeare, Capa, Picasso and Homer, down to facebook fake news, they all made us think and take a stand.

Milgram, Arendt, Sapolsky, Popper, Bandura and others have studied the human mind to understand why we behave the way we do.

Neuroplasticity enables patients to recover motor/ cognitive functions after stroke and, the same way, people can adopt a moral-empathic behavior under the right external stimuli. Gestures and words are, together with images, the main channels for narrative. If narrative is analyzed/understood by a network involving empathy, we can use them to help anybody to become a GOOD citizen. and stay that way.

Electrophysiological correlates of feeling-of-knowing judgments during episodic and semantic memory

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Abstract

Feeling of knowing (FOK) is one such metacognitive process which allows individuals to make predictions about the likelihood of their remembering, in future, information which they currently cannot recall. Although FOK provides a body of evidence for the mechanisms of metacognition, the neurobiological basis of FOK remains unclear. The present study aimed to investigate temporal correlates of FOK judgments under episodic and semantic memory tasks using event-related potentials (ERPs). Volunteer 74 university students participated. Stimulus presentation, recording, storage and analysis were carried out using 32 channel EEG-EP system. FOK judgment was associated with greater positivity for P200 component at frontal, central, and parietal zones and greater negativity for the N200 component at parietal zone. We concluded that (1) ERP components of FOK judgment observed within a 200 ms time window support perceptual fluency-based model, and (2) FOK accompanied with involvement of distributed neural networks rather than strictly linked to frontal lobes.

Slow-worm lizards' decision making in discrimination of two kinds of visual stimuli

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Abstract

The 3 main parameters of decision making were investigated in the same experiment firstly, regarding reptiles' behavior: accuracy, response time and behavior patterns. Slow-worm lizards' choice of 1 of 2 ways in the T-maze was studied in visual discrimination which is poorly known in reptiles. In discrimination of green and red colors the lizards had shown lesser values of the 3 indices recorded as compared to discrimination of small and big circle sizes, i.e., numbers of errors, time spend in the maze before a choice made and numbers of turns towards the left and the right way in the maze. Probably, these turns: a) served for visual information accumulation in favor of the response alternatives compared (the 2 ways and the 2 corresponding stimuli); b) reflected animal's hesitations in a choice made. Thus, the green — red color discrimination appeared to be easier for the lizards than geometric figures (circle sizes) one.

Research in reptiles is theoretically important, since these animals occupy an important intermediate place on the evolutionary ladder between the lower and higher vertebrates. The ability to color vision became known in some species of reptiles through research in the retina (Mathger et al. 2007), which found multi-colored oil droplets in photoreceptors-cones in turtles and in most of lizards (de Lanuza, Font, 2014). In addition, several daytime species of reptiles can able to discriminate between spatial stimuli, including flat geometric figures. When analyzing these data, the author judged difficulty of the tasks presented, as numbers of discrimination trials (attempts) until 90% of correct choices were reached (Safarov, 1990). These discrimination abilities can help the reptiles in finding prey or a sexual partner, recognizing enemies in shape and size, remembering the habitat or ecological niche, avoiding dangers, and finding optimal places for rest. Using primarily the labyrinth technique, conditioned reflexes to various sensory and perceptual stimuli of different modalities were developed in snakes (Clark, 2007), tortoises (Mueller-Paul, 2012) and lizards (Szabo, Noble et al., 2018).

Blue-tongued skinks (*Tiliqua rugosa*) more easily discriminated between black and white stimuli, triangles and circles than between red and green stimuli, which were not significant stimuli for them to determine a location of a shelter (Zuri & Bull, 2000). The Australian tree skinks (*Egernia striolata*) discriminated between color / shape pairs in different combinations and used these two-sign visual stimuli to find food rewards. However, they perceived each combination as a new problem instead of summarizing the stimuli presented in different combinations, and it was suggested that they do not fix attention to the general stimulus in different stimulus patterns (Szabo, Noble et al., 2018).

In the framework of one of the developed psychological approaches to decision making (DM) study, DM is presented as a choice between possible behavior alternatives (Anokhin, 1974; Tversky, Slovic, Kaneman, 1982). The main parameters of DM are its accuracy, time and subject's hesitations (confidence / unconfidence) in its process (Luce, 1986). In easy sensory discrimination and instructions on the speed of responses, erroneous responses are faster than correct ones, while in difficult discrimination and instructions on the response correctness, the opposite relation is true (the Swensson's, 1972, rule). The correspondence is experimentally established and reproduced between some psychological regularities of human DM and data of neurosciences on DM in animals (Smith, Ratcliff, 2004). Available literary sources pay very poor attention to the choice between alternatives in reptiles' behavior. These studies are based on earlier physiological knowledge about the organization of sensory and other mental processes in reptiles.

One of the most important aspects of DM research in animals is recording of behavioral manifestations during a pre-decision: in reptiles according to elementary motor acts (EMA). 30 types of EMA were identified in lizards: attention position, head turns, "pecking", "research", "aiming" and others (Okshtein et al., 2009). Red-legged tortoises (*Geochelone carbonaria*) chose new ways in the eight-arm labyrinth. It was done more often and with fewer errors in animals that used the strategy of turning to one way of the maze than those who used the strategy of turning to two ways (Mueller-Paul, 2012).

In each of the cited works, two of the three basic aspects of DM were simultaneously studied in reptiles: of accuracy, time and behavioral manifestations in the pre-decision. In distinction, in our works, all these three aspects of DM were firstly studied simultaneously in the same experiment in reptiles.

Methods

The three basic DM characteristics have been studied in slow-worm lizards (*Anguis fragilis Linnaeus, 1758*), who made visual discrimination. Namely: accuracy, latent time and reptiles' pre-decisional movements, which probably reflected their perception of external information, orientation and hesitations in a choice made. Experiments were carried out in a T-shaped maze consisted of the following components: a starting chamber (SC); a small corridor (SC); a large corridor (LC); two cabins: a goal one (GC) and a differential one (DC) (Fig. 1). For the both cabins conditions were equalized regarding illumination, temperature, tactile characteristics, visual environment; an influence of an odor was eliminated. Places of a GC and a DC in the LC was changed in different trials.

Firstly, the lizards were trained to choose a GC (but not a DC), receiving a support there by an unconditional stimulus (feeding). The lizards were launched into the starting chamber, an entrance into the maze was opened and their behavior was recorded by a video camera and a web camera. The experiment was completed after the animal's stopping in the selected cabin for more than 1 minute.

Each of the 4 lizards participated in the 3 series of trials on visual discrimination of the 3 kinds of stimuli: 1. circular sizes: small (the goal stimulus) and large (the differential one); 2. color tones: green (the goal stimulus) and red (the differential one); 3. double stimuli: small

circular and green tone (the goal stimulus) and large circular and red tone (the differential one). Each series included 10 trials.

In each trial the following characteristics were recorded.

- 1) A result of a choice made – correct or erroneous.

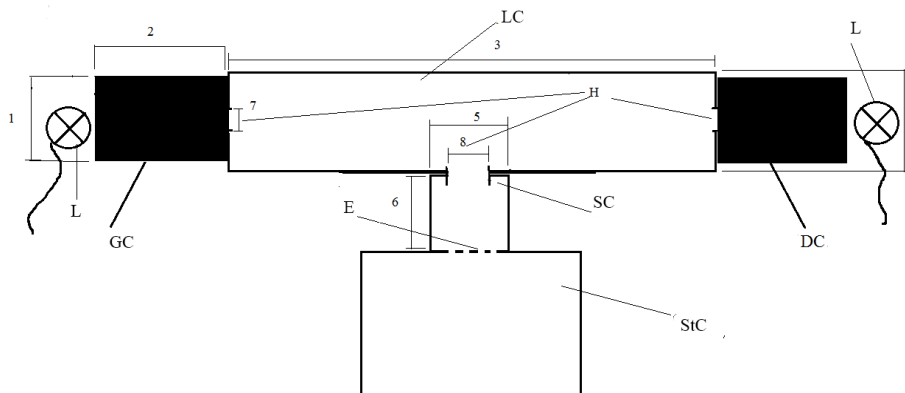


Fig.1. T-maze.

Marks: **StC** – the starting chamber, **E** – the entrance to the maze, **SC** – the small corridor; **LC** – the large corridor; **GC** – the goal cabin, **DC** – the differential cabin, **L** – the lamps, **H** – the holes. Sizes of the maze parts are indicated by numerals.

- 2) 4 time values: intervals (in seconds) between a lizard's entering into the LC and it's reaching a correct cabin or an erroneous cabin (this time interval was considered as corresponding to DM time), and the total travel time from the SC to the cabins in correct choices and in erroneous ones.

- 3) According the video registration, 4 values of numbers of a lizard's head and/or body turns were counted: towards a correct cabin and towards an erroneous one before a correct choice and before an erroneous one.

A statistical significance of differences between the time indices was assessed by Pearson χ^2 test and between the numbers of turns by Mann-Whitney test.

Results

I. Numbers of errors

The maximum percent of erroneous choices (37.5%) was observed in the double stimuli discrimination that were presented first to the animals (Fig. 2). Since a high total time of the LC transit was found in this case, we can talk about the development of learning in the lizards. The minimal percent of erroneous choices was in the color discrimination (20.9%, Fig. 2). In the circle sizes discrimination, percentage of errors was high (30.9%, Fig. 2) and the maximum average total time was observed: 141.6 s (while in the double stimuli discrimination — 135.7 s, in color discrimination — 124.6 s, $p < 0.05$). It indicates a greater difficulty of the circle sizes discrimination in the lizards, than of the color discrimination. This assumption is also consistent with the fact that in the circle sizes discrimination the average time of erroneous choices (160.9 s) was longer than the time of correct choices: (133.0 s, Fig. 3). This fact is typical for a difficult discrimination, according to the Swensson's rule.

II. Time parameters

The maximum time of erroneous choices as averaged of 10 trials, was observed in the circle sizes discrimination: 160.9 s, the shorter time — in the double stimuli one: 116.1 s, $p < 0.05$, and the shortest time in case of the colors: 110.1 s, $p < 0.05$ (Fig. 3). The maximum average time of the correct choices was observed in the double stimuli discrimination: 147.5 s, the shorter time – in the circles one: 133.0 s, $p < 0.05$, and the shortest time in case of colors: 123.9 s, $p < 0.05$ (Fig. 3).

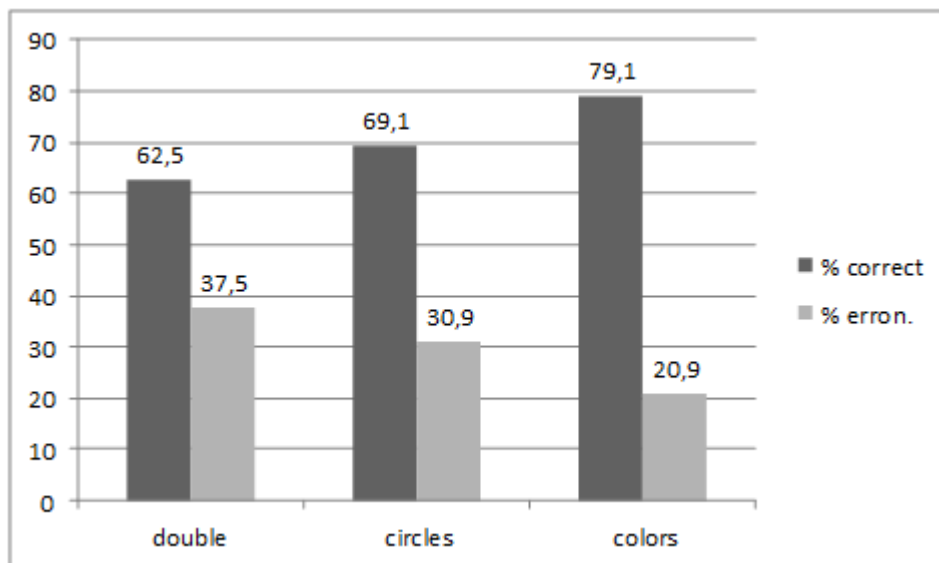


Fig. 2. Percent of correct and erroneous choices in discrimination of the three kinds of stimuli

Since the percentage of erroneous choices was minimal at the same time in the color discrimination (20.9%, Fig. 2), in comparison with the double stimuli discrimination (37.5%) and the circles one (30.9%), then the combination of the minimum values of time and errors may indicate an ease of the color discrimination for the lizards.

This assumption is also consistent with the fact that the average time of erroneous choices (110.1) was shorter than the time of correct choices (123.9 s) in the color discrimination (Fig. 3). This fact is typical for an easy discrimination, according to the Swensson's rule. Also, the lizards' total travel time in the color discrimination (118.2 s) was significantly shorter than in the circle sizes discrimination (141.6 s), $p < 0.05$.

III. Numbers of turns

When discriminating the color tones, the lizards made the minimum number of their heads and/or bodies turns before a correct choice: on average, 2.1 and 1.9 turns towards a correct and an erroneous direction, respectively, compared with the greater number of turns when discriminating between the circles (2.4 and 2.4; $p < 0.05$) and the maximum number of turns when discriminating between the double stimuli (3.0 and 2.6; $p < 0.05$). That is, when discriminating between the colors, they needed to accumulate less visual information than

when discriminating between the circles and the double stimuli. It again indirectly indicates the least difficulty of the color discrimination for the lizards, compared with the other two types of stimuli. The greatest number of turns in discriminating between the double stimuli, apparently, is since this task was given the first one, and therefore the lizards needed to get the maximum value of visual information.

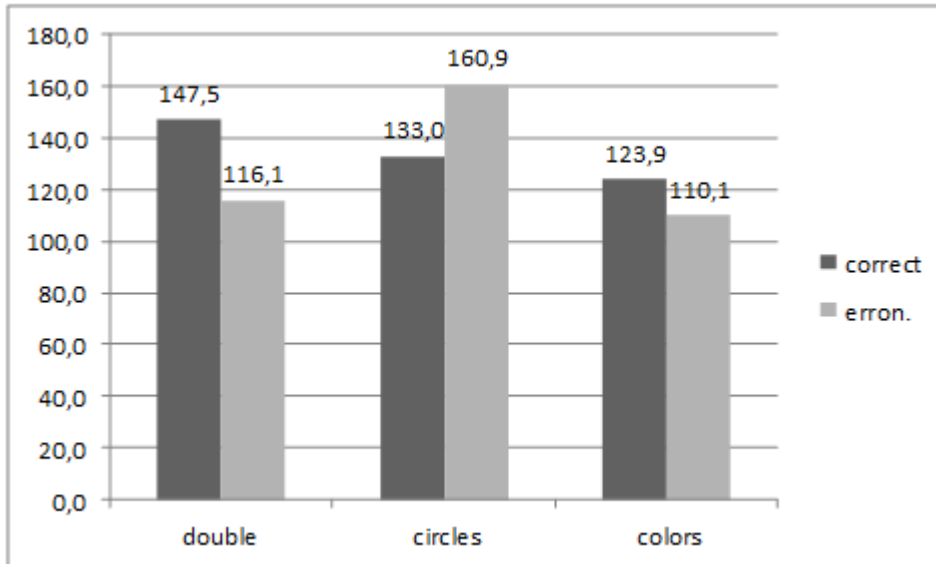


Fig. 3. Average time intervals (in seconds) between a lizard's entering the LC and it's reaching a correct cabin or an erroneous one

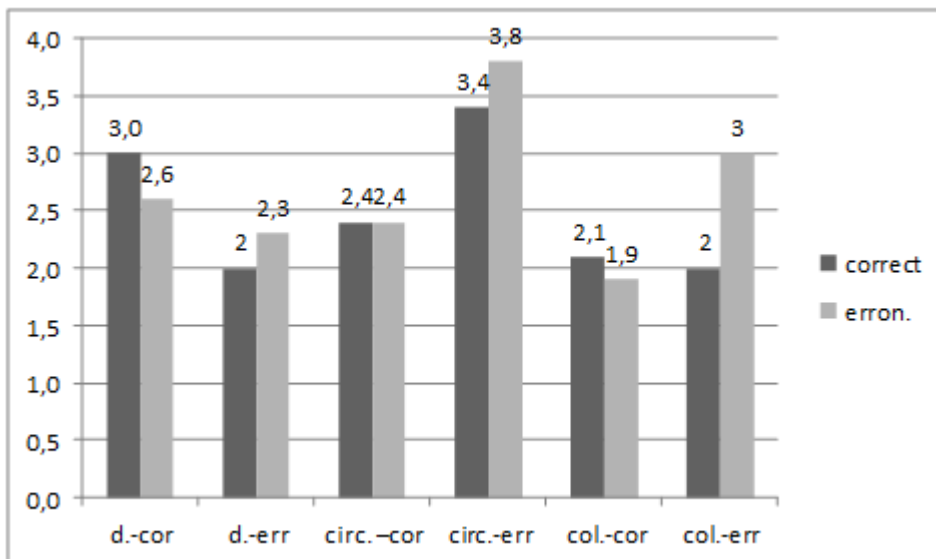


Fig. 4. Average numbers of turns before correct (cor.) choices and before erroneous (err.) ones towards a correct direction and towards an erroneous one. d.- double stimuli, circ. – circus, col. – colors

In color discrimination the average number of turns towards an erroneous direction in erroneous choices (3) was greater than the average number of turns towards a correct direction

in correct choices (2.1, Fig. 4). It may indicate the lizards' more pronounced hesitations in erroneous choices, and less pronounced hesitations in correct choices. Similarly, data obtained from humans show that erroneous responses in visual stimuli discrimination are more often unconfident and slower than correct responses (Skotnikova, 1994).

When discriminating between the circle sizes, the lizards showed the maximum number of turns in erroneous choices (3.8), but in correct choices the average number of turns towards a correct direction was equal to that towards an erroneous direction (2.4, Fig. 4). It may indicate the lizards' pronounced hesitations both in correct and in erroneous choices when discriminating between similar geometric figures, and possibly the greater difficulty of this task as compared to discrimination of double and color stimuli. The difficulty of geometric figures discrimination is also confirmed by the data on the great percentage of errors and on the great average time spend in the maze before a choice made in this task

Acknowledgements

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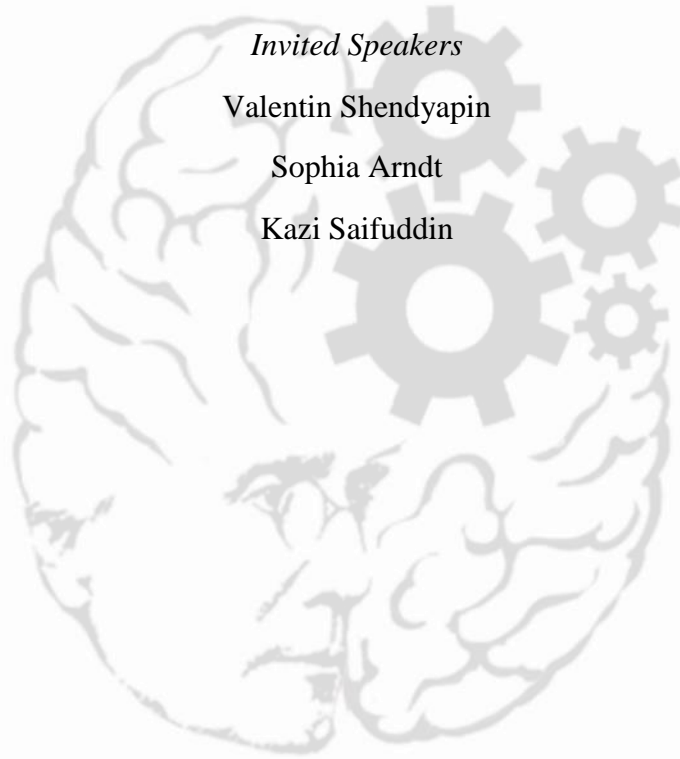
Session V

Invited Speakers

Valentin Shendyapin

Sophia Arndt

Kazi Saifuddin



Fechner Day

Development of evidence concept, suitable for discrimination of several multi-dimensional objects

Valentin M. Shendyapin

Institute of Psychology Russian Academy of Sciences

Abstract

In our model, describing discrimination between similar stimuli A and B , we have introduced a new decision variable Ψ (an evidence in favor of stimulus A) into Bayesian inference. If the evidence Ψ increases, then a posteriori probability $P(A|\Psi)$ and average utility $V(A|\Psi)$ of the stimulus A increase monotonically as well. At the same time $P(B|\Psi)$ and $V(B|\Psi)$ decrease monotonically. Curves $P(A|\Psi)$, $P(B|\Psi)$ intersect at one point only: $\Psi_{cr} = 0$ on the axis Ψ . Curves $V(A|\Psi)$, $V(B|\Psi)$ also intersect at one point only: $\Psi_{cr} = \ln[(v_{Bb} - v_{Ba})/(v_{Aa} - v_{Ab})]$. Thus, the point Ψ_{cr} can be used for unambiguous decision making. Since the Bayes formula is applicable not only for two events, but also for any number of events, we have derived evidences to discriminate any number of stimuli. As an example, we have considered the case of 3 stimuli and have given formulas for the evidences Ψ_A , Ψ_B , Ψ_C in favor of each of the 3 alternative stimuli A , B , C .

Critical Thinking in first (Turkish) and second (German/English) language

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Abstract

This study aims to examine the relationship between bilingualism and critical thinking (CT). Bilingual speakers completed the following online questionnaires: Participants were assessed on their language experience and proficiency (LEAP-Q; Marian, Blumenfeld, & Kaushanskaya, 2007), followed by a newly developed and validated CT assessment in their first (L1: Turkish) and second (L2: German/English) language. This assessment evaluated their ability in five dimensions of CT; hypotheses testing, verbal reasoning, judging likelihood, argumentation analysis and problem-solving, following Halpern's (2002) construct definitions. Outcomes suggest a positive effect of years of education on CT. Moreover, speaking a second language seems beneficial for Turkish native speakers regarding verbal reasoning skills. Outcomes of within-group comparisons were found to be noteworthy, showing an advantage of solving questions under the sub-category judging-likelihood in an individuals' second language.

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Perceived time as a function of acoustic factors extracted from autocorrelation function

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Abstract

Some experiments were conducted in the anechoic chamber to measure perceived time when the parameters were the acoustic factors extracted from the autocorrelation function (ACF). Acoustic stimuli were analyzed by the digital signal processor ACF and found four independent factors. Three factors of them were produced in the anechoic chamber where the normal hearing subjects were conventionally prepared to give responds to the stimuli as per instruction by pressing electrical button. Paired-comparison test was performed to get perceived time. Ten stimuli with different durations (140ms to 230ms) were compared randomly with the standard stimulus (150ms). Subjects were instructed to press button when they feel second (compared) stimulus is longer than first one. All the trials were performed and averaged the data maintain intra-pair and inter-pair gaps as per provision of pair-comparison test. Results revealed that the perceived time is varied significantly for acoustic stimuli as a function of the three factors of ACF.

Poster Session

Presenters

Kurtuluş Mert Küçük, & Canan Başar-Eroğlu

Arda Fidancı, Esin Gürçan, & Evrim Gülbetekin

Seda Bayraktar & Hatice Yorulmaz

Jordan, R. Schoenherr

Muhammed Nurullah Er, Enes Altun, Arda Fidancı, Pakize Keskin, Ayşe Nur Badakul,
Dilara Steenken, Yulet İlhan, & Evrim Gülbetekin

Rosana Maria Tristão & José Alfredo Lacerda de Jesus

Svetlana A. Emelianova & Alexey N. Gusev

Enes Altun, Muhammed Nurullah Er, & Evrim Gülbetekin

Yuko Yamashita & Akemi Ishii

Jingyi Lyu & Yoshitaka Nakajima

Emi Shibato, Yoshitaka Nakajima, & Yuko Yamashita

Xiaoyang Yu, Yoshitaka Nakajima, & Yixin Zhang

Natalia Postnova & Gerard B. Remijn

Tatiana A. Zabrodina, & Kirill V. Bardin

Yixin Zhang, Yoshitaka Nakajima, Xiaoyang Yu, Gerard B. Remijn, Kazuo Ueda, Takuya
Kishida, & Mark A. Elliott

Naomi du Bois, Alain D. Bigirimana, Damien Coyle, Kongfatt Wong-Lin, Martin
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Age-related changes in perceptual reversal rate: A psychophysical investigation

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Abstract

A fundamental feature of multistable visual perception is the spontaneous switching between different perceptual interpretations of an unchanging stimulus (i.e. ambiguous stimulus). The speed of these switches is identified as the perceptual reversal rate. Perceptual reversal rate can be affected by stimulus-related variables such as size, contrast, and continuous or discontinuous presentation. Also, reversal rates are affected by participant characteristics such as age, creativity and mental health. As for aging, several studies showed that participants who are older than 55 years report slower reversal rates than younger participants. However, it is still not addressed which age-related changes in the brain cause such a difference. The aim of this research is to investigate age-related changes in the perceptual reversal rate with a large sample size and two ambiguous stimuli.

Facial mimicry in dynamic and static versions of natural and unnatural emotional expressions

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Abstract

Facial mimicry (FM) is a tendency to imitate perceived emotional facial expressions. FM studies use face datasets including both dynamic and static emotional facial expressions. In our daily life we encounter faces having expressions as dynamic and natural. In this study, face datasets including both natural and unnatural facial expressions in both dynamic and static versions were used. Stimuli were obtained from 6male and 6female models with three emotional expressions (positive, negative and neutral). In natural versions, emotional expressions were recorded while the models were watching emotional videos. In unnatural versions models posed as they were happy or sad. The experiment was conducted in four blocks (1)static-natural (2)static-unnatural (3)dynamic-natural (4)dynamic-unnatural. Each stimulus was presented for 6seconds and the participants were asked if there was any emotional expression or not. Meanwhile, electromyographic activity of *corrugator supercili* muscle and galvanic skin response (GSR) were recorded in order to measure FM. In this study, (1) facial muscle activity and GSR for dynamic and static expressions will be compared (2) facial muscle activity and GSR for natural and unnatural expressions will be compared and (3) it will be analyzed if there is any correlation between facial muscle activity, GSR and correct response ratio. Data collection is continuing.

Understanding pedophilia from forensic neuroscience perspective: A review study

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Abstract

Child sexual abuse, especially pedophilia, is a multifaceted problem that requires interdisciplinary work. Recent studies refer to the importance of neurobiological, neurophysiological, and neuropsychological basis of violence and motivate the researcher to evaluate aggressors in terms of these aspects. Studies, dealing with a pedophile in a forensic neuroscience concept, suggest that manifestation of the neurobiological/ neurophysiological /neuropsychological features are so important for reducing violence, protecting victims, and shaping intervention methods. Hence, in this study, it is aimed to do a review of forensic neuroscience literature in pedophilia. According to the literature, under the favor of neuroscience methods (e.g., EEG, fMRI, eye tracking device, etc.) there are abnormalities in; Orbitofrontal function, cerebellum function, amygdala function, white matter structure, and executive function in pedophilic brains. As a conclusion, using methods from forensic neuroscience is essential for risk assessment and preventing the pedophilia.

Metacognitive assessments of performance: The psychometric properties of confidence scales and confidence models

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Abstract

Confidence reports are used to assess participants' awareness of their performance in studies of perceptual discrimination, memory, and knowledge-based judgments. In contemporary studies, participants make a decision or learn sets of stimuli and are then required to assess their performance. Despite the widespread use of confidence reports, few studies consider how these reports are obtained and how they relate to the primary task (e.g., perception, memory, judgment). Following a review of features of confidence scales that have been used to obtain subjective assessments of performance, a three-dimensional framework is presented that accommodates extant models of metacognitive assessments of performance.

Introduction

In early investigations of sensation and perception, confidence reports were used as a means of probing participants' experiences (e.g., Peirce & Jastrow, 1884). In contemporary studies, subjective reporting methods have additionally been employed in areas including metamemory, reasoning, general knowledge, and jury decision-making. Inferences have been made from the results of these studies concerning the extent to which participants are aware of their performance (for reviews see Lichtenstein, et al. 1982), how awareness differs across tasks (Baranski & Petrusic, 2001) as well as the architecture used to process confidence (e.g., Baranski & Petrusic, 1998). Although intriguing differences have been observed across types of tasks and task difficulty, there is considerable variability in the range of the confidence scale and the number of confidence categories that are used in these studies. Few studies have considered or compared how the use of these measures might influence metacognitive abilities. I review systematic biases in confidence reports, the properties of confidence scales, and suggest that three dimensions can be used to understand the relationship between primary decision performance and metacognitive assessments of performance.

Systematic Biases in Confidence Reports

In contrast to self-confidence, confidence processing reflects a participant's knowledge of their performance in a specific task. Confidence processing reflects a metacognitive monitoring process rather than a regulation process (Nelson & Narens, 1990). Subjective assessments of performance such as confidence reports are usually characterized by systematic deviations from perfect calibration suggesting that participants are not fully aware of their performance (for reviews see Keren, 1991; Kvidera & Koustaal, 2008; Lichtenstein et al., 1982). Individuals

are judged to be perfectly calibrated when their confidence level corresponds to their average accuracy. For instance, when an individual indicates that they are 70% confident about their responses, their mean response accuracy in a condition should also be 70% correct. Experimental evidence, however, indicates that participants are rarely perfectly calibrated. Instead, they typically show biases of *over-* or *underconfidence*. Overconfidence occurs when participant overestimate their performance whereas underconfidence occurs when participants underestimate their performance.

Importantly, miscalibration often appears to be task-dependent: Participants exhibit overconfidence when making difficult judgments and underconfidence when making easy judgments, i.e. the *hard-easy effect* (Lichtenstein & Fischhoff, 1977). While a significant body of literature has firmly established the existence of the hard-easy effect (for a review, see Kvidera & Koustaal, 2008), there is still considerable disagreement about its causes with authors claiming that it is either a result of a failure to access primary decision information or a failure of estimate subjective probability with that information (Keren, 1991).

Confidence Scale Properties and Psychometrics

Peirce and Jastrow (1884) provided the first confidence scale. In addition to using numeric labels, each confidence category included a descriptive term: e.g., “0 denoted absence of any preference for one answer over its opposite... 1 denoted a distinct leaning to one alternative; 2 denoted some little confidence of being right; and 3 denoted as strong a confidence as one would have about such sensations.” The features of the confidence scale that they employed are highly problematic in that the labels do not necessarily reflect a single continuum of uncertainty with transitive labels defined by equal intervals.

Contemporary studies typically use numeric scales with more constrained features. These scales have employed both single- and multi-digit category labels. Moreover, in terms of the absolute value of confidence categories used within these studies, scale ranges have varied from low-range values (e.g., 1-5; Vickers & Packer, 1982), half-range values (e.g., 50-100; Lichtenstein & Fischhoff, 1977) and full-range (e.g., 0-100; Gigerenzer, et al., 1991; Balakrishnan & Ratcliff, 1996). Consequently, the scales used in these studies differ in terms of three dimensions: number of confidence categories, scale range, and scale interval.

Number of Confidence Categories

The features of a ratings scale affect psychometric properties such as its reliability and validity. The number of response categories reflects a basic feature of any response scale. The first such exploration of the effect of the number of response alternatives was conducted by Merkel (1885; as reported by Hick, 1952). Merkel presented participants with Arabic and Roman numerals (1-5 and I-V, respectively) and required them to identify the target stimulus. Crucially, Merkel varied the number of response alternatives from one to ten. Merkel found that response time increased as a function of the number of response alternatives. Hick (1952) replicated these findings and noted that the response time function was well described by $\log n$, where n represents the number of alternative responses. This relationship (Hick’s Law) suggests that the number of confidence categories used to define a scale might increase

cognitive load. Such a finding is suggested by other studies that have observed increases in primary decision response time (as opposed to confidence response time) when the number of confidence response categories are increased (Petrušić & Baranski, 2000; Schoenherr & Petrušić, 2015).

Confidence Scale Range

Another feature concerns the range of the confidence scale used. To explore the influence of scale range on miscalibration, Ronis and Yates (1987) and Juslin et al. (1999) conducted studies that used both full-range (0-100) and half-range (50-100) scales. Ronis and Yates (1987) had participants predict the outcome of games as well as answer two-alternative general knowledge questions. They were assigned to half-scale and full-scale confidence conditions in a between-subjects design. Ronis and Yates found the smallest overconfidence bias when participants used the full-range format. Using identical scaling methods, Juslin et al. (1999) employed tasks that required predicting the frequency of car models (Experiment 1) and the populations of European countries (Experiment 2). Juslin et al. also observed the smallest overconfidence bias when participants used the full-range scale. Taken together, these studies appear to support the conclusion that scale range is an important determinant of miscalibration. In this case miscalibration is a result of a mismatch between the underlying psychological continuum of certainty and the available labels. Prior to considering this possibility, another scale parameter must also be taken into account.

Scale Interval

Conjointly, variations in the number of categories and the range of a confidence scale result in differences in confidence scale interval. In most studies examining subjective probability ratings, scale interval is held constant within a scale (cf. Gigerenzer et al. 1991; Wallsten et al. 1993). Many studies employ 10-unit intervals in full- and half-range scales whereas others use single-unit intervals. Formally, the relationship between range, the number of categories, and interval is given by:

$$i = (k - 1)/R, \tag{1}$$

Where i represents a constant interval, R represents the range of the scale (i.e., $R = S_{MAX} - S_{MIN}$), and k , represents the number of confidence categories.

As Cox (1980) noted while describing his conceptual scaling framework, a stimulus can be represented as a magnitude on some psychological continuum (e.g., extent, luminosity, loudness). Scaling requires that these continuous values be associated with a portion of the decision space partitioned by the available scale values. When a continuous dimension is divided into discrete categories, information loss will occur. For instance, a mark of 89.5% on a test is assigned a letter grade of A, thereby losing information ($A = 85-90\%$). Small differences are thereby obscured by adopting a scale with fewer categories.

If confidence scaling is affected in a similar fashion and the confidence scale interval used to report confidence is smaller than that of the internal representation of confidence, the information loss resulting from rescaling will contribute to miscalibration. Consider an error

monitoring task (Rabbitt, 1966) wherein participants use a two-category scale representing certainty in correct and certainty in error. If an individual guess is due to a lack of sufficient evidence, they must adopt a rule for partitioning evidence into a discrete judgment (error or correct). Under such conditions, the certainty category might be used with greater frequency relative to conditions in which participants might report guessing responses (i.e., participants “round up”), resulting into miscalibration. This would occur if a process of evidence accumulation was attempting to produce an accurate, rather than erroneous, responses.

Conversely, if the scale interval is too narrow, it is possible that the need to discriminate between similar categories (e.g., choosing between 50% and 55%) will increase time to render the response without any increase in confidence calibration. Moreover, it is conceivable that accumulated evidence retained in working memory could degrade during this time (i.e., leaky integration), leading to greater miscalibration. Greater imprecision in scaling could be observed if the task becomes too difficult. To compensate, participants could adopt a strategy of neglecting categories that are too precise, and this would be reflected in the time to report confidence, calibration, and response frequency.

Modelling the Metacognitive Architecture

Nelson and Narens (1990) proposed a prominent taxonomy of metacognitive processes that distinguishes between monitoring and regulation processes. They classify metacognitive assessments of performance in terms whether they occur 1) prior to (e.g., ease-of-learning; EOL) or 2) following (e.g., judgment-of-learning; JOL) studying test items or 3) after a decision has been made and information has been retrieved (e.g., confidence reports). However, they do not distinguish between the kinds of processes that inform these monitoring processes. A review of these models suggests that a minimum of three dimensions are required to describe the relationship between the primary decision and confidence processes: whether information is directly or indirectly scaled from the primary decision, the locus of confidence processing, and the source of information used to obtain a subjective estimate of performance.

Direct- and Indirect-Scaling Processes

Historically, two broad classes of confidence models have been proposed (Baranski & Petrusic, 1998). I refer to these as direct- (DSM) and indirect-scaling models (ISM) of confidence. DSMs assume that estimates of performance are generated from either the strength of the evidence obtained over the course of the primary decision (e.g., Ferrel & McGooney, 1980; Hart, 1967) or the validity of the cues that were used as a decision heuristic (Gigerenzer et al., 1991). In this way, primary decision and confidence processes reflect the same underlying process with confidence reports reflect a direct-scaling of information from the primary decision. In short, confidence reports require no additional operations and reflect an effortless by-product of the primary decision. Many researchers who use confidence ratings appear to explicitly or implicitly endorse these accounts.

Locus of Confidence Processing

ISMs have assumed that a separate, dependent cognitive process is required to assess performance in a task (for a review, see Baranski & Petrusic, 1998). Prior to generating a confidence report, the primary decision is assumed to sequentially sample sensory evidence in terms of either a random-walk or accrue evidence in separate accumulators for each response alternative. ISMs can be further distinguished on the basis of a second dimension: the locus of confidence processing. By decoupling primary decision and confidence processing, confidence reports can be generated following the primary decision (post-decisional) or during the primary decision (decisional).

Support for ISMs comes from a number of sources. Studies that have increased processing demands during the primary decision by requiring speeded responses (e.g., Baranski & Petrusic, 1998) or the performance of a concurrent task (Schoenherr, 2009) have observed increases in confidence response times relative to baseline conditions. For instance, Baranski and Petrusic (1998) found that when a speeded deadline was imposed on primary decision response selection, participants' confidence response times increased. Alternatively, when accuracy was stressed, confidence response time decreased. According to Baranski and Petrusic (1998), the observed difference reflects a shift from post-decisional confidence processing in the speeded condition due to limited time to a decisional confidence processing when there are no limits of time (see also Baranski & Petrusic, 2001; Petrusic & Baranski, 2003). More generally, such findings can be interpreted as indicating resource sharing between confidence processing and primary decision response selection. Similar patterns of performance have been observed when an executive working memory load is performed concurrently with the primary decision: participants postponed confidence reports until after the primary decision (Schoenherr, 2008). In the absence of additional assumptions, these findings cannot be readily explained by DSMs.

Converging evidence for the effortful nature of confidence processing is also provided by Schoenherr and Petrusic (2015). They provided participants with a simple line bi-section tasks while manipulating the number of confidence categories (e.g., 2, 6, or 11), confidence scale range (50-100 or 0-100), and scale interval (5, 10, or 20). They found evidence that participants tended to use confidence scales with the same range in the similar manner regardless of the number of categories when the number of categories was blocked (Experiment 1 and 2). However, when participants were required to use a confidence scale with the same range but a random number of confidence scales on a given trial (e.g., 2, 6, or 11), participants became entirely miscalibrated. They interpreted this result as suggesting that the rescaling of confidence was too demanding when the number of categories could not be predicted in advance of an experimental trial. This suggests that confidence processing reflects an effortful monitoring process (Nelson & Narens, 1990).

Source of Information

While ISMs assert that two processes are required to accumulated evidence and rescale evidence into a confidence report, many assume that primary decision evidence is necessary and sufficient for confidence reports. However, this ignores studies that find that confidence

reports can be altered independently of accuracy (Busey, et al. 2000; Schoenherr, et al., 2010; Schwartz, 1994) when information supports neither response alternative, i.e. evidence is nondiagnostic. For instance, in a study of facial recognition conducted by Busey et al. (2000), variations in the luminosity of face stimuli produced variations in the subjective certainty of identification of stimuli from a target set. Supporting a partial dissociation of confidence and the primary decision, Schoenherr et al. (2010) found that once accuracy was equated across stimulus conditions, information that was irrelevant to the completion of a task could alter confidence reports without affecting the primary decision (e.g., Stimulus Set 1 in Experiments 2 and 3).

Finally, in the metamemory literature, there is considerable evidence that overconfidence is inversely related to the amount of experience that participants have within a task, referred to as the underconfidence-with-practice effect (UWP; Koriat et al., 2002). Schoenherr et al. (2018) provide a recent demonstration. In their study, clinicians learned to use a novel (US) technology (point-of-care ultrasound, or POCUS). Clinicians were required to self-report their experience with US in general and with POCUS in particular. They were then provided with clinical US cases and asked diagnostic and treatment questions. Confidence reports were requested after each set of questions. Results demonstrated that clinicians' confidence decreased as a function of their POCUS experience but was unrelated to their general US experience. While US diagnostics requires memory, perception, and reasoning skills, it suggests that DSM and ISM models that fail to account for multiple sources of information likely provide an inadequate account of metacognitive processes.

Conclusions

The preceding review considered the nature and extent of systematic discrepancies between performance (e.g., response accuracy) and the subjective assessment of that performance (e.g., subjective confidence). In contrast to the distinction presented by Nelson and Narens (1990) based on the timing of the report relative to stages of information processing, I have argued for a classification framework based on whether information is scaled directly from the primary decision process or indirectly scaled through a second set of processes (i.e., DSM v. ISM). The review also highlights that ISMs can be further distinguished in terms of where the locus of confidence processing is thought to occur, and whether information other than that used during the primary decision can influence subjective confidence. Studies using confidence reports need to consider these assumptions when interpreting their results.

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Effect of stimulated face side on multisensory perception

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Abstract

Recent multisensory stimulation studies show that self-other face perception is interrelated. A mirror-like effect can be induced with another face by using both visual and tactile stimulation simultaneously during the illusion called “enfacement”. We aimed to find out if stimulated side of the face has any effect on experiencing enfacement illusion. Therefore 59 participants watched a video including a model face. In the video, a cotton bud was touched above the eyebrow, near the eye region, on the cheek and near the lip region of the model for 2 sec with 2 sec inter-stimulus interval (ISI). Following this stimulation model’s face was touched on cheek three times for 3 sec with 3 sec ISI. At the end of the procedure a syringe was approached but not touched to the cheek. While participants were watching this video, they were touched synchronously or asynchronously either on the right or the left side of their faces. However, nothing was touched on participants’ faces during the syringe period of the video. Galvanic skin response (GSR) was measured.

We observed that GSR measures changed among the baseline condition, touching condition and syringe period in both synchronous and asynchronous stimulations ($p < .01$). The participants gave higher GSR when they were touched on their faces comparing to the baseline condition. The highest GSR was given when they saw the syringe on the video although nothing was touched on subjects’ faces (Table 1). We found that left face stimulation induced greater GSR in synchronous but not asynchronous condition ($p = .03$) (Figure 1).

Table 1. Mean Galvanic skin responses for three conditions during synchronous and asynchronous touch.

	Synchronous Touch		Asynchronous Touch	
	Mean	SE	Mean	SE
Baseline	20,851	1,707	19,150	1,570
Touch	21,795	1,729	20,169	1,589
Syringe	24,870	1,850	22,774	1,701

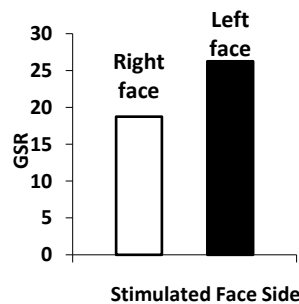


Fig. 1. Galvanic skin conductance responses in left and right face stimulation during synchronous touch condition.

Psychophysical analysis of a one-dimensional pain scale in full term new-borns

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Abstract

The Evaluation Enfant Douleur (EVENDOL) is a one-dimensional pain assessment tool composed by 5 indicators: vocal or verbal expression, facial expression, movements, postures and interaction with the environment. It was developed in French to evaluate painful event in children from birth to 7 years age. Increase of its score above 4/15 denotes pain. We did not find evidence in the medical literature relating EVENDOL with the basic psychophysical parameters of a physiological pain indicator as view by Initial Value Law. The aim of this study was to evaluate whether the psychophysical parameters of Intensity, Direction, Reactivity, Regulation and Slope are achieved in pain assessment on newborns using the EVENDOL scale. Thirty-eight healthy newborn infants were conveniently sampled whilst being videotaped before, during and after heel lance blood sampling. Two-trained ratters scored the images. Overall EVENDOL and its indicators met the parameters of Intensity, Direction and Slope (all $p < 0.01$). Except to the Interaction With the Environment ($p=0.057$), overall EVENDOL and its other subscores fitted the Reactivity parameter within 30 seconds after pain stimulus, while at 30 seconds after pain stimulus, where was measured the Recovery parameter, only the subscore Expression Facial to fit it ($p=0.048$). We concluded that the overall EVENDOL and the majority of its subscores met the assumptions of the psychophysical parameters within 30 seconds after the pain stimulus, but it is not sufficient to discriminate between pain and non-pain after this time period.

Pain evaluation in newborn infants is challenging due their inability to express it clearly (Nader & Craig, 2008). Different pain assessment scales based in behavioural changes such as COMFORT (Ambuel et al, 1992), Neonatal Infant Pain Scale- NIPS (Lawrence et al, 1993), Premature Infant Pain Profile – PIPP (Ballyntine et al, 1999; Stevens et al, 1996), Neonatal Facial Coding System - NFCS (Grunau & Craig, 1987) and Neonatal Pain, Agitation and Sedation Scale – N-PASS (Hummel & van Dijk, 2006; Hummel et al, 2008; Hummel et al, 2010) were developed in order to fill this gap. Other tools based on variability of physiological indicators such as blood or salivary cortisol (Bagci et al, 2009, Goldman & Koren, 2002), oxygen saturation (Hummel & van Dijk, 2006; Jesus et al, 2011), heart rate (Jesus et al, 2011; Pereira et al, 1999; Padhye et al, 2009), blood pressure and brain hemodynamic activity (Slater et al, 2007) and skin conductance (Jesus et al, 2011; Storm & Fremming, 2002; Gjerstad et al, 2008; Eriksson et al, 2008) have been also related with acute pain in newborn infants. Quantitative changes in these physiological indicators reflect the activation of the autonomic or central nervous systems and denote of pain (Stevens et al, 2007).

Variability in the measures of physiological indicators after a stressor stimulus has been investigated since 1963 (Oken & Heath). The dimensions of these physiological indicators

could be described through the psychophysical parameters of *Intensity, Direction, Reactivity, Regulation and Slope*. These parameters have been often used to interpret pain response, considering three moments: baseline, reactivity to the painful stimulus and recovery (Stevens et al, 2007). We found in the literature only one study relating pain scales and these psychophysical parameters on pain assessment (Oliveira et al, 2012). The remained question is if a exclusively behavioural scales fit the physiological parameter model cited above, knowledge which can be valuable when applied in comparison studies with new physiological devices and tools.

The Evaluation Infant Douleur (EVENDOL) is a one-dimensional scale for pain evaluation proposed and validated in France at 2012, being of fast application and easy analysis in children from birth to 7 years age. It is a 5- indicator 4-point composite pain scale consisting of the vocal or verbal expression, facial expression, movements, postures and interaction with the environment. A measured EVENDOL score above 4 during the painful event is related with pain (Fournier-Charrière, 2012). However, despite of its validation and use in Francophone and Anglophone countries it was yet not analyzed in the light of psychophysical parameters. Our hypothesis was that, although solely behavioural indicators composes the EVENDOL, it reflects a response in connection with both nervous system and would respond similarly to psychophysical parameters of a physiological pain indicator. The purpose of this study was to investigate whether the EVENDOL and its indicators fit these psychophysical parameters.

Methods

Thirty-eight at term healthy newborns between 6-48 hours of postnatal age indicated to heel lance blood sampling for glucose screening were selected at the University of Brasília Hospital, Brazil, between January 2018 and July 2019. The sample size was calculated in twenty-six, considering an alpha error of 5%, a beta error of 20% and a statistical power of 80%. The mothers signed formal agreements. Excluded from the sample newborns were those who received medications that could interfere with the perception of pain; with postnatal ages lower than 24 hours and whose mothers were subjected to general anaesthesia or have used opioid derivatives during the pregnancy, except up to half hour before birth; those with Apgar score lower than seven in the 5th minute of life; those with diagnosis of intracranial haemorrhage third or fourth degree; those with metabolic, respiratory, circulatory, nervous and congenital diseases.

Procedure

The clinical information concerning mother and newborn was referenced from the medical files. Heel lance was the acute painful stimulus. Unpleasant stimuli were not applied at the last hour before until six minutes after heel lance, except this last one. The newborns were videotaped with an objective angle sufficient to observe all your body parts. The video recordings were assessed later by slow motion and second-to-second stop frame technique. The EVENDOL was scored according to Fournier-Charrière et al guidelines at rest on 15 sec time period prior heel lance, during heel lance and 30 seconds time period after the procedure. Each indicator of EVENDOL was scored on 4-point (0, 1, 2, 3) for a possible total score of 15

(Fournier-Charrière, 2012). For the analysis of the psychophysical parameters of the EVENDOL and its indicators three periods were considered: a) baseline, where the neonate was quiet without intervening handling or recent therapeutic interventions, referred as period before; b) pain event, started immediately after heel lance, referred as period during; c) supposed non-pain period, started at the end of 30 seconds after heel lance, the newborn receiving no handling throughout, referred as period after. Two trained independent raters evaluate the scores. Each newborn was considered his or her own control.

Statistical Analysis

Pearson's coefficient checked the Interrater reliability. The one-way ANCOVA verified whether the clinical variables would have any effect having the EVENDOL score in the period *during* as dependent variable, the EVENDOL score in the period *before* as factor. Kolmogorov-Smirnov's normality test was passed for all data sets ($p > 0.05$) and the Levene's test of homogeneous variances was not significant for all analyses ($p > 0.05$). Averages and standard deviations observed in the periods *before*, *during* and *after* heel prick represented the *Intensity* parameter. Non-parametric Friedman test verified the differences of *Intensity* among the periods. Non-parametric Wilcoxon tested the *Reactivity* parameter, where it was analyzed the difference of the scores between the periods *before* and *during* heel lance. The same occurred to calculate the *Regulation* parameter, verifying the statistical significance of the difference of scores between the periods *during* and *after*. Linear logistic regression assessed the *Direction* and *Slope* parameters. It was considered statistically significant level of $p < 0.05$.

Results

The Pearson's correlation coefficients among the raters on period *before* ($r = .855$, $p < .001$); on period *during* ($r = .895$, $p < .001$); on period *after* ($r = .945$ and $p < .001$). Because the correlation coefficients showed a relevant agreement was used the values obtained by one of them. No effect was found among the clinical covariates and the variation between *before* and *during* the painful event (one-way ANCOVA, $p < .05$) and so the entire data sample was used for analyses. The *Intensity* of EVENDOL and all its indicators presented significant difference among the three periods ($p < 0.001$), although the interaction with the environment was the least responsive (Table 1). The *Reactivity* of all indicators and EVENDOL score ($p < .05$) showed the same behaviour as the *Intensity* (Table 1). However, except for facial expression ($p = .048$), no indicator and EVENDOL score met the *Regulation* parameter at 30 seconds of observation (Table 1). EVENDOL score ($R = .633$ $R^2 = .401$ $p = .000$) and all its indicators showed relevant *Slope*.

Discussion

The hypothesis tested argues that the EVENDOL pain scale meets the criteria for the psychophysical parameters. These parameters involve three dimensions of responses: magnitude, variability and direction (Stevens et al, 2007). According this model the pain indicator must present the parameters *Intensity*, *Direction*, *Reactivity*, *Regulation* and *Slope*.

Table 1. EVENDOL and its indicators scores for the periods *before*, *during* and *after* heel lance; differences between the periods *Before-During* and *After-During* in the in 38 healthy newborns.

Indicators	<i>Before</i>		<i>During</i>		<i>After</i>		X^2	<i>p</i>	<i>Before-During</i>			<i>After-During</i>		
	M	SD	M	SD	M	SD			D	Z	<i>p</i>	D	Z	<i>p</i>
Vocal expression	.45	.75	2.18	1.13	1.90	1.21	45.02	.000	-1.73	-3.50	.000	-.22	-1.47	.059
Facial expression	.73	.76	2.30	.92	2.00	1.00	45.02	.000	-1.57	-3.60	.000	-.30	-1.22	.048
Movements	.91	.89	2.16	1.03	1.97	1.07	45.36	.000	-1.57	-3.50	.000	-.18	-.51	.226
Postures	.91	.98	1.97	1.05	1.94	1.03	35.39	.000	-1.06	-3.34	.000	-.03	-.27	.786
Interaction environment	.15	.36	.30	.53	.24	0.44	6.66	.037	-.15	-1.41	.057	.06	-1.00	.160
Total Score	2.97	2.97	8.90	4.10	8.03	4.16	48.37	.000	-5.88	-3.53	.000	-.875	-1.03	.100

NOTES: *M*= mean; *SD*= standard deviation; *D*= *Difference*; X^2 = Friedman test; *Z*= Wilcoxon test; *p*= level of significance; *SD* = standard deviation, *p*= level of significance.

In this model, *Intensity* and *Reactivity* are interdependent. The *Reactivity* is conversely basal value dependent, i.e. the higher the basal value, lower the *Reactivity* would be and vice versa. On the other hand, the return of measured values to a previous basal value before the painful stimulus or its *Regulation* would be faster (Stevens et al, 2007, Geenen & van de Vijver, 1993, Berntson et al, 1994). For the *Direction* parameter, the response could be in ascending or descending order, if the stimulus increases or decreases compared to the baseline. The *Slope* refers to the rate at which the change occurs from baseline score during the painful stimulation. It is calculated by the linear logistic regression testing, i.e., the closer the coefficient to one, higher the slope and more relevant the possibility of the baseline score predicts the response to painful event (Oken & Heath, 1963, Berntson et al, 1994).

Does EVENDOL scale react similarly regarding these psychophysical parameters? No references were found concerning exclusively behavioural pain scale with the psychophysical parameters discussed earlier. It was found only one study involving a two-dimensional scale with behavioural and physiological indicators that tested this hypothesis (Oliveira et al, 2012).

In this study the *Intensity* parameter was statistically meaningful to the EVENDOL score as well as to its indicators, showing that they met the theoretical assumptions required for a physiological pain measure. By the model studied here, the *Intensity* parameter is associated with a score for each observational period related to painful event and its potential change (Stevens et al 2007). It has been established that EVENDOL score above “4” would be compatible with acute pain (Fournier-Charrière, 2012). In our study, even without taking into account the gestational age, the average and standard deviation of EVENDOL score during the painful stimulus was 8.9 (± 4.1), similar behaviour those found on study using PIPP (Oliveira et al, 2012).

The *Direction* parameter was relevant to the EVENDOL and its indicators as viewed by Friedman test (Table 1). These responses may or may not occur and could even be a paradoxical event (Stevens et al 2007), as demonstrated for PIPP scale, where the total score and the majority of its indicators do not exhibit the same behaviour (Oliveira et al, 2012).

The *Reactivity* parameter was relevant for both EVENDOL score and its indicators (Table 1). Generally, the topography of the pain response by this kind of tool includes the increase of the scores for a period of time followed by return to or close to basal levels (Stevens et al 2007). We found scientific evidence regarding *Reactivity* of behavioural indicators as described in this article. Our findings were consistent with other authors that observed significant increase of PIPP score during painful event. In a study including 32 healthy newborns between 3-5 days of age subjected to routine blood sampling for metabolic screening an increase of six points in the PIPP score was observed during the painful stimulus (Eriksson et al 2008). Another survey involving 33 premature newborns with gestational age between 28-36 weeks without any relief care, the PIPP during heel lancing achieved the score of 21, while two other groups of similar size and age, exposed to skin-to-skin contact or oral glucose had scores of 10.9 and 17.8 respectively (Freire et al 2008). Oliveira et al (2012) described significance increase in behavioural indicators and PIPP total score in full term infants within 48h postnatal age.

The *Regulation* parameter was significant only to the facial expression indicator of EVENDOL (the only one with $p < .05$) (Table 1). These results did not conform to the expected by us and with other surveys. A study with 70 healthy full term newborns after 24h age observed immediately before heel lance, during and after 1, 3, 5 and 10 minutes showed that the *Regulation* is achieved after 3 minutes for both NIPS and NFCS scales (Pereira et al, 1999). Oliveira et al (2012) analysing 40 full term newborns against PIPP found positive *Regulation* after 3 minutes of the procedure for total score and for your behavioural indicators. A justificative for our findings would be that the observation time of the indicators of EVENDOL after 30 seconds was insufficient to model the *Regulation* parameter. In this sense, except to the facial expression, all other variations are significantly smaller, and those indicators will be the first to regret to similar levels before pain stimulus. We believe that the observation time for *Regulation* should be increased in order to better observe this variation.

Finally, the *Slope* parameter showed statistical relevance for all indicators and EVENDOL score, receiving the same explanation as the *Direction* parameter (all $p < 0.05$). As the *Slopes* were significant, we interpret that the baseline scores had the ability to predict the response (*Reactivity*) and the recovery (*Regulation*) to painful event.

The approach adopted in this research helps to understand how the components of a behavioural pain scale react to painful stimulus, with reference to the viewpoint of the psychophysical parameters normally found in physiological indicators. The general findings confirm that a significant and quickly response of the Central Nervous System to painful stimulus can be revealed through the application of the EVENDOL. Possible limitations would be the presence in the sample of newborns that received oral glucose or breastfeeding before the painful event, which can reduce the pain response and the observation time employed after the heel lance. We suggest that the observation time after pain stimulus should increase in order to avoid misinterpretations of EVENDOL analyses.

Conclusions

We found that the EVENDOL is proper to be used in validation of tools for pain evaluation, especially to new physiological devices, as it meets the psychophysical parameters of *Intensity*, *Direction*, *Reactivity* and *Slope*, although it didn't do to *Regulation* within 30 seconds and it can be considered consistent with physiological indicators of acute pain in the newborn. The EVENDOL and its indicators should be considered in further controlled studies.

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The role of style of self-regulation in loudness discrimination

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Abstract

The purpose of our research is to clarify the role of the personal self-regulation mechanisms defining the observer`s strategies that are used to solve threshold task of loudness discrimination of two tonal signals. The psychophysical research of loudness discrimination of tonal signals (method 2AFC) was carried out N=106. The influence of self-regulation processes (questionnaires: HAKEMP-90 (Kuhl J.); Style of self-regulation of behavior (Morosanova V.); Self-organization of behavior (Bond M., Feather N.) on RT and sensory sensitivity index A' was found out. The individual performance strategies were identified in self-reports by the content analysis. The qualitative analysis of individual ways in signal discrimination was carried out. It is developed the idea that the variation of stimuli uncertainty leads to appropriate transformation of the functional organ or functional perceiving system relevant to sensory discrimination task demands.

Keywords: sensory uncertainty, psychophysics, individual differences, sensory task, loudness discrimination, self-regulation.

From the modern psychophysics point of view the increase in detection efficiency and threshold loudness discrimination can be achieved through various methods: 1) through increasing sensory sensitivity during training, 2) through finding the most optimal position of decision-making criteria. Changes in decision making criteria means changes in observers' mode of action.

According to the hypothesis of our research it can be expected that the most successful in loudness discrimination in a difficult threshold task will be those observers who, on the one hand, will be attentive to their subjective impressions and experiences and, on the other hand, will be able to mobilize their functional reserves in case of failure during the process of sensory threshold task implementation dedicated to loudness discrimination (Emelianova, Gusev, 2018).

Methods

Stimulation

Tonal signals lasting 200 ms with a frequency of 1000 Hz. An interval between trials was 3 sec, an interval between stimuli - 500 msec. The difference between stimuli in different series was equal to 1, 2 (basic) or 4 dB (training). Equipment and software. Registration of the

responses and stimulus presentation was done with the help of personal computers with standard audio cards and stereo earphones AKG (K-44). Motor responses were recorded through special consoles that could ensure accurate registration and avoid measurement errors of reaction time (RT). Sound stimuli were synthesized in program "Sound Forge 4.5". Observers. The research comprises 106 subjects (average age is 31 years old), 88 women and 18 men.

Procedure

A psychophysical research of loudness discrimination of tonal signals (method 2AFC) was carried out. The observer was asked to listen to two sound signals and decide which of them – the first one or the second one – is louder. Within two days a participant of the experiment took part in two tests corresponding to a simple (2 dB) and more complicated (1 dB) signal discrimination task. Each separate test included training and introductory series (20-60 trial with a difference of 4 dB) and main series that consisted of four blocks each having 100 trials. In case the observer carried out the training series without errors he moved on to the main series.

Upon completing each of the blocks of trial presentation the observer was shown the outcomes of his work – a screen displayed an estimated probability of correct responses, percentage of correct responses and false alerts. There was a break after. During that break, the observer shared with the tester his subjective impressions that he experienced during implementation of the task. Reply protocol of the observer was recorded via voice recorder and was decoded after. If the observer detected the characteristics, different from loudness, in sound of the stimuli presented to him during the test, the observer filled out a standard self-control questionnaire.

Before the research the observers filled out questionnaires: HAKEMP-90 (Kuhl J.); Style of self-regulation of behavior (Morosanova V.); Self-organization of behavior (Bond M., Feather N.) The following sensory task performance indices were calculated for each series: 1) sensory sensitivity index A, 2) RT. The data obtained were processed with the help of one-factor analysis of variance (ANOVA) in IBM SPSS statistical package for Windows 17.0. Independent variables (factors) were 1) 3 scales of the factor «Control over an action»: «Control over an action when planning», «Control over an action in case of failure», «Control over an action in case of action realization» (each subfactor was presented by two levels – «state orientation» (SO) and «action orientation» (AO). In order to determine the levels of the factors, the values obtained through the scales of HAKEMP-90 questionnaire («Control over an action») were split at the midpoint, i.e. the groups of AO-observers and OS-observers were defined for each scale); 2) scales: «Planning» and «Programming»

Results

Our hypothesis has been confirmed. There were identified significant effects of a cross-factor interaction. First of all, a combined effect of such factors as «Control over an action» and «Planning» ($F=3,254$ $p=0,045$), «Planning» and «Programming» ($F=2,519$ $p=0,050$) on sensory sensitivity index; second of all, a combined effect of factors «Control over an action»

and «Programming» on decision making criteria. The analysis of the cross-factor interaction revealed that the task specific is the key point that identifies the character of changes included in its solution of psychological processes. During complex threshold sensory task, the observers oriented to a condition with low and average marks on the scale of «Planning» demonstrated higher differential sound sensitivity rather than the observers oriented towards an action and a state with high marks on the scale of «Planning». The results are consistent with the suggestion made by I.A.Vasiliev and U. Kuhl that a plan complexity is linked with a motivation type (Kuhl, 1992). It was shown that the observers with the pursuit of success motivation, high level of task involvement and action-oriented tend to create as many sub-goals as possible, which are, in their subjective opinion, instruments to achieve the main objective, and to make less aimless decisions than the observers with the motivation to avoid failure that is confirmed by self-report materials.

In the conducted research it was also determined that the strictest criteria during the decision making in a complicated sensory task is used by SO-observers with strongly expressed need to think through their action methods to achieve established goals, to refine and produce detailed programs of their performance (i.e. SO-observers with high marks on the scale of «Programming»). And, vice versa, the least strict (liberal) criteria was used by AO-observers with a high level of action programming during self-regulation (i.e. AO-observers with high marks on the scale of «Programming»).

It was also demonstrated that the lowest differential sound sensitivity (in comparison with the rest groups of observers) have the observers with a highly developed ability of conscious action programming and a low level of planning during self-regulation (i.e. with high marks on the scale of «Programming» and low ones on the scale of «Planning»). In comparison with them more sensitive are the observers with a medium level of development programming and a low level of sensory actions planning (medium marks on the scale of «Programming» and low ones on the scale of «Planning»).

According to literature sources, the differences in planning (the scale of «Planning») are connected with a various subject activity during goals setting, their acceptance and retention (Morosanova, 2007). Programming features (the scale of «Programming») are, first of all, the reflection on forthcoming performing actions, in our case, sensory actions necessary to achieve an established goal. We showed that the means of achieving an objective and the methods of performing actions detail can be individually specific depending on which group the observers belong to (action-oriented or state-oriented) and also what kind of sustainable individual features of programming and planning are typical to them and to what extent they are able to correlate programs of perceptual action with its objective conditions.

It should be emphasized that in a self-regulation structure the process of a goal setting is a component that shapes the system (Gusev, 2004; Shapkin, 1997; Kuhl, 1992; Morosanova, 2007). This thesis was also confirmed in our research because the main effects of a cross-factor interaction were linked with the scales of «Programming» and «Planning». In the context of obtained outcomes, it seems to us perfectly justifiable to include psychometric assessment of personality traits connected with functional components of a self-regulation system in the psychological mechanisms analysis of a sensory action.

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Does genetic similarity matters? Face recognition performance for primates

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Abstract

Face recognition plays a critical role in our evolutionary history. Previous studies demonstrated “the other-ethnicity effect” showing that the human face processing changes for unfamiliar faces. But is there any difference in processing faces of other primates? Is there any ‘other-species’ effect? From this evolutionary perspective, our study aims to find out if human facial recognition system processes other primate faces in respect to their genetic similarity or not.

Twenty undergraduate students participated the study. Thirty different high-quality natural monkey faces including bonobos, gorillas, chimpanzees, and orangutans and 10 human faces were used as stimuli. In the first experiment, we presented faces with 2sec inter-stimulus interval (ISI) in a random order and asked them to determine whether the stimulus was a human or non-human face. In the second experiment the subjects were tested in a face recognition task. We measured subjects’ correct response ratio and response time for each type of faces. Since face recognition and empathy is related, we also measured the degree of empathetic abilities by using the Empathy Scale developed by Baron-Cohen and Wheelwright (2004). Additionally, Galvanic Skin Response (GSR) was measured during the task.

Two repeated measures ANOVA were conducted for response time (RT) and correct response ratio (CRR). The results indicated that there was no significant difference among accuracy scores for different primate faces in the first experiment. However, the response time results indicated that there was a significant difference among different primate faces ($p<.01$). (Table1).

Table 1. Mean correct response ratio(CRR) and mean response time(RT) in experiment 1

Stimulus Type											
Female		Male		Chimp		Bonobo		Orangutan		Gorilla	
CRR	RT	CRR	RT	CRR	RT	CRR	RT	CRR	RT	CRR	RT
.99	761.47	1	854.430	.99	809.79	1	783.300	.99	785.33	.99	734.05

The repeated measures ANOVA indicated that both CRR and RT changed in respect to the type of the facial stimulus in Experiment 2 ($p<.01$).

Table 2. Mean correct response ratio(CRR) and mean response time(RT) in experiment 2

Stimulus Type											
Female		Male		Chimp		Bonobo		Orangutan		Gorilla	
CRR	RT	CRR	RT	CRR	RT	CRR	RT	CRR	RT	CRR	RT
.51	1408.44	.35	1672.08	.53	1577.72	.47	1320.51	.44	1333.41	.45	1423.93

The results showed that the participants’ categorization of the faces was fastest for gorilla and female faces. However, their face recognition performance was highest for the chimpanzee and female faces.

The production of English vowels by Japanese and Brazilian Portuguese speakers

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Abstract

This study examined the production of English vowels by Japanese and Brazilian Portuguese (BP) speakers. A total of 18 participants (5 English, 6 BP, and 7 Japanese speakers) took part in the study. The first two formant values of six English vowels (/ʊ/, /ɪ/, /ɑ/, /æ/, /ɛ/, /ʌ/) were chosen for measurement, and 30 minimal pairs (e.g., cat-cut, foot-fat) were constructed as stimuli. Each participant pronounced each word and speech data were audio-recorded with a digital sound recorder. The value of the first formant frequency (F1) and second formant frequency (F2) was automatically measured at the midpoint. Neither the Japanese nor the BP vowel inventory has /æ/, and thus the English vowel /æ/ was a new category for both groups. Japanese speakers produced overlap between /æ/ and /ʌ/, while BP speakers produced overlap between /æ/ and /ɛ/. This study thus sheds light on the vowel acquisition of second language learners.

With the growth of English as an international language, many speakers use English as their second language. Many learners have problems pronouncing unfamiliar phonemes, which can hinder comprehensibility or intelligibility. Jenkins (2000) reported that pronunciation at the segmental level negatively impacted comprehensibility or intelligibility in L2 mixed-language dyads. Deterding (2005) found that Singaporean listeners had difficulty listening to nonstandard British English at the segmental level. It is thus important to be familiar with a variety of accents produced by different speakers in different backgrounds for comprehensibility or intelligibility.

A number of previous studies have investigated the production of English vowels by second language (L2) learners. For example, Simon and D'Hulster (2012) examined the acquisition of the English vowel contrast /ɛ/-/æ/ by Dutch speakers, which was chosen because Dutch has only one of these vowels, /ɛ/, in its vowel system. The results showed that they created a new category for English /æ/, but transferred their Dutch /ɛ/ into English /ɛ/ and did not seem to create a new category for the similar sound of English /ɛ/. Rauber et al. (2005) investigated the relationship between the perception and production of English vowels with high-proficiency Brazilian Portuguese (BP) learners of English. The results showed that they had difficulty in discriminating the contrasts /ɛ/-/æ/, /ʊ/-/u/, and /ɔ/-/ɑ/. Rauber et al. (2005) suggested that the F1 and F2 values of these two English vowels were similar to those of a single vowel in BP, and thus they had difficulty making a clear contrast between the two English vowels. Evans and Alshangiti (2018) explored the perception and production of English vowels and consonants by Saudi Arabic speakers at different English proficiency levels. The results showed that even advanced learners had difficulty identifying English vowels without a direct counterpart in Saudi Arabic. Rauber et al. (2005) stated that the difficulties of L2 vowel acquisition can be explained by the similarities between L1 and L2 vowels (Escudero, 2002; Rauber et al., 2005), the size differences of the respective vowel

systems, and the presence or absence of vowels in different vowel systems (Simon and D'Hulster, 2012; Evans and Alshangiti, 2018).

The present study explored the production of English vowels by Brazilian Portuguese (BP) speakers, Japanese speakers, and native English speakers. To our knowledge, no previous study has directly compared BP speakers and Japanese speakers. Japanese has only five vowels, /a/, /i/, /u/, /e/, /o/, while BP has seven vowels, /a/, /ɛ/, /e/, /i/, /ɔ/, /o/, /u/. Japanese and BP have differences in size between their vowel systems, and only BP has /ɛ/ and /ɔ/; Japanese has no contrast between these two vowels. We explored the similarities and differences of English vowels produced by speakers from two different language backgrounds, Japanese and Brazilian Portuguese, compared with those of native English speakers.

Method

A total of 18 participants took part in the study. Seven Japanese female speakers were students at a private university in Japan aged between 18 and 22 years old. They were born and raised in Japan and had not had experience living in an English-speaking country for more than 1 month. English was a compulsory subject for all the Japanese speakers and they were studying English formally at the time of the experiment. Their English proficiency level was from lower intermediate to intermediate based on an English proficiency test (TOEIC). Female Brazilian Portuguese speakers aged between 20 and 25 years old also took part in the experiment. They were students at a university in Brazil and had been born and raised in Brazil. They were exchange students at the private university in Japan at the time of the experiment, and the length of their exchange program in Japan was from 6 months to 1 year. Their English proficiency was advanced based on the English proficiency test they took. Four female English speakers were the students at the university in Canada. They were aged between 18 years old and 27 years old. One female English speakers were the editor and her age was in forties.

We constructed 30 minimal pairs (e.g., *cat-cut*, *desk-disk*, *fat-foot*), using six English vowels (/ʊ/, /ɪ/, /ɑ/, /æ/, /ɛ/, /ʌ/). Each word was presented with a picture via PowerPoint on a laptop screen. Each participant pronounced 60 words. In total, 1080 tokens were recorded. Speech data were audio-recorded with a digital sound recorder (TEAC, DR-07) set to 44.1-kHz sampling and 16-bit linear quantization. After recording, the digital data were stored in a database. We excluded 9 tokens because of poor recording quality.

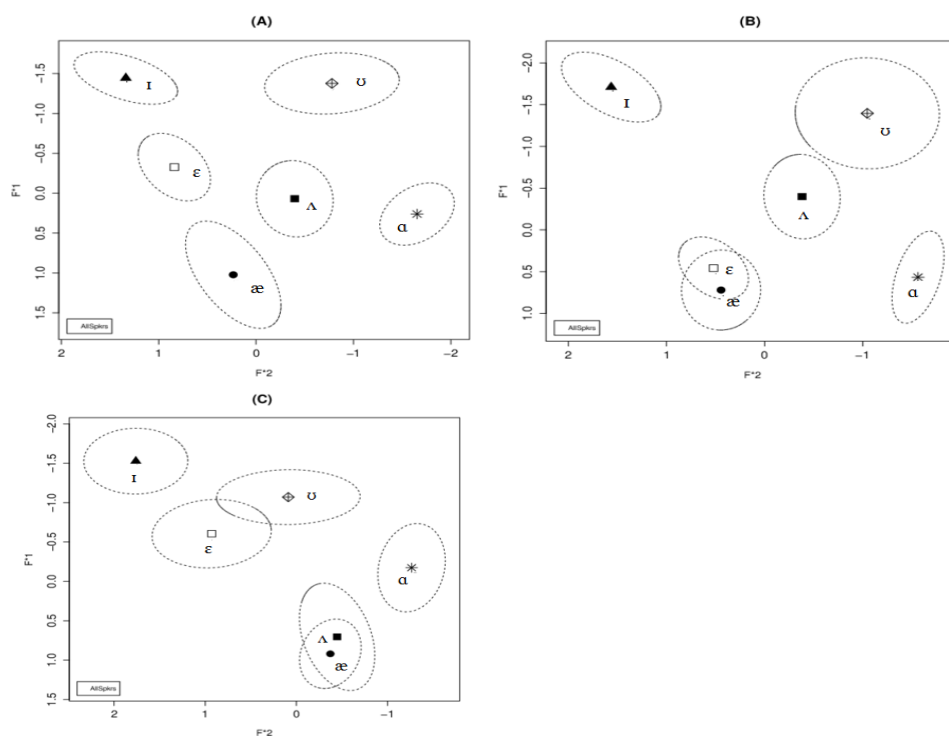
Measurements of the first two formants were made. Deterding (1997) suggested the following guidelines for the measurement of the first and second formants of vowels: avoid preceding or following /r/, /w/, /j/, and avoid following /l/, /ŋ/. We extracted 108 tokens (6 tokens × 18 speakers) for further analysis based on Deterding (1997)'s guideline. The author marked the vowel boundaries manually with audio software PRAAT (Boersma and Weenink, 2018). The midpoint of the vowel was determined and the values of the first formant frequency (F1) and second formant frequency (F2) at the midpoint were automatically measured by PRAAT. If the F1 and/or F2 value was more than 2 standard deviations away from the mean, the author and one research assistant listened to the audio data again and checked the waveforms and the value of F1 and F2 manually. When the two agreed that F1 and/or F2 values

at the midpoint were to be considered as an outlier, the tokens were excluded from further analysis. In this way, 4 tokens were excluded, leaving a total of 963 vowel tokens.

In order to compare the first two formant values of first language and second language, the Japanese speakers produced five words containing the Japanese vowels (/a/, /i/, /u/, /e/, /o/) and the BP speakers produced seven words containing the BP vowels (/a/, /ɛ/, /ɐ/, /i/, /ɔ/, /o/, /u/).

Results and Discussion

Figures 1(A)–(C) show the mean F1 and F2 values of the six English vowels (/i/, /ɪ/, /a/, /æ/, /ɛ/, /ʌ/) pronounced by English, Brazilian Portuguese, and Japanese speakers, respectively. Lobanov (1971) was used to normalize the data, as shown in Figures 1. Ellipses represent one standard deviation from the mean of F1 and F2 values. Ellipses represent one standard deviation from the mean F1 and F2 values. Figure 1(A) shows that English speakers produced six clear distinct vowel categories. Figure 1(B) shows that BP speakers showed an overlap between /æ/ and /ɛ/. The mean values of F1 and F2 for /æ/ and /ɛ/ were 839 Hz and 1971 Hz, and 803 Hz and 2002 Hz for BP speakers; and 835 Hz and 1537 Hz, and 584 Hz and 2087 Hz for Japanese speakers. Paired-samples *t*-tests were conducted for each group of speakers. For the BP speakers, the F1 and F2 values of the two vowels were not significantly different, while for Japanese speakers, the F1 and F2 values of the two vowels were significantly different (F1:



$t(73) = 14.189, p < .01, F2: t(73) = -16.75, p < .01$).

Fig. 1. The English vowels pronounced by English (A), Brazilian Portuguese (B), and Japanese speakers (C). Ellipses represent one standard deviation from the mean.

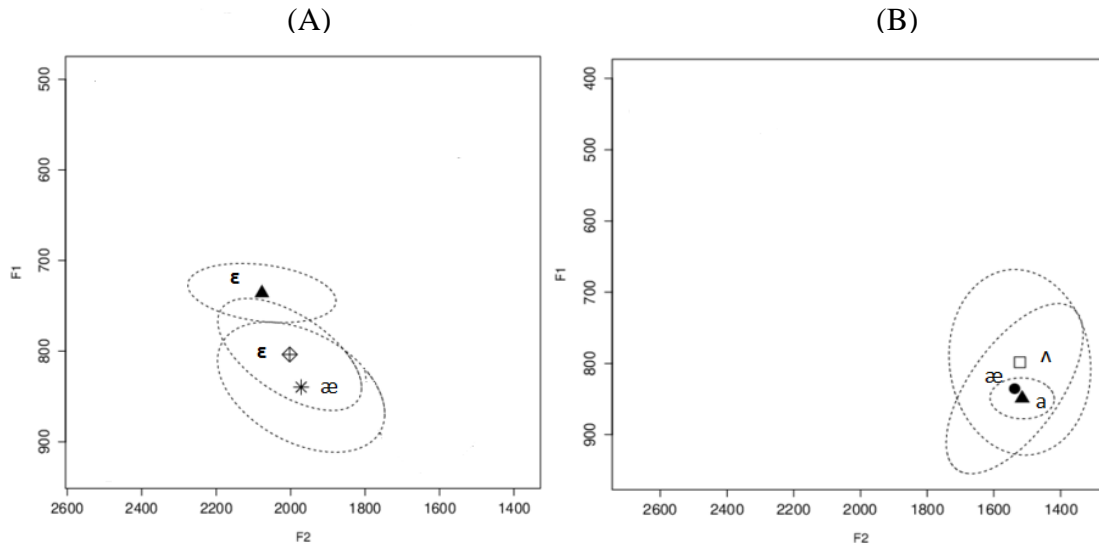


Fig. 2. The English vowels /æ/ and /ε/ and BP vowels /ε/ produced by BP speakers (A), and the English vowels /ε/ and /Λ/ and Japanese vowel /a/ produced by Japanese speakers (B). Ellipses represent one standard deviation from the mean.

We further examined whether and how BP influences their pronunciations of /æ/ and /ε/. We did not normalize the data because both Japanese and BP speakers were female aged between 18 and 27 years old. Figure 2(A) shows the mean F1 and F2 values of the English vowels /æ/ and /ε/ and the BP vowel /ε/ produced by BP speakers. Their /ε/ and /æ/ were close to the BP vowel /ε/, indicating that BP speakers did not establish a new category for the English vowel /æ/, which in their speech overlapped with the English vowel /ε/. The results were consistent with those of Simon and D’Hulster (2012) and Raubert et al. (2005), in that the distinction between the English vowels /æ/ and /ε/ was difficult for them to acquire because of the lack of vowel in their L1 vowel inventory.

For Japanese speakers, the pronunciations of /æ/ and /Λ/ were found to overlap. The mean values of F1 and F2 for /æ/ and /Λ/ were 839 Hz and 1971 Hz, and 690 Hz and 1651 Hz for BP speakers; and 835 Hz and 1537 Hz, and 798 Hz and 1522 Hz for Japanese speakers. The F1 and F2 values of the two vowels were significantly different for BP speakers (F1: $t(53) = 7.69, p < .01$, F2: $t(53) = 11.41, p < .01$). Figure 2 (B) shows the mean values of F1 and F2 of the English vowels /æ/ and /Λ/ and Japanese vowel /a/ produced by Japanese speakers. The results show that their production of the English vowels /æ/ and /Λ/ was close to that of the Japanese vowel /a/. These results were consistent with our previous study (Yamashita and Ishii, 2019) with young Japanese learners, in that Japanese speakers produced overlap between /æ/ and /Λ/.

Neither Japanese nor BP has /æ/, and thus the English vowel /æ/ is a new category to both groups. Japanese speakers produced an overlap between /æ/ and /Λ/, while BP speakers produced an overlap between /æ/ and /ε/. Moreover, for Japanese speakers the F1 and F2 values

of both /æ/ and /ʌ/ were close to those of the Japanese vowel /a/. For BP speakers, the F1 and F2 values of English vowel /æ/ were close to English /ɛ/ and BP /ɛ/. Despite its small number of participants, this study sheds light on vowel acquisition by second language learners.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Numbers 26770194 and SIT (Shibaura Institute of Tech.) grant for a newly appointed faculty member.

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Perception of music scales based on 31-tone equal temperament

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Abstract

Previous studies on tonality in music had quantified the hierarchy of tonal functions with 12-tone equal temperament [Krumhansl, C. L. (1990). *Cognitive Foundations of Musical Pitch*, Oxford University Press, NY]. In the present study, the perceptual hierarchy of tone chromas based on 31-tone equal temperament, which has been used in a relatively small music community, was investigated by utilizing major scales and harmonic minor scales. An auditory experiment based on the probe tone technique as in the previous studies was conducted employing 10 participants. Only ascending scales were utilized. Shepard tones, which were very close to one another in tone height, were used, and thus 31 tones representing the 31 tone chromas were provided. The 31 major or minor scales and the 31 probe tones, paired in all possible ways, made 961 stimulus pairs, and these pairs were presented once each to each participant in random order for rating. Only major or minor scales were presented within each session. A probe tone was presented after each presentation of a major or minor scale, and the participant rated how well the probe tone fitted the context, i.e., the major or minor scale, on a seven-point scale from “fits poorly (1)” to “fits very well (7)”. The results indicated the tonal hierarchy of the 31 tone chromas, and were consistent with the results for 12-tone equal temperament. This provides a possibility to investigate how the keys in 31-tone equal temperament are connected to one another psychologically. An advantage of employing 31- instead of 12-tone equal temperament is that this makes it easier for us to employ musical scales that are very different from those used commonly. This will be an effective way to further clarify the mechanism of tonality perception in music.

Pre-speech development of Japanese-learning infants

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Abstract

How and when utterances with syllables or proto-syllables appear in the development of infant speech was investigated. Speech or speech-like sounds of five Japanese-learning infants (three boys and two girls) were recorded at 3, 8, and 12 months of age in natural situations in each infant's home. In total, 890 utterances were obtained. In a preliminary observation, one of the authors listened to these recorded utterances and classified them into seven categories related to syllable formation. As the infants' age increased, utterances with no syllable structure decreased, while utterances with clear syllables increased. Upon an assumption that some speech or speech-like sounds uttered by infants are attempts to communicate something to their parents or caregivers, we now plan to conduct perceptual experiments on how adults categorize these speech or speech-like sounds collected in the infants' developmental processes. We aim at clarifying how phonemes appear in the process of infant's development.

How the perception of an initial consonant is influenced by the duration of the following vowel

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Abstract

We aimed to investigate whether the perception of consonants is influenced by the length of the following vowel in English. From a new database of English speech (Fukuoka-Galway English Speech Database 2019), a part roughly corresponding to a CV sequence /ge/ was extracted from a word ‘get’ for a listening experiment. A tentative boundary between /g/ and /e/ was determined in the waveform, and the lengths of the waveform portions to be taken before and after this boundary were varied systematically. An illusory phenomenon appeared in a pilot experiment in which one fluent nonnative English speaker participated. When the portion before the boundary was 12-48 ms, the relative frequency for /ge/ to be perceived was lower if the portion after the boundary was as short as 22 ms than if it was longer, leading to the perception of /j/, /je/, or /e/ (Figure 1).

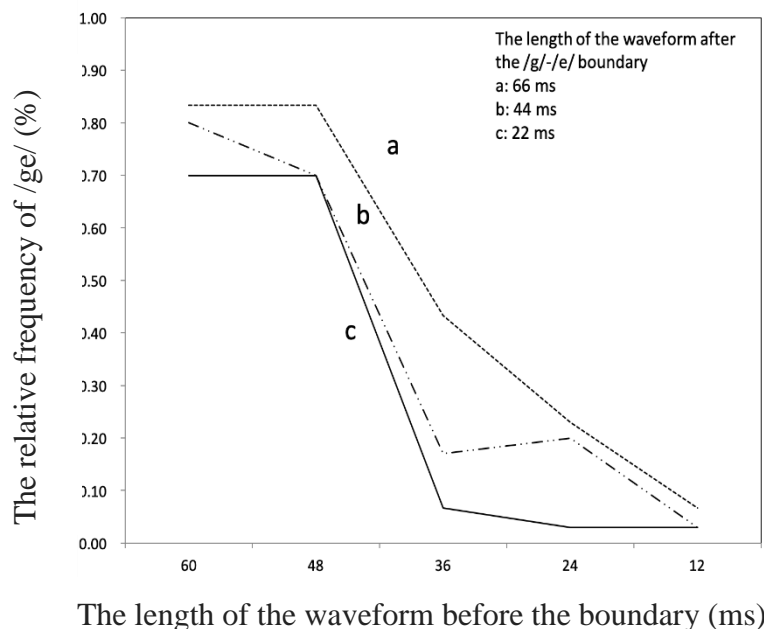


Fig. 1. The proportion of percepts /ge/ as a function of the waveform lengths before and after the tentative boundary between /g/ and /e/ in a spoken word ‘get’ (/get/). The relative frequency for the consonant /g/ to appear was different depending on the length of the following vowel.

The effect of sound modulation mode on perceived audiovisual congruency of pure tones and Gabor patches

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Abstract

Audiovisual (in)congruency studies typically use frequency- and/or amplitude-modulated sounds in combination with flickering and/or moving Gabor patches. Here we investigated which type of sound modulation (amplitude or frequency) influenced perceived audiovisual congruency more profoundly. We examined different combinations of sound modulation and Gabor patches of various spatial frequencies and different presentation modes - flickering and moving. Participants were asked to judge perceived audiovisual congruency on a rating scale. The obtained heat maps demonstrate that perceived congruency varies in relation to the sound modulation frequency and visual temporal frequencies. For both visual presentation modes in the examined range of spatial frequencies, a change in a sound's amplitude modulation influenced (in)congruency percepts more than a change in a sound's frequency modulation, and the difference was statistically significant.

In multisensory studies, numerous combinations of stimuli of different modalities have been employed with the aim to create an interaction between the senses. Experiments in the audiovisual domain often proceed from basic stimuli, such as (modulated) pure tones or noises for the auditory modality and Gabor patches for the visual modality. Different parameters of these stimuli then are matched to create “congruent” or “incongruent” audiovisual combinations. Typical examples are matchings of the spatial frequency of a Gabor patch with the frequency of a pure tone (Heron et al., 2012) or amplitude-modulated white noise (Orchard-Mills et al. 2013), or combinations of the modulated spatial frequency and flicker of a Gabor patch with frequency-modulated audio signals (Covic et al., 2017). In most studies, though, audiovisual stimulus parameters have been set without clear empirical evidence on whether the stimulus combinations are indeed perceived by participants as congruent or incongruent, and if so, to what degree. Although these settings determine the breadth and depth of experimental objectives and outcomes, comparative experimental evidence about the perceived (in)congruency of various combinations of basic audiovisual stimuli does not seem to be readily available.

The current study is designed to obtain (in)congruency judgments of some basic audiovisual stimulus parameters. In particular, we examined whether sound modulation mode, amplitude modulation or frequency modulation, caused a difference in perceived audiovisual congruency in combination with Gabor patches that were varied in two modes as well –

flickering and moving. Participants were asked to rate the congruency of various combinations of these stimuli on a rating scale.

Method

Participants

Fourteen participants (8 males, 6 females, mean age = 28.83 years, SD = 6.24) took part in the experiment. All had normal or corrected-to-normal vision and normal hearing. The purpose of the experiment and the procedure were explained to the participants in the beginning of the experiment and written informed consent to participate was obtained from each participant.

Stimuli

The stimuli consisted of various combinations of visual and auditory stimuli. The duration of each stimulus was 2000 ms. The visual patterns were 5 Gabor patches with spatial frequencies of 2, 4, 6, 8 and 10 cycles per visual degree. The diameter of the stimuli was approximately 2 degree in visual angle (chin-rest was set 57 cm from the monitor). Each Gabor patch was presented in 2 modes – moving and flickering. In the moving mode, the patch was presented with 5 different speeds of 0.5, 1.0, 1.5, 2.0, or 2.5 visual degrees per second, moving from left to right (Fig. 1A). The luminance of the Gabor patches on screen ranged from 0.02 cd/m² (black) to 9.8 cd/m² (white). The experiment was conducted in a dim-lit room, with an illuminance at the participant level of 0.9 lx (measured with the grey background screen in the experimental conditions).

In the flickering mode, the patch was presented with 5 different frequencies, flickering 0.5, 1.0, 2.0, 3.0, or 4.0 times per second. The flickering effect was created by gradually changing the opacity of the pattern from 0 to 1 and back. With every new flicker the phase of the Gabor patch changed (Fig. 1B).

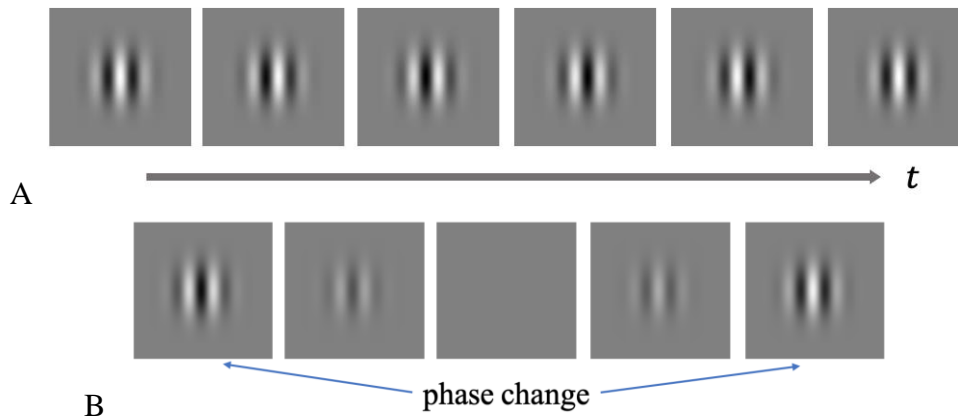


Fig. 1. Example of Gabor patches used in this study. A) In the moving mode, the patch moved with a speed of 0.5, 1.0, 1.5, 2.0, or 2.5 degrees per second. The phase of a moving Gabor patch changed with time, as can be seen in the figure, creating an effect of stripes moving from left to right. B) In the flickering mode, the patch was flickering 0.5, 1.0, 2.0, 3.0, or 4.0 times per second. The opacity of a Gabor patch changed, creating a flickering effect. A phase change happened when the Gabor patch was completely transparent.

The auditory stimuli consisted of a 1000 Hz pure tone, 2000 ms in length with a 500 ms rise and fall time. The tone was modulated in amplitude (amplitude modulation, AM) or frequency (frequency modulation, FM). For both modulations the same 5 frequencies were used: 0.5, 1, 2, 3 and 4 Hz. Each modulation was applied with a phase shift of -0.5π , so that the beginning and the end of the amplitude or frequency rise corresponded to the beginning and the end of the tone. The sound level was set to a comfortable level and reached its maximum at 57.8 dBA (fast-peak). The experiment application was developed using PsychoPy3 software (Peirce et al., 2019).

Apparatus

The stimuli were presented using a CRT monitor (Iiyama HF703U E, 16 inches). The sounds were presented through an active filter NF DV-04 (14.5Hz cutoff frequency), equalizer ART EQ355, a headphone amplifier (STAX SRM-323A) and headphones (STAX SR-307). The luminance of the visual stimuli was measured with a TOPCON Luminance Meter BM-9 and the illuminance with a TOPCON Illuminance Spectro Meter IM-1000.

Procedure

The experiment was conducted in a sound-proof room. The experiment consisted of practice sessions (5 trials chosen randomly for each participant) and 5 experimental sessions (50 trials each), separated by breaks of 3 minutes. The experiment started with short instructions provided to the participant on paper. The participant was then asked to click a mouse to confirm that he/she understood the instructions and to start the practice session. After the practice session, the experimental sessions started. Each trial started with a 2-second pause (empty grey screen), followed by the appearance of a fixation cross for 1 second in the middle of the screen.

This was followed by another 1-second pause and a stimulus. After the stimulus was presented, a 2-second pause was followed by the appearance of the rating scale on the screen. Participants were asked to rate the perceived congruency of a Gabor patch and a tone on a 1-7 rating scale, where “1” corresponded to “not congruent” and “7” corresponded to “very congruent”. After each 50 trials a compulsory break was given. The experiment was done on two different days in order to complete the rating of all 500 combinations. The procedure was approved by the Ethical Committee of the Faculty of Design, Kyushu University, Japan.

Results

Flickering Gabor patches

For every combination of Gabor-patch flickering frequency and tone modulation frequency we calculated the mean (in)congruency ratings across participants (Table 1).

Table 1. Average (in)congruency ratings of the combinations of flickering Gabor-patch frequency and tone modulation frequency (FM and AM) across participants (n=14). Darker tones show higher audiovisual congruency.

Patch Flickering frequency	FM tone					AM tone				
	0.5 Hz	1 Hz	2 Hz	3 Hz	4 Hz	0.5 Hz	1 Hz	2 Hz	3 Hz	4 Hz
0.5 cycle/s	6.14	4.54	4.01	3.59	3.51	6.46	4.77	4.37	4.63	4.56
1 cycle/s	4.53	5.8	4.34	3.49	3.63	4.66	6.41	5.13	4.13	4.46
2 cycle/s	3.97	4.56	6.03	3.03	3.54	3.79	5.3	6.44	3.13	4.23
3 cycle/s	3.04	3.26	3.44	5.71	3.67	3.27	2.9	3.41	6.04	3.93
4 cycle/s	2.43	2.8	3.99	3.84	5.17	2.74	2.57	3.56	3.64	6.09

As can be seen in the Table 1, the combinations consisting of a flickering Gabor patch and an AM or FM tone modulated with the same frequency as the flickering (patch flickering frequency = tone modulation frequency) had the highest perceived congruency. Thus, when the ratio of these frequencies could be expressed as a whole number, the ratings were higher than in other cases. In order to demonstrate this graphically (Fig. 2), we calculated the logarithm of the frequency ratio (LFR) using the following formula:

$$LFR = \log_2 \frac{\text{tone modulation frequency}}{\text{flickering frequency}}$$

The highest ratings were as expected at the point where LFR was equal to 0, i.e. where the tone modulation frequency and the Gabor patch flickering frequency were equal. We could also observe two roughly symmetrical spikes at LFR = -1 and 1, where tone modulation frequency was twice as high as flickering frequency and vice versa. The ratings for AM tones were generally higher than for FM tones [F(1,69) = 29.879, p<0.001, especially in conditions

where the modulation frequency of a tone was equal or higher than the flickering frequency of a Gabor patch.

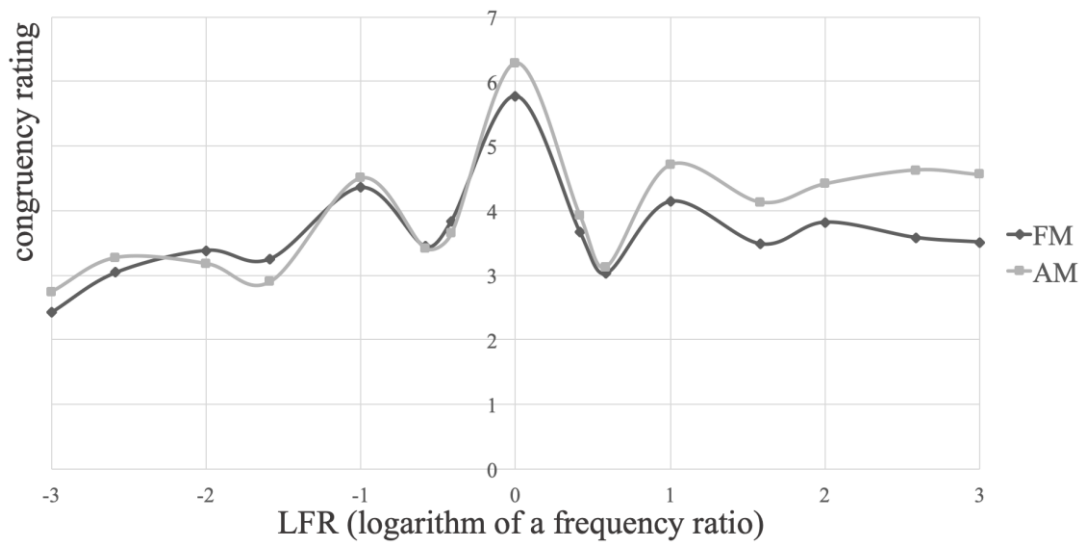


Fig. 2. Average rating of flickering Gabor patches in combination with the FM or AM tones aggregated per LFR (logarithm of the frequency ratio).

Moving Gabor patches

Compared to flickering Gabor patches, moving Gabor patches with AM or FM tones showed a profoundly different (in)congruency rating pattern (Table 2). Here too the congruency between a Gabor patch and an AM tone was scored as generally higher than that between a Gabor patch and an FM tone [$F(1,69) = 9.354, p=0.003$] However, at a modulation of 1 Hz, the ratings for AM dropped below those for FM and became the least congruent in all combinations according to most participants (Figure 3A). We calculated the average rating range for each Gabor patch (Figure 3B) by taking the difference between the rating for a given patch in combination with a tone that gave best congruency (highest ratings) and the rating for to the same patch in combination with the tone that gave worst congruency (lowest rating). An analysis of the average rating range for each moving Gabor patch showed that AM modulated tones were given more extreme ratings – higher for congruent combinations and lower for incongruent combinations. The average rating range for Gabor patches was 3.04 (SD=0.35) in combination with AM tones and 2.73 (SD=0.28) in combinations with FM tones ($t=3.47, p = 0.002$).

Table 2. Average (in)congruency ratings of the combinations of moving Gabor-patch frequency and tone modulation frequency (FM and AM) across participants (n=14). Darker tones show higher audiovisual congruency.

Patch Moving Speed	FM tone					AM tone				
	0.5 Hz	1 Hz	2 Hz	3 Hz	4 Hz	0.5 Hz	1 Hz	2 Hz	3 Hz	4 Hz
0.5 degree/s	5.13	4.29	4.07	4.11	3.89	5.59	4.04	4.24	4.7	4.83
1.0 degree/s	4.79	3.97	4.46	4.67	4.97	5.19	3.9	4.54	5.04	5.07
1.5 degree/s	4.8	3.96	4.49	4.71	5.19	5.14	3.99	4.26	5.11	5.27
2.0 degree/s	4.9	4.13	4.1	4.74	5.1	5.17	3.64	3.93	4.96	5.46
2.5 degree/s	4.8	4.11	4.11	4.73	5.06	4.99	3.83	4.1	4.51	5.4

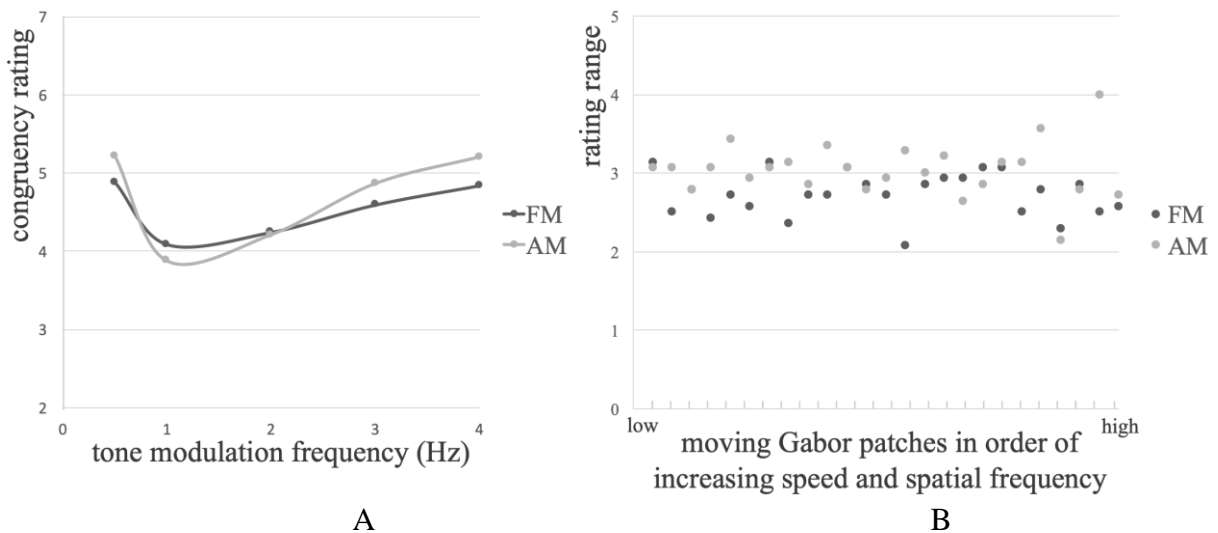


Fig. 3. A) Congruency ratings for different tone modulation frequencies (AM and FM) averaged for all moving Gabor patches. B) Average rating range for moving Gabor patches with AM and FM tones.

Discussion and future research

The current study investigated the relation between various parameters of Gabor patches and modulated tones on perceived audiovisual (in)congruency. Results showed that amplitude-modulated (AM) tones evoked higher perceived congruency than frequency-modulated (FM) tones. This effect was especially strong for combination of AM tones with flickering Gabor patches. One plausible explanation for the AM dominance as found here is that amplitude modulation in the auditory domain corresponds naturally to the contrast with the background or visibility of the Gabor patch in the visual domain – both the AM tone and the visual stimulus seem to appear and disappear with a certain frequency. Results for the moving Gabor patches demonstrated a similar, yet less strong difference in congruency rating between AM and FM. Combinations of Gabor patches with AM tones had a wider rating range than combinations

with FM tones. That is, AM tones showed stronger congruency (higher ratings) and stronger incongruency (lower ratings) with Gabor patches, demonstrating that AM tones had a stronger effect on audiovisual congruency perception overall.

In order to understand this effect better it is necessary to conduct an experiment with parameters that would better allow comparisons between flickering and moving Gabor patches. This might be achieved, for example, by examining moving Gabor patches as groups of single dots that flicker with the same frequency, but in a different phase, creating an effect of moving stripes. By matching that flickering frequency and then match the frequency of the flickering with the AM or FM tones' frequency, these different modes can be compared.

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Changes of visual sensitivity when solving mental tasks

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Abstract

The most important position of psychophysics based on the Signal Detection Theory is the independence of sensory sensitivity from non sensory factors, including higher mental processes. We decided to check experimentally whether there would be any change in the sensitivity index d' , if sensory stimuli discrimination would be combined with a solution of mental tasks. Straight line segments served as sensory stimuli presented (“Yes – No” method). The main series of the experiment combined these stimuli discrimination with the solution of two kinds of mental tasks: figurative and numerical ones. Discriminability increased regarding the background one in the case of solving the both kinds of tasks. Along with the tasks difficulty increasing, the discriminability increased in the case of figurative tasks solving, while decreased in the case of numerical ones. Thus, mental activity acts here as a determinant of change in sensory discriminability.

Introduction

The most important position of psychophysics, based on the Signal Detection Theory (SDT), states the independence of sensory sensitivity from non-sensory factors, including higher mental functions. The influence of the latter on sensory performance is limited to moving the decision-making criterion along the axis of observation. It allows to increase or decrease a proportion of correct and incorrect responses without affecting the sensitivity index d' (Green, Swets, 1974; Macmillan, Creelman, 2005).

We decided to check whether there would be any changes in the sensitivity index d' if sensory stimuli discrimination is combined with a solution of a certain mental task.

Methods

Initially, sensory sensitivity was measured in a series where visual discrimination was the only activity for observers (“Yes – No” method). A similar series was repeated at the end of the experiment. Both of these series were considered as background ones and were respectively designated as the “background-I” and the “background-II”. The main series, however, combined visual stimuli discrimination and a solution of certain mental tasks. Two kinds of these tasks were used – figurative and numerical ones.

The stimuli were two straight line segments presented visually. They were different in length in signal trials and equal in empty ones. In the background series the subjects had the only task to decide whether the lines presented were equal in length or not. In the series

including the mental tasks of figurative type, the participant got a certain geometrical task, where the solution depended on whether the presented segments were equal or not. For example, the task might ask what kind of figure, parallelogram or trapezium, can occur when mentally connecting the ends of the presented segments. In the series including the tasks of numerical type, the subject, guided by a given rule, had to transform one numerical sequence into another. In this case, the task was to repeat the number called by the experimenter in cases when the presented lines were equal, or to call a number of a new sequence if the lines appeared unequal.

Three tasks of figurative type and three tasks of numerical type were used. For each type a difficulty of the tasks increased from the task presented firstly to the third one. All the series, both background and those with mental tasks were repeated three times using the three prior probabilities of the signal trial (Ps): 0.2, 0.5 and 0.8. Each series included 100 trials. The order of the tasks' presentation was randomized for the group as a whole, so it was different for each subject. Wilcoxon test was used to estimate statistical significance of differences between d' values in the "background-I", "background-II" and the series with the mental tasks of increasing difficulty. Four participants took part in the experiment.

Results

It was expected that the introduction of mental tasks could give a dramatic effect on the stability of the criterion but not on the sensory sensitivity. Another option was considered as figurative tasks could lead to the sensitivity improvement, while the numerical ones could decrease it. However, data obtained have shown more complicated picture.

The Table 1 shows the average experimental results for the whole group. Two interesting findings were revealed: the first one showed the difference between the influence of the figurative and the numerical mental tasks on sensory performance; the second one points to the similarity between their effects.

Table 1. The sensitivity index d' in different series of the experiment (total data for 800 trials on each d').

Series \ Ps	d'		
	0,2	0,5	0,8
"Background-I"	0,10	0,20	0,06
Figurative tasks:			
Task 1	0,20*	0,20	0,03
Task 2	0,38**	0,28*	0,26**
Task 3	0,58**	0,46**	0,38**
Numerical tasks:			
Task 1	0,38**	0,28*	0,26**
Task 2	0,31**	0,16	0,20*
Task 3	0,22*	0,08	0,24**
"Background-II"	0,22	0,00	0,14

Note: the asterisk indicates significant differences between the series with mental tasks and the background-I ($p < 0,05$, $p < 0,01$).

The first pattern appears if we trace the change in d' as it depends on the complexity of the task. The data (see Table 1) show that in the case of figurative tasks, the value of d' increases with increasing complexity.

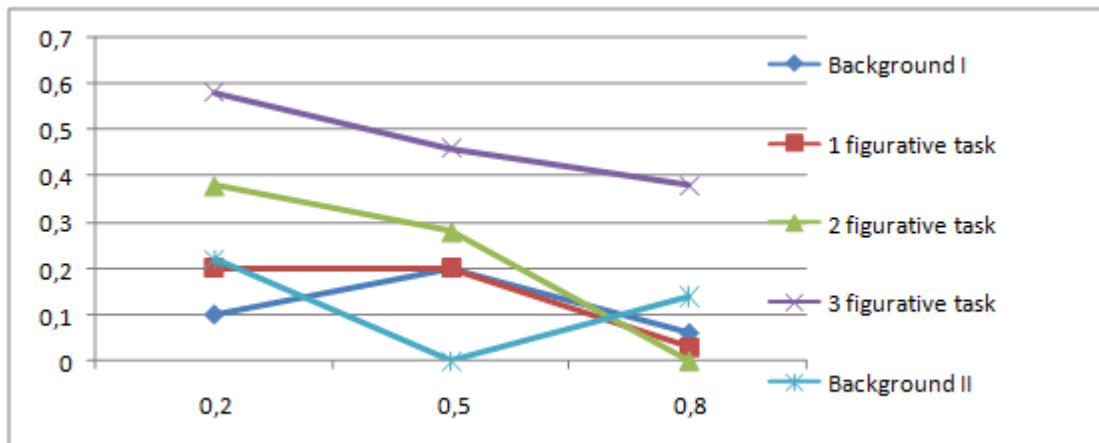


Fig. 1. Values of d' obtained in the series with the figurative tasks.

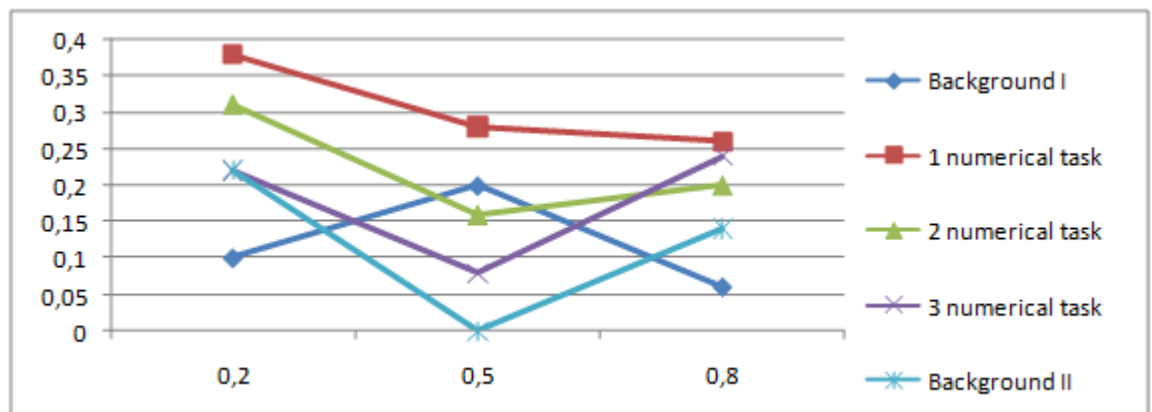


Fig. 2. Values of d' obtained in the series with the numerical tasks.

The first finding appears if we trace the changes of d' -values as they depend on the tasks difficulty. The data obtained (Table 1) show that the value of d' increases with increasing difficulty in the case of the figurative tasks. The opposite trend is observed in the case of the numerical tasks: along with an increase in their difficulty, the value of d' decreases. The first of these trends (concerning the figurative tasks) appears in all cases without exception; the second one (concerning the numerical tasks) appears in all cases with only one exception.

If we compare between d' values obtained in the figurative tasks of varying difficulty but not with those from the “background-I”, then the difference reaches a significant level ($p < 0,01$) for all the three difficulties. In the numerical tasks, this difference reaches such a significant level for the most and the least difficult tasks 1 and 3. The corresponding values for the task 2 take an intermediate position between the results of the tasks 1 and 3. However, the differences

between the values of d' in the tasks 1 and 2, as well as in the tasks 2 and 3, do not reach the level of significance. All these data suggest that the numerical and the figurative tasks have different effects on the parameter of interest – the differential sensitivity.

The second finding, which appears in the data analysis (Table 1), reveals similarity between the figurative and the numerical tasks. Upon the presentation of the both types of the mental tasks, the sensory sensitivity is higher than in the background series. This fact turns out to be unexpected. If the first finding, consisting in a multidirectional effect of the figurative and the numerical tasks on the sensory performance, could have been foreseen to some degree, the second one was difficult to predict. More precisely, it could be predicted for the figurative tasks, but it could hardly have been foreseen for the numerical ones. Rather, one could expect that for the latter tasks all the values would be lower than the background ones.

Individual data are given in the Table 2. Those two findings that were so clearly visible when analyzing the averaged results (Table 1) do not manifest in all of the individual results. So, if we take the results of the figurative tasks solving, the first finding (the d' value increases as the task becomes more difficult) is disturbed in 4 cases out of 36. Here the case is considered as a violation when the value of d' in the 3rd task was less than that in the 1st task. If we also add cases where the d' value in the 2nd task turned out to be either lower than in the 1st one, or higher than in the 3rd one, then the number of such violations will increase to 9. If we consider the second finding (the value of d' turns out to be higher in the 1st task than the background one), the number of exceptions is also quite large: in 4 cases d' for the 1st task was lower than the background value, and in the two cases it was equal to it.

Table 2 Individual values of sensitivity index d' in different experimental series.

Subjects	P_s	Background-I	Figurative Tasks			Numerical tasks			Background-II
			1	2	3	1	2	3	
S 1	0,2	0,00	0,30	0,90	0,72	0,28	0,36	0,13	0,54
	0,5	0,05	0,00	0,10	0,58	0,43	0,20	0,39	0,05
	0,8	0,21	-0,28	0,47	0,64	1,44	0,55	0,52	0,48
S 2	0,2	0,17	0,33	0,02	0,50	0,22	0,18	0,52	0,02
	0,5	0,62	0,31	0,58	0,62	0,18	0,41	0,08	0,20
	0,8	-0,16	0,40	0,37	0,48	-0,34	0,19	-0,30	-0,32
S 3	0,2	0,08	0,00	0,52	-0,35	0,44	0,16	-0,08	0,20
	0,5	0,12	0,40	0,73	0,00	0,02	0,05	0,08	-0,32
	0,8	-0,08	0,31	—	-0,02	0,33	-0,31	0,50	-0,20
S 4	0,2	0,36	0,12	0,31	0,66	0,58	0,39	0,06	0,58
	0,5	0,00	0,00	1,08	-0,05	-0,13	-0,03	-0,26	-0,20
	0,8	0,24	0,28	0,43	0,15	-0,04	0,56	0,13	0,60
				0,44					

Discussion

How can the two established findings be interpreted? The first trend is easy to explain: different types of connection between the sensory and the mental task are established in the figurative and the numerical tasks. In the first case, we can talk about the included tasks – the sensory task is included into the mental one in a rather organic way; the second case deals with

combined tasks – independent sensory and mental tasks are connected only in the response block, i.e. externally.

It is more difficult to explain the second finding. Along with the influence of the task type (included or combined), the total activation of the cognitive subsystem, resulting from the introduction of a mental task, is essential. However, the data presented in the Table 1 allow us to express the following considerations. In the figurative tasks, d' values for the first one, the easiest one, do not achieve a significant difference regarding the background ones. Moreover, in one case the value of d' increased in comparison with the background, in the other case it remained the same, and in the third one it decreased. The general trend of d' increase, being typical for the figurative tasks, does not appear at all. It leads us to the conclusion that there is some minimal level of difficulty, below which the mental task does not affect sensory discrimination. Thus, it is possible to design the mental tasks which do not significantly affect the sensitivity indices. It leads to the two important consequences.

I. It is obvious that simple mental tasks, presented in the experiments according to standard psychophysical procedures, are just below this minimum level of difficulty. These tasks are reduced to determining where the decision-making criterion should be shifted when instructions change (a priori probability, payment matrix). Hence, the fact that their influence does not have a noticeable effect on the sensitivity indices is well-known in psychophysics and leads to the idea of independent functioning of the sensory and the decision-making processes.

II. It is possible to predict a variety of results, including the mutually exclusive ones, depending on the difficulty of experimental task. Apparently, this is the reason for the diversity of data on the influence of mental processes on the sensory performance, presented in general psychology.

If the minimum level of difficulty, below which mental tasks are neutral to sensory processes, is established, it is possible to assume that there exists a certain maximum level. With regard to figurative tasks, this should mean that with further increase of tasks difficulty, a level can be achieved, where the introduction of a mental task will no longer improve, but impair the discrimination ability. This level was not reached in our experiments, but it does not mean that it does not exist at all.

Regarding the numerical tasks, the first finding reflects the decrease in d' as the task grows more difficult. The individual data show that d' values for the 3rd task are higher than those for the 1st one in four cases out of 36. In the seven more cases, d' value for the 2nd task turned out to be either higher than for the 1st task, or lower than for the 3rd task. The second finding for the numerical tasks was the same as for the figurative ones. There were three cases when the trend was broken in the individual data. Thus, although individual results in most cases follow the general trends established in averaged data, the number of exceptions remains quite noticeable.

How should these exceptions be treated? This experiment was designed as to make the averaged data as representative as possible, so the possibility of obtaining homogeneous individual results was neglected to a certain extent. For instance, randomization of experiments for the group as a whole was used. The individual order of tasks presentation was given to each subject. So, for the participant 1 this order was as follows (F means a figurative task, N stands for a numeric one, Roman numeral is the number of the task, the number in brackets is Ps):

FIII (0.5) — NI (0.2) — FII (0.8), etc. For the participant 2, this order was as follows: NIII (0.8) — FI (0.5) — NII (0.2), etc.

This structure of the experiment makes it possible to level such a factor as the sequence of the series for group averaging. However, it turns out to be not leveled in individual results. For each subject, the effect of the preceding tasks on the subsequent ones was different due to the different order of their presentation. Similarly, the possibility of the formation of similar settings in the subjects is neutralized; the elaboration of efficient working methods is hampered, etc. It leads to the fact that the individual data do not coincide with the general group data.

It seems that the considered factor makes it possible to explain the discrepancy between the group and the individual data, noted in some cases. It allows to suggest that the existence of such discrepancies does not call into question the legitimacy of the above-stated findings, revealed on averaging the results.

The solution of numerical tasks along with simultaneous discrimination of lines turned out to be difficult for the subjects. Therefore, a transformation of the task was possible if not to a comfortable level, then to a certain level acceptable for the subject. For instance, the subject 2 deviated from the instruction and instead of naming different numbers for cases of equality and inequality of lines, called new numbers at each presentation. The subject 3 facilitated his work by repeating the numbers after the experimenter, i.e. he did not observe the condition according to which, in the case of unequal lines, the next number of the sequence should be called. The subject 1 focused on the lines discrimination, and solved the numerical task formally which led to numerous errors. Only the subject 4 solved the numerical tasks without introducing visible simplifications into the work.

If we consider the two above-mentioned factors associated with the solution of mental tasks (the type of tasks – included or combined – and the total activation of cognitive system), there is a good reason to believe that the negative effect of the first one was substantially neutralized by the simplifications, which the subjects introduced in the course of the mental tasks solving, while the positive effect of the second one was fully preserved. Apparently, it explains the fact that the values of d' turned out to be higher than the expected ones in the series with numerical problems.

There is a confirmation of the fact that the discrepancy between the expected and the obtained result is associated with a decrease in the difficulty of the mental task solved. In our experiments, the subjects clearly perceived the series, where $P_s = 0.5$, as much more difficult than those where $P_s = 0.2$ or 0.8 . So, in this the most difficult series three of four our subjects showed lower values of d' in solving the numerical tasks than the d' values obtained in the “background-I” series. The exception was the subject 1, who had a formal approach to the solution of the numerical tasks.

Conclusion

Sensory discriminability increases compared with the background one in the case of solving both the figurative and the numerical mental tasks.

However, there is a difference in the effect of the two kinds of mental tasks on discriminability. When using the figurative tasks, the sensitivity increases with the tasks difficulty, in contrast to the case of the numerical ones, when it decreases. Apparently, this is

due to the fact that the process of stimuli discrimination acts as an included activity when the observer solves a figurative task, and as a combined activity when he solves a numerical task.

We may suppose that when introducing a mental task, the process of sensory discrimination is accompanied by an intense mental activity which may lead to reorganization of the sensory performance. The sensory process appears to be closely connected with high-level cognitive processes that are activated by the mental tasks performance. Mental activity acts here as a determinant of change in the sensory sensitivity.

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Acoustic analysis of word-initial consonant clusters: A perceptual basis of English syllables

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Abstract

Consonant clusters at the initial positions of English syllables give us intuition into how English syllables are formed (Harris, 1994), and we are interested in dealing with such consonant clusters in a psychophysical paradigm to examine how we perceive syllables. We created a new English speech database which is suitable for this purpose; three native speakers of Irish English (two females and one male) spoke 200 English sentences. We then analyzed the labeled phonemes acoustically. Power fluctuations in critical-band-like filters were measured and subjected to factor analysis. A new method of factor analysis was employed; this method was developed in order to summarize many acoustic power fluctuations into a few factors that can be used to resynthesize the original fluctuations (Kishida, 2016). Only word-initial consonant clusters were taken up in the present analysis. Three factors were extracted, and thus three factor scores were given to each uttered phoneme as those at the central temporal point. Two of the factors were closely related to *sonority*, a concept used in linguistics to classify phonemes. One of the factors, the *mid-low-frequency* factor, had factor loadings around 1100 Hz; frequency components in this range seemed to increase sonority. The other factor, the *high-frequency* factor, had factor loadings around 3300 Hz and above; frequency components in this range seemed to suppress sonority. Two well-established categories of initial consonant clusters appeared: ‘obstruent + sonorant consonant’ (/pr/, /bl/, /sm/, /sr/) and ‘obstruent + obstruent’ (/sp/, /st/, /sk/). From the initial to the second consonant of words, the factor scores of the *mid-low-frequency* factor tended to go up, and the factor scores of the *high-frequency* factor tended to go down. In English phonology, sonority is supposed to go up in most initial consonant clusters, so there must be a positive correlation between sonority and *mid-low-frequency* factor. The initial-consonant clusters /sp/, /st/, and /sk/, in which *sonority* goes down, have been considered exceptional in phonology, but no such exceptional tendency was observed in the present acoustic analysis.

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NeuroDAT: Advanced neuroimaging data analytics tool

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Abstract

Neuroimaging is the discipline concerned with the in vivo representation of anatomy and function of the central nervous system (CNS). Common techniques include electroencephalography (EEG), magnetoencephalography (MEG), and functional magnetic resonance imaging (fMRI). While there are several software packages freely available with which to analyse neuroimaging data, such as Brainstorm, SPM8, FieldTrip, and EEGLAB, and commercial software such as Brainvoyager, there is substantial room for improvements in the application software quality, both for research use and clinical diagnosis. NeuroDAT aims to fill the gaps.

A key objective is to provide a user-friendly interface for intelligent analyses and visualisation of data and results, appropriate tests for statistical significance, and a summary report. The Beta release version will include online analysis for Brain-Computer-Interface (BCI) experiments, access to commonly used paradigms for psychology-based experiments, clinical applications, and case studies. The NIFBM facility is a forerunner in neurotechnology and neuroscience research, renowned for its award-winning research and commercialisation of neurotechnology through Ulster spinout NeuroCONCISE Ltd. A primary research focus is on accurately classifying neural markers for common brain disorders, such as epilepsy, PTSD and ASD. The eventual aim is to include applications in NeuroDAT to assist effective diagnoses of such disorders – and to develop non-pharmaceutical interventions involving wearable, personalised neurotechnology.

Effects of number of auditory stimuli on time perception

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Abstract

Time is not an independent concept and people take reference from other concepts when perceiving time. Regarding spatial and quantity related information is crucial for and widely utilized during time perception, we hypothesized that number of auditory stimuli would affect time perception. 52 undergraduate students participated in a task where they imagined that they were on a daily journey while listening to an audio with eyes closed and replicated the duration of the journey. There were five durations (6s, 11.22s, 16s, 21s and 26s) and few and more stimuli conditions for each duration. There was a main effect of duration and stimuli condition; more stimuli condition was perceived to be longer than few stimuli condition for 6s and 11.22s but not in other durations. Although results point to that time perception can be affected by external cues, future research should be done with different durations to explore the relationship further.

Keywords: time perception, number of stimuli, a theory of magnitude, duration replication

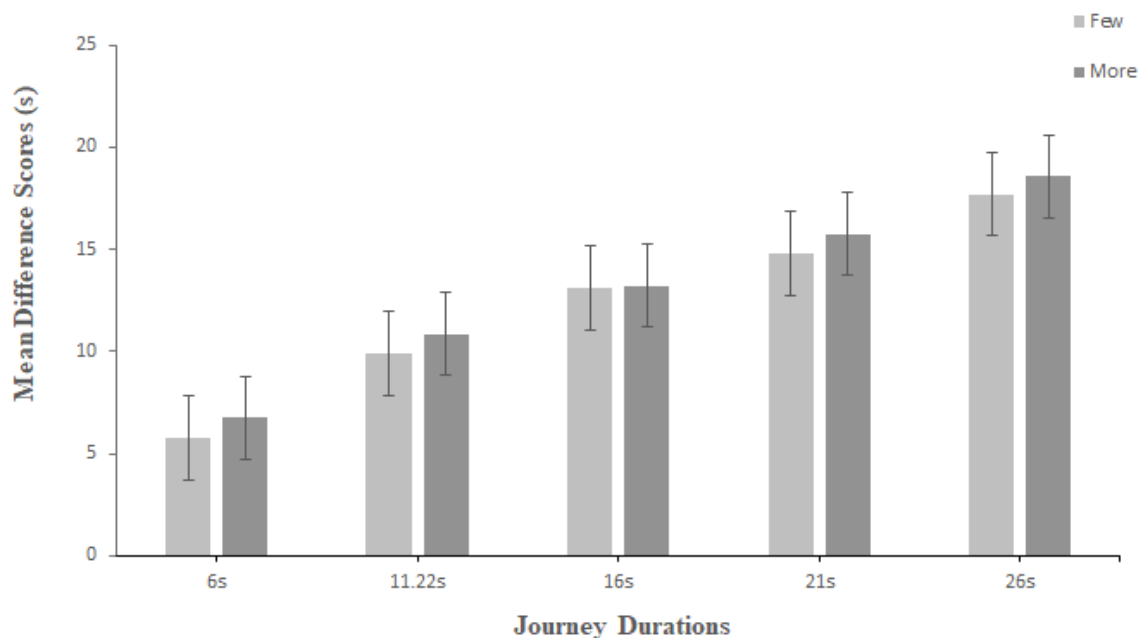


Fig. 1. Mean difference values (s) representing duration reproduction values of each journey duration conditions subtracted from mean duration reproduction judgments of participants.

One psychological second does not necessarily last 1000 ms

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Abstract

In this study, we wanted to estimate the duration of the representation of one second. Two different methods were used, one based on the adjustments of the duration of a sound, and one based on the production of 10 seconds with counts from 1 to 11. Instead of an expected value close to 1000 ms, the estimations varied considerably. Mean values in both methods were significantly different, and there was a lot of variability within these methods. The results indicate that assuming that the representation of one second is necessarily close to 1000 ms could be misleading: this representation might well be neither accurate, nor reliable.

In order to keep track of time, people often choose to count, or segment intervals (Killeen, 1992; Killeen & Weiss, 1987). Because most of us would assume knowing what one second is, we may well adopt spontaneously the explicit counting of seconds for estimating a relatively long time interval. Indeed, the Weber fraction remains relatively stable around one second (Grondin, 2012; Grondin, Laflamme, & Mioni, 2015). However, although it is reasonable to assume that human adults have an accurate and reliable representation of what a second is, do we really know how long one second lasts?

There are reasons to believe that our representation of a second might not be that accurate and reliable. For instance, if we have to estimate an interval that is not that long, we may prefer, for keeping track of time, to adopt a “one steam-boat, two steam-boats...” or a “one thou-sand, two thou-sands...” strategy, which is indicating that we intuitively feel the need for some support for estimating one second. Also, even when we look at the second hand of a watch or of a clock, each second may not necessarily have the same subjective value; if someone makes voluntary saccadic eye movements while watching a ticking clock, the observer will have the impression that it takes longer time for the second hand to move to its next position (Yarrow, Haggard, Heal, Brown, & Rothwell, 2001). This phenomenon, called chronostasis, is also observed in the auditory (Hodinott-Hill, Thilo, Cowey, & Walsh, 2002) and tactile (Yarrow & Rothwell, 2003) sensory modalities.

There is not much direct evidence in the literature of the value of one second. One way of obtaining such direct evidence would be to use a method called interval production. Indeed, the production of an interval defined with chronometric units is not as popular as some other classical methods (comparison/bisection/discrimination, reproduction, estimation) used for studying time perception. When this method is used, it is often for producing intervals longer than one second (Glicksohn, & Hadad, 2012) and in the context of a comparison of the effect of cognitive variables (Block, Hancock, & Zakay, 2010).

Some other reports, designed to compare clinical and control groups for estimating time, are occasions for having an estimate of a second with an interval production method. Although the focus in these papers is to quantify the magnitude of a temporal distortion, if any,

between these groups, it remains possible to look at the value, per se, of the 1-second productions. For instance, in a task involving the production of a series of 45 successive 1-sec intervals (46 taps), anxious ($M = 997$ ms) and depressed ($M = 1027$ ms) patients remained very close to the 1 second target while control participants ($M = 819$ ms) were far from one second (Mioni, Stablum, Prunetti, & Grondin, 2016). This 819-ms value is somewhat consistent with the data reported for the control group ($M = 863$ ms) in the study by Perbal, Couillet, Azouvi, and Pouthas (2003). In the same study of Mioni et al. (2016), the normalized absolute error (absolute value of produced interval minus target interval, divided by the target interval) for the production of .5-, 1-, and 1.5-sec single intervals was calculated. For the 1-second condition, the normalized absolute error was lower for the control group than for the clinical groups, but remained quite high at circa .40; moreover, the mean productions of the control group were about 30% lower than the target. In brief, there are reasons to believe the representation of one second could be far from accurate.

The aim of the present investigation was to provide direct estimations of the value of the representation of one second. We decided to use more than one method for estimating this value, knowing that the way of implementing an interval as brief as one second, in a reproduction task for instance (Mioni, Stablum, McClintock, & Grondin, 2014), might have an impact on the reproduced interval. If there is a stable representation of the value of one second in long-term memory, the estimated values should remain close to each other.

Method

Participants

The target sample size of the present experiment was derived from a preliminary power analysis. The objective of the latter was to determine the sample size required to achieve 80% statistical power to find effect sizes of roughly the same magnitude as what was reported in the literature cited above: Mioni et al. (2016), Perbal et al. (2005) and Yarrow et al. (2001). First, we examined the result sections of these articles in order to extract the mean and the standard deviation of all temporal estimates where the target duration was exactly 1 second. Only the data from non-clinical subjects were considered (i.e. only the data from the control group of Mioni et al. was retained). We then computed the Cohen's d s corresponding to the difference between each relevant mean and the target duration of 1 second. We combined these into a single value using the methodology outlined in Morris and DeShon (2002). This yielded a weighted average d of -0.54. Using this value as the minimally interesting effect size, the power analysis showed that the minimum sample size was 23. Twenty-three Laval University students were thus recruited for the present experiment.

Of the 23 recruited participants, two did not understand the instructions of either task properly and adjusted/produced the wrong interval. Another did not complete the adjustment task, but did the production task. Thus, the effective sample size was 20 for the first task (adjustment) and 21 (15 female participants, mean age = 22.61) for the second task (production), but when comparing the final mean value in both tasks, we conducted the analysis on the results of the 20 participants who completed both tasks.

Apparatus

Each participant was seated in a chair, about 60 cm from the sound source, in a dimly lit room where the illumination condition was kept constant for all participants. The presentation of the auditory stimuli and the recording of participants' responses were computer recorded using E-prime 2.0 software.

For the adjustment task, the intervals presented were marked with a .5-kHz sound presented free field at around 50 dB SPL. The participants adjusted the length of the sound by pressing "1" or "3" for increasing or decreasing, respectively, its duration. For the production task, participants had to press the spacebar of the keyboard.

Procedure

We adopted two methods for measuring the internal duration of a representation of one second. Although, strictly speaking, we estimate neither an absolute nor a difference threshold, one method retained for the experiment is adapted from a mixture of Fechner's methods of limits and adjustment. Compared to other methods, the adjustment method is rarely used in the field of time perception (but see Hasuo, Nakajima, & Ueda, 2011; Kuroda & Hasuo, 2014). In the present version of the adjustment method, after the presentation of a sound, a participant had to adjust its length (from the sound's onset to sound's offset), in steps of 20 ms, until reaching the target duration, one second. The initial value for a given series of adjustments was 780, 800, 820, 840 or 860 ms (expected ascending series) and 1140, 1160, 1180, 1200 or 1220 ms (expected descending series). Ascending and descending series alternate, with each starting point presented in a random order and only once. Therefore, ten final adjustment values, estimated to be equivalent to one second, were collected.

The second method used was interval production (Grondin, 2008). However, instead of asking for the production of one second, the same participants were asked to count from one to 11, tapping on the space bar at "one" and at "11", at a pace of one per second. Therefore, the produced intervals were expected to last close to 10 seconds, the reported production being divided by 10 for estimating the duration of one second. The adoption of this strategy was for reducing the contribution of the motor component in our estimation of one second, assuming that two taps over the expected 10-sec productions would contribute less to the overall production than two taps over a 1-sec production.

Results

With the limits/adjustment method, the mean final values in the expected ascending series were all much lower than one second. Indeed, the highest mean adjustment value was 856 ms, obtained in the series beginning at 860 ms (the lowest mean value was 816 ms, at the 800-ms starting point). In the expected descending series, the mean final values were all higher than one second. Indeed, the lowest mean adjustment value was 1029 ms, in the series beginning at 1160 ms (the highest mean value was 1170 ms, at the 1200-ms starting point). Overall, as indicated in Figure 1, there is a clear linear relationship between the starting point in the series and the final value estimated as equivalent to one second. In order to assess whether this linear

trend was statistically significant, a test on the weighted polynomial contrasts was conducted (see Baguley, 2012, p. 600-602). The contrast weights were generated so as to reflect the relative spacing between the different starting durations. The test on the linear contrast showed that it was statistically significant, $F(1, 171) = 494.01, p < .001, r^2_{al} = .98, \eta^2_{p(linear)} = .742$ (90% CI: [.690, .780]). The higher order polynomial contrasts were assessed through a single combined F test, which was not statistically significant, $F(8, 171) = 1.38, p = .791, r^2_{al} = .02, \eta^2_{p(non\ linear)}$.

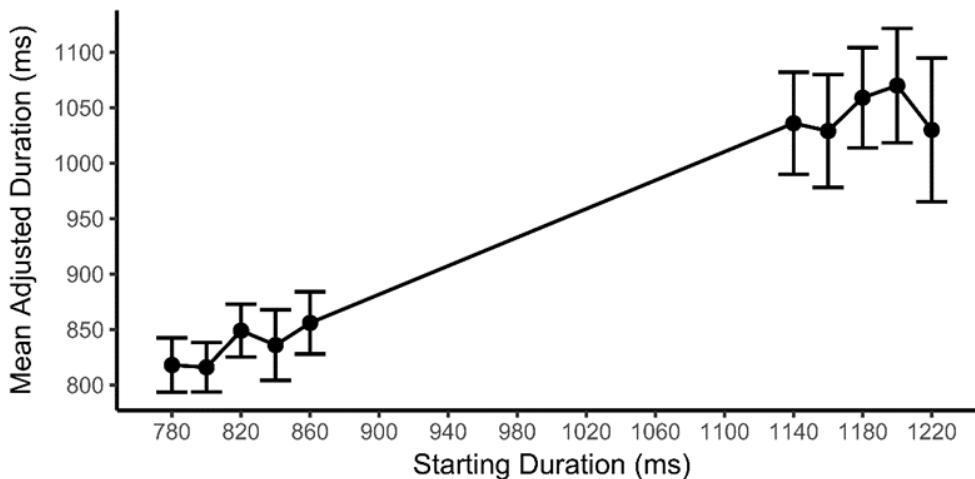


Fig. 1. Mean final adjusted durations as a function of the starting duration in the limits/adjustment task. Error bars correspond to 95% confidence intervals around the means.

The mean subjective values were 835 ms and 1045 ms, in the expected ascending and descending series, respectively. In other words, participants were more inclined to reduce than to increase the duration of the sound marking the targeted duration (one second). Note that participants took in average 5.03 adjustments ($SD = 2.37$) before reaching their final value.

With the production method, the mean interval between the first tap (count of 1) and the second tap (count of 11) was 11290 ms ($SD = 2900$ ms). In other words, the mean duration of the targeted 1-sec step was actually longer than a second ($M = 1129$ ms, $SD = 290$ ms). This estimate of the internal representation of a second was significantly larger than that measured through the adjustment/limits method ($M = 939.9$ ms, $SD = 61.41$ ms), $t(19) = 3.39, p = .003, d_C = -1.153$ (95% CI: [-1.815, -0.491]).

Discussion

The results of the experiment clearly show that the representation of one second is not as stable as one might expect, at least not when using the two methods retained in the present study for testing it, adjustment/limits and production. The results indicate that the estimated values are not accurate, with the mean value in both methods not being equal to one second. As well, the estimate values are not reliable, as indicated by the distribution of values obtained with the limits/adjustment method, and the inter-individual variability observed with the production method.

Obviously, the starting point in the limits/adjustment method has an impact on the estimated value of one second. While there was some variability within the ascending and within the descending series, these two types of starting points lead to a significant difference in the evaluation of the representation of one second. A relatively precise long-term representation of one second should resist the variability of the testing method. This finding therefore can be interpreted as a demonstration that there is no stable representation of one second. Note however that, with this limits/adjustment method, the overall mean estimated value is 940 ms. The fact that intervals were marked by continuous auditory signals may have contributed to the observed overall under-estimation of one second. It is known that filled intervals are perceived as longer than empty ones (Block et al., 2010; Hasuo, Nakajima, Tomimatsu, Grondin, & Ueda, 2014). Assuming that this representation would be built on the basis of empty intervals (ticking of the second hand of a clock/watch; beeps of the end of microwaves' cooking period; visual/auditory stimuli signaling a pedestrian the time remaining for crossing the street), the 940-ms value would be a consequence of using a filled auditory signal for marking intervals to be adjusted. That said, this would not explain the ascending vs. descending difference.

Somewhat along the same filled vs. empty time difference, the overproduction may also be interpreted in those terms. Strictly speaking, in the production task (counting every second), there is no sensory signals filling the intervals. What is more, the production task was performed after the limits/adjustment task in the present experiment. The fact that filled intervals (continuous sounds) were used in the first part of the experiment may have biased the representation of one second. In order to reach a representation that would match a filled second, an empty second would need to be longer. This interpretation is plausible considering that the productions of one second, or of a series of 1-second successive empty intervals, were reported in some experiments to be much lower than one second (Mioni et al., 2016; Perbal et al., 2003), which is clearly not the case in the present experiment. It cannot be discarded though that the overproductions reported here depend on the particularity of the task used where only two motor actions (two taps) were need for marking not a 1-, but a 10-sec intervals. Longer reproductions in the present experiment may be attributed by the fact that each second was not filled with a motor action; if this contrast between experiments (motor interpretation) is incorrect, it may be that the count of seconds is cognitively demanding and detract from the passage of one second.

In conclusion, although the fluctuations of the results can be interpreted in terms of methodological effects, it seems reasonable to question, based on the variability of the present results and the contrast with previous results, the idea that a human adult knows quite precisely what one second is. This knowledge seems approximate and volatile, as the 1-second estimates fluctuate considerably with methods.

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Influence of typicality on the time course of responses in adults with ASD: Event history analysis of ultra-rapid object categorization

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Abstract

People can categorize items with ultra-rapid presentation times (PT; 20 ms; Thrope et al., 1996). In individuals with autism spectrum disorder (ASD) these categorization processes may be impaired (Plaisted, 2000). This difficulty seems to be caused by abnormal categorization of atypical rather than typical items (Gastgeb et al., 2006). To combine these lines of research, we compared behavioural data of two different categories (food/animals) with short (23 ms) and long (83 ms) PT. With the applied event history analysis, we studied the time course of typicality-PT-category interactions in ASDs (N = 14) compared to matched controls (N = 17). The selected discrete-time hazard model shows that only fast responses are influenced by group and category. The conditional accuracy model revealed that the accuracy of slower responses is influenced by the interaction of group and typicality. These results support the notion of a possible malfunctioning feedback loop (Carmo et al., 2016).

Development of visual thresholds among younger schoolchildren

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Abstract

The ability to assessment of visual stimuli is formed at primary school age. The values of visual thresholds can be used as indicators of level of maturation of sensory systems. Data of age dynamics of visual thresholds is necessary for successful adaptation of younger schoolchildren to solution of new cognitive tasks.

The purpose of research is to trace age dynamics of visual thresholds of perception of two-dimensional figure by 213 children 6 -10 years old. The method of constant stimuli in the conditions of time - deficiency and without it was used.

Three major factors effect on a visual threshold: age, sex and time of presentation. The general patterns are revealed: visual threshold decreases with age; the value of the visual threshold is lower in the conditions of time - limitation; boys show more precisely estimates of stimuli size. Besides, factors' interactions can also have significant effect on this picture.



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