TIME PERCEPTION

Time and Number
Hayashia, M. J., Aino Valli, A., & Carlson, S. (2013). Numerical quantity affects time estimation in the suprasecond range. Neuroscience Letters, 543, 7–11.

It is known that time intervals and numerical magnitude interact. This is caused by the fact that time, space and quantity share neural representation in the intraparietal cortex (IPC). In the past, most demonstrations of the specific effect of numbers on time perception were obtained with a categorical duration discrimination task, which is prone to decision bias. Moreover, the demonstrations were limited to very brief intervals (<1 s). In their experiment, Hayashia and colleagues (2013) asked 22 males and 22 females to reproduce intervals lasting 1.5 to 2.7 s. The interval to be reproduced during a given trial was presented visually, and the gray circle marking time contained either 1, 4, 7 or 10 dots. In other words, the influence of numerosity was not tested with a presentation of Arabic numbers as often used when investigating number-time interactions, but with a non-symbolic dot array. The results showed that for suprasecond intervals, there is a significant influence of numbers on interval reproduction. Interestingly, there are sex differences regarding the strength of the association between time and numerosity: the influence of numbers applied only in females. This finding is consistent with some demonstrations in neuroscience that, in the IPC, the regional gray-matter volume is larger in females than in males. In other words, the present finding is probably due to the degree of connectivity between neural populations that represent time and numerosity in the IPC.—S.G.

BEHAVIORAL SYNCHRONY

Tappy together
Wu D.W., Chapman C.S., Walker E., Bischof W.F., & Kingstone A. (2013). Isolating the perceptual from the social: Tapping in shared space results in improved synchrony. JEP:HPP, 39(5), 1218.

When people engage in rhythmic behaviors such as drumming, walking, and rocking in chairs, they spontaneously synchronize their behaviors, entraining to one another’s rhythms. This interpersonal synchrony appears to facilitate social connectedness, leading to reports of increased social affiliation for the increasingly coordinated partners. It seems we like to be in sync. Two mechanisms have been proposed to underlie this type of behavioral coordination. One relies on the low-level perceptual processing of social stimuli and the other on higher-level social motivational goals. Wu et al. (2013) evaluated these alternatives by examining the influence of a “higher-level” social variable, spatial proximity, on spontaneous synchronization in a tapping task.

Pairs of participants were asked to synchronize their tapping behaviors to an auditory beat, either a drum or guitar, and then to continue the beat without the auditory stimuli. Dyads were either seated in the same or different room, but were not able to see one another and were not told to synchronize their behaviors. Participants in the same room were aware of the other participant in the room and could hear their tapping behaviors, but were seated facing in different directions. Half of the participants in different rooms could hear the other participant’s taps over a speaker and half could not. All participants saw flashing squares representing their own and the other participant’s tapping behavior so that across conditions, perceptual stimulation was held constant while spatial proximity varied. The results showed that spatial proximity significantly influenced behavioral adaptation within pairs. Dyads who were tapping in the same room showed significantly greater synchronization than dyads tapping in different rooms, regardless of whether participants could hear each other’s taps. The impact of spatial proximity indicates that social environment or context may play a large role in the spontaneous coordination of behaviors. Behavioral coupling is enhanced in circumstances where social interactions are possible.—L.C.N.

CAMOUFLAGE

Learning that the leopard has spots
Troscianko, J., Lown, A. E., Hughes, A. E., & Stevens, M. (2013). Defeating crypsis: Detection and learning of camouflage strategies. PLoS ONE, 8(9), e73733. doi:10.1371/journal.pone.0073733.g005
A great deal of research has gone into the study of camouflage. Camouflage is a widely used strategy in the zoological kingdom, used by both predators and prey, and across the phyla from moths to leopards. It is also important for human hunting and warfare. Several different camouflage strategies have been identified, including background matching, in which the camouflaged object’s color and texture is similar to its surroundings (think of a gerbil in the desert); disruptive camouflage, in which the object is marked with a pattern of high contrast edges which mask the actual contours; and distractive camouflage, in which a high contrast isolated feature, away from the body contour, helps prevent detection. Most of the research on camouflage has focused on the purely perceptual characteristics of camouflage: if an observer sees this pattern on this background, how difficult is it to find? But in many situations, an observer might see a particular camouflage pattern on multiple occasions. Perhaps some patterns are easier to learn than others?

This is the question that Troscianko, Lown, Hughes, and Stevens (2013) set out to answer. They created camouflage targets by taking photographs of tree bark and inserting triangular regions (like abstract moths) whose texture was creating by mathematically manipulating the underlying bark texture. They varied the type of camouflage (background matching, disruptive, and distractive), and the contrast of the patterns. Critically, they also varied the mode of presentation, including how many targets were presented together and how many different types of camouflage each (human) observer saw. In general, disruptive camouflage was the best (i.e., produced the lowest capture rates). In experiments where observers saw only one type of camouflage, the learning rates (increase in capture rate across trials) were similar for all of the patterns. When different types of camouflage were presented to the same observer, however, things got interesting. For example, within disruptive camouflage, high contrast is usually better. But it turns out that when the same observer sees low and high contrast patterns, the high contrast pattern is easier to learn, suggesting that with experience, the low contrast pattern might actually prove harder to see. Furthermore, when multiple types of camouflage pattern were presented on the same trial, differences in learning between pattern types were exacerbated, suggesting that perhaps observers are selectively attending to some camouflage types and not others.

These experiments indicate that the evolution of camouflage patterns is not as simple as settling on the texture that is hardest to see at first glance. In environments where your predators are long-lived and may have the opportunity to learn your texture, it may be optimal to develop a pattern which is easier to see initially, but harder to learn.—T.H.

### FACE PERCEPTION

**A Neuron’s View of a Face**

Boremanse A., Norcia A.M., & Rossion, B. (2013) An objective signature for visual binding of face parts in the human brain. *Journal of Vision, 13*(11), doi:10.1167/13.11.6

When we gaze at a human face, we have the sense that qualities we extract from the face depend in subtle and complicated ways on the configuration of the parts of the face. This experience suggests that face processing is “holistic,” that our brain extracts statistics from the face that depend nonlinearly on the global configuration of face components. Perhaps, however, our sense of the richness of face processing is illusory; the alternative (non-holistic) possibility is that the face is analyzed into its component parts, and the brain extracts statistics to characterize these parts separately; then all higher order processing of a face is limited to adding these part-specific statistics together in various ways.

Boremanse, Norcia and Rossion (2013) have performed a simple but revealing experiment that bears on this issue. They used a very clever technique pioneered by Regan & Regan (1988) in which an ssVEP (steady state visual evoked potential) is recorded simultaneously from a large number of electrodes attached to the scalp of an experimental participant while the participant views a stimulus comprising of two distinct, highly salient spatial components—call them A and B—flickering at different temporal frequencies \(f_A\) and \(f_B\). The activity of the neurons in the brain sensitive only to component A will be modulated with temporal frequency \(f_A\), and the activity of neurons sensitive to B will be modulated with temporal frequency \(f_B\). Therefore, when we take the Fourier transform of the time-varying ssVEP, we expect to find (at least at some of the electrodes) large spikes at each of the frequencies \(f_A\) and \(f_B\).

Some neurons may be driven by both of the components A and B. There are, however, boring ways and non-boring ways for a neuron to be driven by both components A and B. A boring way for a neuron N to be driven is for it to merely add together the responses of A- and B-driven neurons. Merely adding two signals together cannot register the existence of some new feature distinct from A and B. To discover something novel that depends on the simultaneous presence in the stimulus field of both A and B, the neuron N must combine A- and B-driven signals nonlinearly (i.e., in some other way than just adding them): e.g., by adding the signals together and then taking the result to some power. And now here’s the insight exploited by Regan & Regan: if a neuron combines A- and B-driven signals nonlinearly, then its response will contain frequencies other than merely \(f_A\) and \(f_B\). In particular, the Fourier transform of the response of this neuron is likely to contain spikes at frequencies \(f_A + f_B\), \(2f_A - f_B\), \(2f_A + f_B\) and more generally at frequencies \(k f_A + h f_B\) for integers h and k. Which spikes are present and how big they are will depend on the
specific form of the nonlinear combination rule the neuron uses. Thus, the presence of such spikes in the Fourier transform of the ssVEP indicates the existence in the brain of neurons that are in some sense “on the look-out” for the joint occurrence of A and B. For these neurons, a stimulus that contains both A and B is special; it is more than just the sum of its parts.

Boremanse, Norcia and Rossion (2013) used this trick to investigate whether face processing is holistic vs parts-based. They let stimulus component A be the left half of a face and B be the right half. They discovered very large spikes in the ssVEP Fourier transform not only as expected at $f_A$ and $f_B$ but also at frequency $f_A - f_B$ indicating the existence of neurons for which the stimulus comprising both half-faces is more than the sum of its parts. This spike was absent if the two face-halves were separated slightly in space or vertically misaligned. Inverting the stimulus also substantially reduced the strength of this special spike.—C.C.

Additional References
Regan M. P. & Regan D. A. (1988) Frequency-domain technique for characterizing nonlinearities in biological-systems. *Journal of Theoretical Biology*, 133, 293–317.

Animal Perception

Elephants get the point
Smet, A.F. & Byrne, R.W. (2013). African elephants can use human pointing cues to find hidden food. *Current Biology*. doi:10.1016/j.cub.2013.08.037

We are adept at gathering information from the gestures of other humans. If a police officer in the middle of the street points an arm to direct our car to the left, to the left we will go. Your dog or your cow might go left if you point left, but they are domesticated animals and the history of domestication might have bred in them a sensitivity to such human signals over time. Smet and Byrne (2013) wondered whether an elephant would get the same message if a human were pointing. Elephants are smart, social animals. They work with humans but they are not domesticated. Working elephants are captured in the wild, not bred for the job. Smet and Byrne studied captive elephants at a safari park. Presumably, it was simply not practical to go out into the brush to see if the truly wild elephants were interested in two-alternative forced-choice psychophysics. The elephants were trained to work with humans but, apparently, they had not been explicitly trained to respond to gestures. They responded to verbal instructions as they ferried tourists about.

Smet and Byrne set up a task where an elephant had to choose between two buckets in an effort to acquire some hidden food. If a human just stood in between the buckets, the choice was random. However, if she (Anna Smet seems to have been both author and stimulus) pointed at one bucket, the elephants chose that bucket at well above chance levels. You can watch this in videos associated with the paper. Were the elephants really responding to the pointing? Time for some variations and control conditions. Maybe the elephants just went to the bucket closest to some part of the human experimenter. No, if the experimenter stood by one bucket and pointed to the other, the elephants followed the pointing. Maybe the elephants were sensitive to the asymmetry of the body, going to the side with the more visible arm. Apparently not. They continued to follow the pointing arm even if the arm contralateral to the target was the arm that was doing the pointing. This worked when the contralateral arm was outstretched with a hand crossing the body midline. In this case, performance was reduced but still above chance. Elephants did not get the message if the contralateral arm was bent so that the elbow pointed one way and the hand the other. Now they were at chance. Thus, should the occasion arise, if you indicate direction clearly with an outstretched arm, there is a reasonable chance an elephant will get the point.—J.M.W.