Journal Club

Editor’s Note: These short reviews of a recent paper in the *Journal*, written exclusively by graduate students or postdoctoral fellows, are intended to mimic the journal clubs that exist in your own departments or institutions. For more information on the format and purpose of the Journal Club, please see http://www.jneurosci.org/misc/ifa_features.shtml.

Attention and Intention, Decoded!

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Review of Quiroga et al. (http://www.jneurosci.org/cgi/content/full/26/13/3615)

Whether neural activity in the posterior parietal cortex (PPC) reflects attention and/or intention (i.e., motor plans) remains controversial. Some researchers emphasize the attentional properties of neural activity (Colby and Goldberg, 1999), whereas others argue that it is predominantly reflective of motor intention (Snyder et al., 2000). The recent paper by Quiroga et al. (2006) in the *Journal of Neuroscience* applies a novel analytic approach to the debate.

Specifically, the investigators used a combination of population analysis and decoding methods. Population analysis combines the activity of multiple cells into a multidimensional representation of the system. Once a multidimensional space is created for each condition, it can be used to generate predictions by correlating a given pattern of activation to the already established multidimensional space. Tight correlations suggest that a given pattern of activation reflects a particular state of the system. This method differs from traditional neurophysiological analysis in that functionality is determined by the predictive power of the aggregate neural activity rather than by tuning curves and receptive fields of single cells in each region. An obvious strength of this method is that it speaks to the most probable physiological reality: one in which activity from populations of neurons, rather than from discrete single cells, generates behavior.

Quiroga et al. (2006) trained monkeys in delayed saccade and reach tasks. An array of eight possible target locations was presented with an illuminated central fixation. Then, one of eight peripheral light-emitting diodes (LEDs) signaled the target location. If it turned green, it indicated a saccade, and if it turned red, it indicated a reach (Fig. 1A). After a delay, fixation offset cued the monkey to initiate the appropriate movement to the location of the target. Saccade and reach trials were randomly interleaved. Single-cell activity was recorded from lateral intraparietal sulcus (LIP) and parietal reach region (PRR) [located in the medial intraparietal sulcus and extending dorsally into the parieto-occipital area, as described by Snyder et al. (2000)]. As in previous studies (Snyder et al., 2000), Quiroga et al. (2006) found activity consistent with effector specificity for LIP and PRR. Namely, after the effector cue (green or red LED), LIP cells showed sustained activity enhancement for trials in which saccades were cued and, conversely, PRR cells showed sustained activity enhancement for trials in which reaches were cued (Fig. 1B).

On a trial-by-trial basis, the authors aimed to decode either intention or attention from aggregated population activity. They tested two hypotheses: that population activity in LIP and PRR would best predict intention and that there would be effector-specific activity in the two PPC areas. Specifically, LIP activity would better predict saccade endpoint, and PRR activity would better predict reach endpoint. Framed in the attention versus intention context, if LIP or PRR cells code for attention only, then the effector should have no influence on activity. In other words, neither area should show modulation according to the movement plan, only according to target location. When LIP and PRR activity were grouped according to target location, the population activity was predictive of target location [Quiroga et al. (2006), their Fig. 3 (http://www.jneurosci.org/cgi/content/full/26/13/3615/F3)]. However, the activity from LIP also predicted saccade endpoint. Similarly, the activity in PRR strongly predicted reach endpoint but showed no lateralization. Despite this evidence for effector specificity, activity from both areas showed above-chance prediction of the other endpoint as well, providing evidence for both attentional (location-predictive) and intentional (action-predictive) signals [Quiroga et al. (2006), their Fig. 4 (http://www.jneurosci.org/cgi/content/full/26/13/3615/F4)]. Quiroga et al. (2006) emphasized that prediction of intention was greater than target location, concluding that the movement plan carries more weight than attention in the two PPC areas tested.

Quiroga et al. (2006) presented analyses on only a subset of their rich dataset. An additional line of inquiry could supplement the attention/intention debate, possibly in important ways. First, when comparing the activity in the PPR cell [Quiroga et al. (2006), their Fig. 2A (http://www.jneurosci.org/cgi/content/full/26/13/3615/F2)] with that of the LIP cell [Quiroga et al. (2006), their Fig. 2B...
al. (2006) used with a stronger attention
elegant intention design that Quiroga et
tasks. We argue that complementing the
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maintain all of the critical features for the
report by Quiroga et al. (2006).

Additionally, a more demanding atten-
tional task might be informative. As
implemented by Quiroga et al. (2006), an
abrupt visual onset serves to indicate the
appropriate movement plan. However, if
selection of a task-relevant location were
more demanding, the design might pro-
provide a stronger test of attention. To
achieve this, a condition in which a visual
transient is irrelevant should be included.
For example, adding irrelevant visual on-
sets (i.e., distracters) to the other seven
nontarget locations would allow a differ-
etiation between PPC attention-related
activity attributable to visual onsets and
that attributable to task-relevant selection
(Fig. 1, compare A, C). It would also
maintain all of the critical features for the
intermixed delayed saccade and reach
tasks. We argue that complementing the
elegant intention design that Quiroga et
al. (2006) used with a stronger attention
manipulation will help resolve the atten-
tion/intention debate.

In summary, Quiroga et al. (2006)
have presented intriguing data. The find-
ings are encouraging when considering the
implications for rehabilitation. Specif-
cally, neural population decoding in real
time has implications for brain–machine
interfacing and neuroprosthetics (She-
noy et al., 2003). Furthermore, the au-
ths offer a novel approach to analyz-
ingen neural activity in PPC. Examination
of a different temporal window and a
slight task modification may provide
even additional insight into the dynam-
ics of PPC as a region involved in both
attention and intention.

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