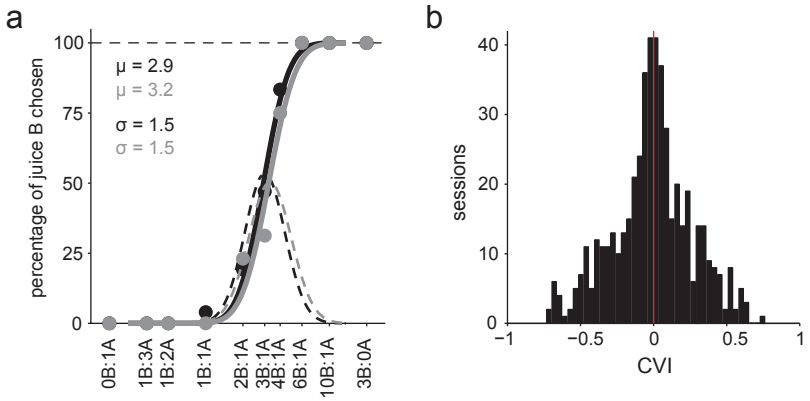

Figure S1. Independence of choice pattern from offer position (related to Figure 1). **a.** One session. Two sets of data points refer to trials in which the position of the chosen offer was in the same (congruent, black) or in the opposite hemifield (incongruent, gray) of that for the chosen target. Continuous lines are fitted sigmoids and dashed lines are the underlying normal distributions. For each fitted sigmoid, the mean (μ) and standard deviation (σ) of the normal distribution provided an estimate and error of measure for the log relative value (see Experimental Procedures). **b.** Distribution of the congruence variability index (CVI) across sessions. If spatial incongruence lead to higher choice variability, CVI would be generally greater than zero. Contrary to this prediction, the distribution of CVI was not significantly displaced from zero (mean CVI = 0.007; p = 0.3, t test).

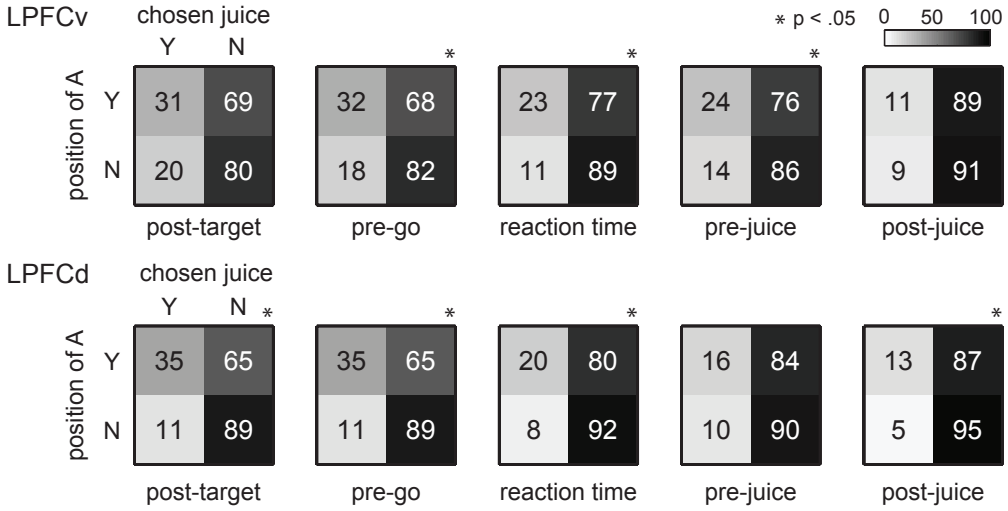

Figure S2. Neurons in LPFCv/d multiplex signals related to juice type and target position (related to Figure 3). For each cell and each time window, we determined whether a particular component of the 4-way ANOVA was significantly encoded ($p<0.01$). We thus assessed whether the same cells that encoded the chosen juice in the pre-target time window also encoded the position of A after target presentation. **Top.** Of the 561 cells recorded in LPFCv, 62 (499) encoded (did not encode) the chosen juice in the pre-target time window. For each time window after target presentation, each of these two groups was divided depending on whether cells encoded the variable position of A. Each panel in the figure illustrates the results of conjunctive coding of chosen juice and position of A. Numbers and shades of gray indicate the percent of cells, normalized by the row. For example, considering the leftmost panel, 31% (69%) of cells that encoded the chosen juice in the pre-target time window also encoded (did not encode) the position of A in the post-target time window, whereas 20% (80%) of cells that did not encode the chosen juice encoded (did not encode) the position of A. **Bottom.** LPFCd. Same format as for LPFCv.

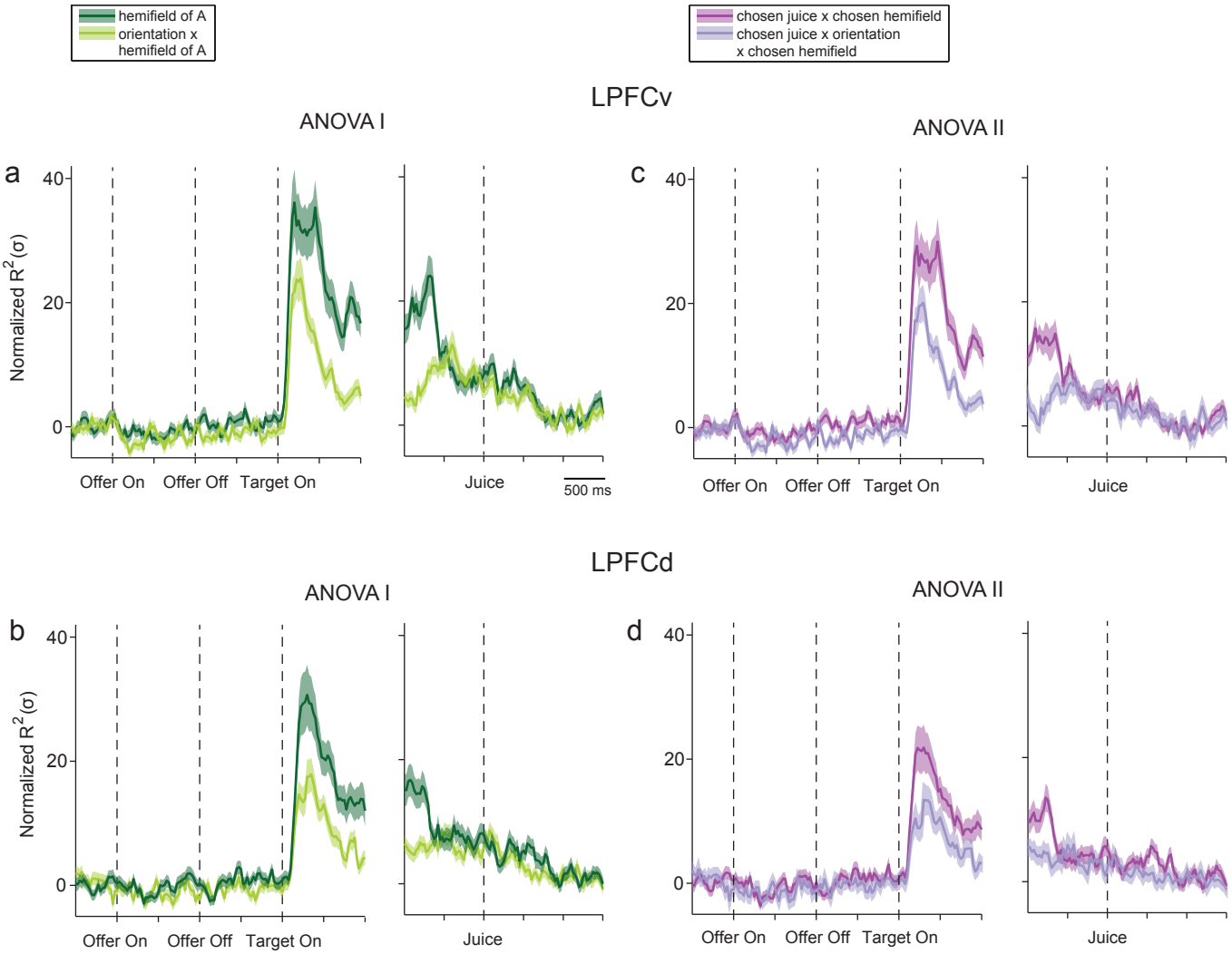

Figure S3. Interaction between chosen targets and chosen juice (related to Figure 4). **a,b.** The two panels labeled "ANOVA I" show, respectively for LPFCv and LPFCd, the results for the same 4-way ANOVA described in the main text analyzing separately the two terms hemifield of A and [orientation x hemifield of A]. In Fig.4, these two terms are combined in the component position of A. **c,d.** The two panels labeled ANOVA II show the results of a 4-way ANOVA with factors chosen value, chosen juice, orientation and chosen hemifield. Here the interaction between chosen juice and chosen target is captured by the following two terms: [chosen juice x chosen hemifield] and [chosen juice x orientation x chosen hemifield]. Note that the temporal profile obtained for hemifield of A in the ANOVA I matches well that of [chosen juice x chosen hemifield] in ANOVA II. This is true for both LPFCv and LPFCd. Likewise, the term [orientation x hemifield of A] in the ANOVA I matches well that of [chosen juice x orientation x chosen hemifield] in ANOVA II.

Supplemental Experimental Procedures

Analysis of behavioral choice patterns: possible effects of spatial congruence

Behavioral data were analyzed as in previous studies (Padoa-Schioppa and Assad, 2006; 2008). Briefly, we expressed choice patterns as a function of $\log(q_B/q_A)$, where q_A and q_B are the quantities of juices A and B offered to the monkey, respectively. Each choice pattern was then fit with a normal sigmoid. The underlying Gaussian can be viewed as a distribution of probability for the relative value. The mean of that distribution, corresponding to the flex of the sigmoid, identified the relative value of the two juices. The sigmoid fit also provided a measure of the choice variability (σ).

For a control, we tested whether the spatial congruence between the offer location and the target location affected the animals' choices. More specifically, we examined whether the choice variability was higher when the left/right location of the chosen offer was spatially incongruent with the chosen target (left/right hemifield). For each recording session (221 sessions for monkey B; 282 sessions for monkey L), we divided trials in two groups depending on whether the chosen offer and chosen target were in the same hemifield (congruent condition) or in opposite hemifields (incongruent condition). We fit the choice patterns for the two groups of trials separately (Fig.S1a) and we obtained the two measures of variability $\sigma_{congruent}$ and $\sigma_{incongruent}$. We then defined the congruence variability index $CVI = (\sigma_{incongruent} - \sigma_{congruent}) / (\sigma_{incongruent} + \sigma_{congruent})$. To test whether the choice variability measured in the incongruent condition was higher than that measured in the congruent condition we submitted the distribution of CVI to a t-test. The result showed that the spatial congruence did not affect the choice variability (Fig.S1b).

Multiplexing of signals related to juice type and target position in the LPFC.

Neurons in LPFCv/d generally multiplex different kinds of signals especially juice type and visual and action-related signals. To illustrate this observation, we performed the analysis of conjunctive encoding examining the *chosen juice* and *position of A* signals from the same time windows after target presentation. As shown in Fig.S2, there was conjunctive encoding of *chosen juice* and *position of A* in most of the time windows after target presentation in LPFCv/d.

Interaction between the spatial location of the chosen target and the chosen juice

In our 4-way ANOVA, the component *position of A* also captures the interaction between the location of the chosen target and the chosen juice. To appreciate this point, consider that this interaction can be broken down in two parts – the interaction [chosen hemifield x chosen juice] and the interaction [chosen target x chosen juice]. In our analysis, the chosen hemifield is represented by the term [*hemifield of A* x *chosen juice*]. Consequently, the first part is [[*hemifield of A* x *chosen juice*] x *chosen juice*] = *hemifield of A*. Similarly, in our analysis, the chosen target is represented by the term [*hemifield of A* x *orientation* x *chosen juice*]. Consequently, the second part is [[*hemifield of A* x *orientation* x *chosen juice*] x *chosen juice*] = [*hemifield of A* x *orientation*]. As detailed in Table 1, the component *position of A* combines these two parts and thus fully captures the interaction. Fig.S3ab illustrates each of these two parts separately.

To validate this point, we performed an additional 4-way ANOVA (referred to as ANOVA II in Fig.S3) with factors *chosen value*, *chosen juice*, *orientation* and *chosen hemifield*. In this formulation, the interaction is quantified directly by the terms [*chosen hemifield* x *chosen juice*] and [*orientation* x *chosen hemifield* x *chosen juice*]. As illustrated in Fig.S3cd, these two terms closely match the terms *hemifield of A* and [*orientation* x *hemifield of A*] of the original ANOVA (referred to as ANOVA I in Fig.S3).