SUPPLEMENTARY NOTE

Here we show algebraically the precise predictions of the standard hyperbolic model for the discount rates we estimate for the NOW and 60-DAY conditions using **Equation 3**. Our derivation follows a similar one outlined by Green and colleagues (2005). Recall that the hyperbolic model is:

$$SV^H = \frac{A}{1 + k^H D},$$

and that the reduced-form ASAP model used to estimate discount rates *separately* from the NOW and 60-DAY datasets is:

$$SV^{ASAP_{g=1}} = \frac{A}{1 + k^{ASAP}(D - D_{ASAP})}.$$

First, note that for the NOW condition, $D_{ASAP} = 0$, so the ASAP model collapses to the standard hyperbolic model in this case. Therefore the discount rate estimated in the NOW condition is the same as the discount rate that would be estimated using the hyperbolic model:

$$k_0^{ASAP} = k^H.$$

For the 60-DAY condition, the hyperbolic model predicts that the indifference amounts at later delays will have the same subjective value as the fixed sooner reward ($20 in 60 days):

$$\frac{20}{1 + 60k^H} = \frac{A^{indif}}{1 + k^H D}, \text{ or rearranging, } \frac{20}{A^{indif}} = \frac{1 + 60k^H}{1 + k^H D}.$$

Define $D' = D - 60$. Then:

$$\frac{20}{A^{indif}} = \frac{1 + 60k^H}{1 + k^H(D' + 60)} = \frac{1 + 60k^H}{1 + 60k^H + k^H D'} = \frac{1}{1 + (\frac{k^H}{1 + 60k^H})D'}.$$

In the 60-DAY condition, we estimate a discount rate by assuming that the indifference amounts at later delays are related to the fixed sooner reward ($20 in 60 days) by the ASAP equation above:

$$\frac{20}{1 + k_{60}^{ASAP}(60 - D_{ASAP})} = \frac{A^{indif}}{1 + k_{60}^{ASAP}(D - D_{ASAP})}.$$

Remembering that $D_{ASAP} = 60$ in this case and rearranging:

$$\frac{20}{A^{indif}} = \frac{1}{1+k_{60}^{ASAP}(D-60)} = \frac{1}{1+k_{60}^{ASAP}D'}.$$

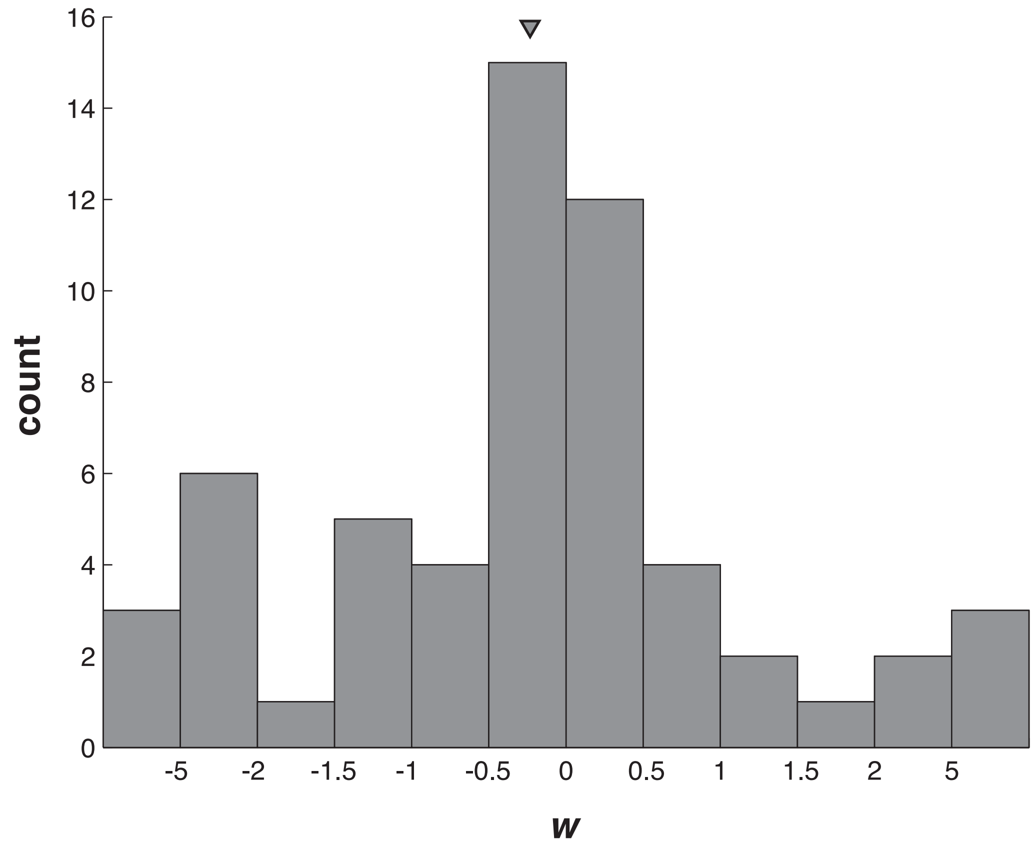
Thus, if the hyperbolic model is the correct one, then the discount rate estimated in the 60-DAY condition will be related to the discount rate in the hyperbolic model as follows:

$k_{60}^{ASAP} = \frac{k^H}{1+60k^H}$, or equivalently, $k_{60}^{ASAP} = \frac{k_0^{ASAP}}{1+60k_0^{ASAP}}$, since $k_0^{ASAP} = k^H$.

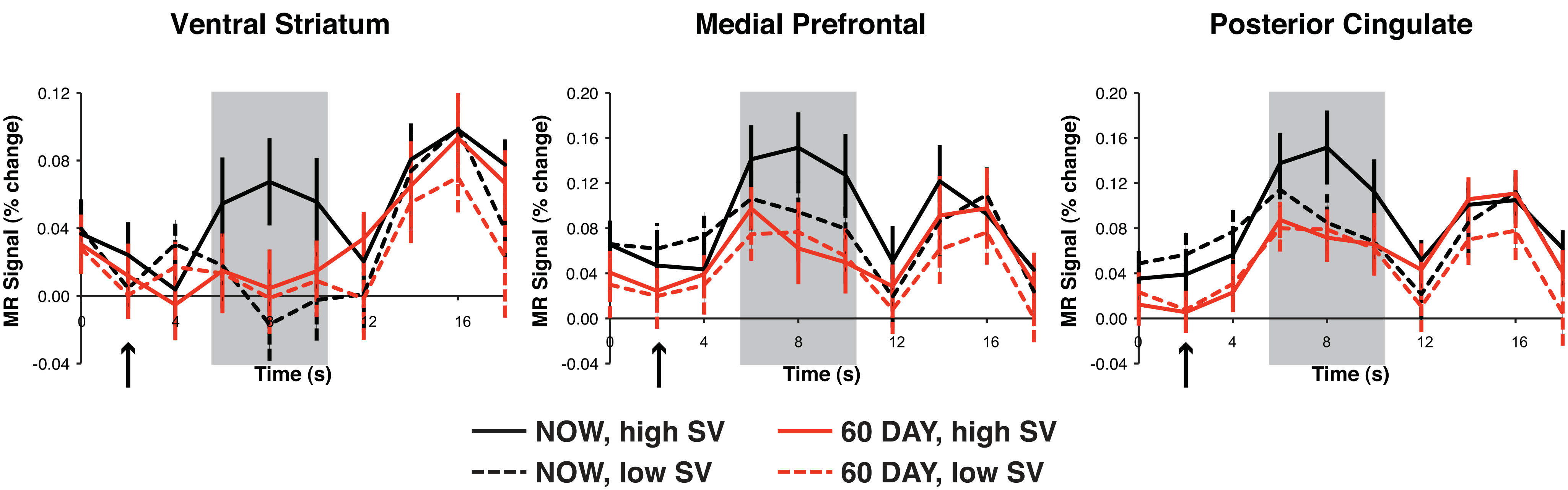
In their paper, Green and colleagues (2005) discuss three models: "present-value comparison," which corresponds to the hyperbolic model; "elimination-by-aspects," which corresponds to the reduced-form ASAP model; and "common-aspect attenuation," which is intermediate between these two. Specifically, "common-aspect attenuation" would predict that:

$$k_{60}^{ASAP} = \frac{k_0^{ASAP}}{1+60wk_0^{ASAP}}$$

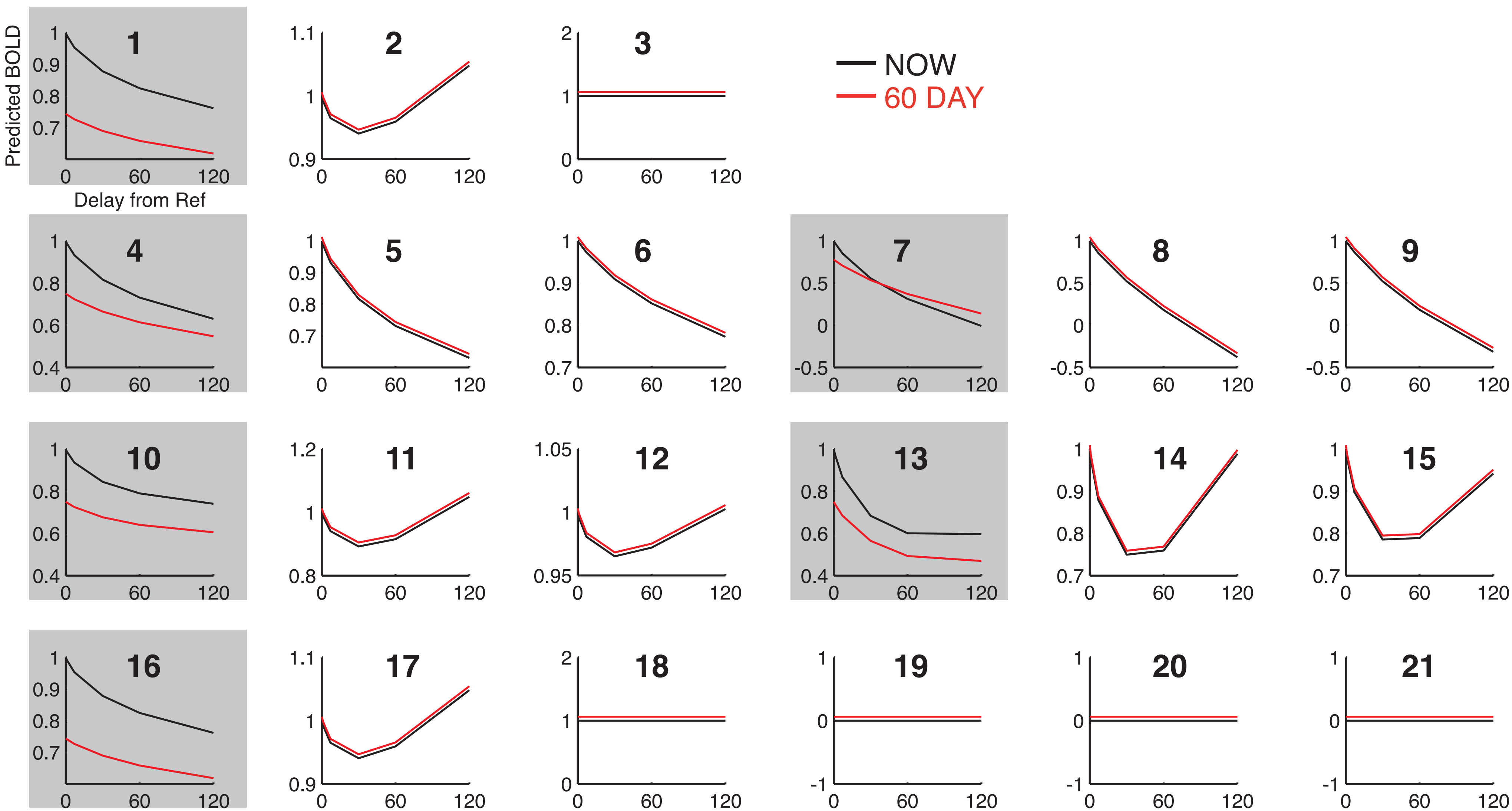
where w is a weighting parameter. When $w = 1$, this model corresponds to hyperbolic discounting (or "present-value comparison"). When $w = 0$, this model corresponds to reduced-form ASAP (or "elimination-by-aspects"). In Supplementary Figure 1, we plot the implied weighting parameters (w), given the ASAP discount rates we estimated separately in the NOW and 60-DAY conditions.



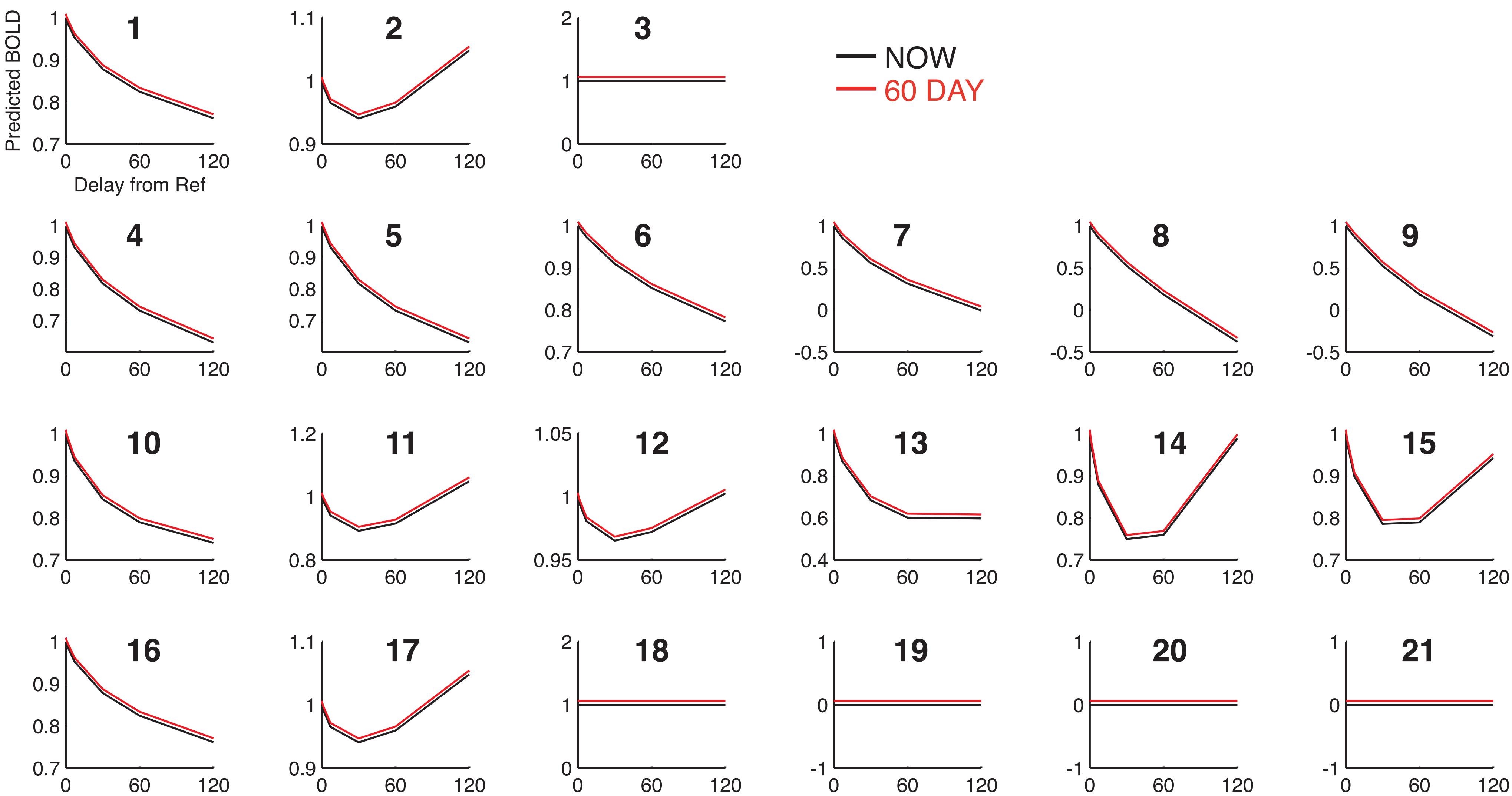
Supplementary Figure 1. Histogram of the implied weights (*w*) in the "common-aspects attenuation" model, given the estimated discount rates in the NOW and 60 DAY conditions in Experiment 1. See supplementary note for a description of this model. The triangle indicates the median weight. Note that the two bins on the end are larger than the central bins. The fact that this distribution is centered on zero is further evidence for ASAP discounting. Hyperbolic discounting would predict that *w* is centered on 1, while "common-aspects attenuation" was proposed to account for intermediate results ($0 < w < 1$).



Supplementary Figure 2. Group average timecourses for each region. Plotted are the trial averages, averaged across all subjects, in ventral striatum, medial prefrontal and posterior cingulate cortex ROIs. Trial averages are shown separately for NOW and 60 DAY conditions, with each condition divided into high and low subjective value trials (median split). The 6–10 s window on which our anlyses are focused is shown in gray. The arrows note when both options were presented.

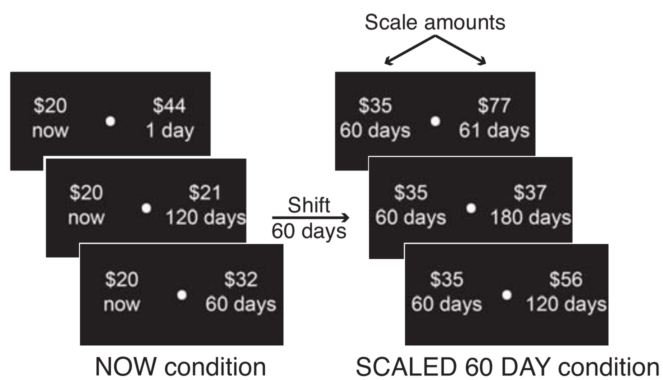


Supplementary Figure 3. Predicted pattern of BOLD activity in NOW and 60 DAY conditions in Experiment 1, for different possible combination rules. The different numbers refer to the different combination rules listed in **Supplementary Table 1**. These predictions were calculated using the discount functions estimated for each individual and the choices presented to each participant, and assuming the subjective value function in **Equation 2** with the gain factor in **Equation 5** . Note that only six combination rules (highlighted in gray) predict different modulations in the NOW and 60 DAY conditions. Predictions for the 60 DAY condition are slightly offset so that both lines are visible.

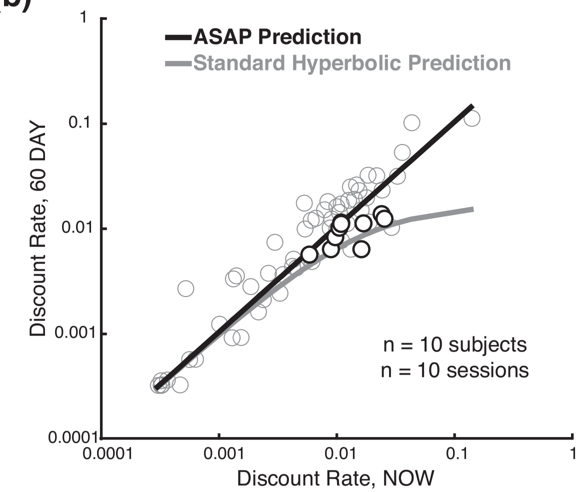


Supplementary Figure 4. Predicted pattern of BOLD activity in NOW and 60 DAY conditions in Experiment 1, for different possible combination rules. The different numbers refer to the different combination rules listed in **Supplementary Table 1**. These predictions were calculated using the discount functions estimated for each individual and the choices presented to each participant, and assuming the subjective value function in **Equation 3**. Note that all combination rules in this case predict the same modulations in the NOW and 60 DAY conditions. Predictions for the 60 DAY condition are slightly offset so that both lines are visible.

(a)



(b)



Supplementary Figure 5. (a) Schematic illustrating the two conditions in Experiment 2. The NOW condition involved choices between a fixed immediate reward of $20 and a larger variable reward available after some delay. The SCALED 60-DAY condition was constructed from the choices in the NOW condition by adding a fixed delay of sixty days to both options, and scaling the amount of both options as described in the main text. **(b)** The discount rate in the SCALED 60-DAY condition is plotted as a function of the discount rate in the NOW conditions, for all participants and all sessions. Results from Experiment 1 are plotted in the background. The points lie predominantly between the predictions of the ASAP hypothesis and standard hyperbolic discounting. The decrease in discount rates in the SCALED 60-DAY condition in Experiment 2, compared to the 60-DAY condition in Experiment 1, is likely due to the widely observed magnitude effect in intertemporal choice, where increases in the magnitude of rewards leads to a decrease in the discount rate. Thus these results are consistent with the ASAP hypothesis plus a magnitude effect. Note that we cannot test for preference reversals in this experiment because the amounts are different in the two conditions.

Supplementary Table 1. Possible combination rules for the subjective values of two options. This table is more exhaustive than **Table 2** in the main text. The superscript on SV is omitted here for clarity, since the combinations could apply to any subjective value function (**Equations 1-4**). The subscripts refer to how the two options are distinguished, whether the two options are interchangeable (SV_1, SV_2), or the later and sooner options (SV_L, SV_S), the chosen and unchosen options (SV_C, SV_U), or the left and right options (SV_L, SV_R) are distinguished. The combinations shaded in gray are listed in **Table 2** and compared in **Figures 5-7**. **Supplementary Figure 1** shows what these combination rules predict regarding the modulations in the NOW and 60-DAY conditions assuming ASAP subjective values (SV^{ASAP}), while **Supplementary Figure 2** shows what these combination rules predict assuming ASAP relative subjective values ($SV^{ASAP_{g=1}}$).

Treat Both Options Interchangeably	*Dependent on the Soonest/Latest Option*	*Dependent on the Chosen/Unchosen Option*	*Dependent on the Right/Left Option*
(1) $SV_1 + SV_2$	(4) SV_L	(10) SV_C	(16) SV_R
(2) $\frac{SV_1}{SV_2} + \frac{SV_2}{SV_1}$	(5) $\frac{SV_L}{SV_S}$	(11) $\frac{SV_C}{SV_U}$	(17) $\frac{SV_R}{SV_L}$
(3) $\frac{SV_1 + SV_2}{SV_1 + SV_2}$	(6) $\frac{SV_L}{SV_L + SV_S}$	(12) $\frac{SV_C}{SV_C + SV_U}$	(18) $\frac{SV_R}{SV_R + SV_L}$
	(7) $SV_L - SV_S$	(13) $SV_C - SV_U$	(19) $SV_R - SV_L$
	(8) $\frac{SV_L}{SV_S} - \frac{SV_S}{SV_L}$	(14) $\frac{SV_C}{SV_U} - \frac{SV_U}{SV_C}$	(20) $\frac{SV_R}{SV_L} - \frac{SV_L}{SV_R}$
	(9) $\frac{SV_L - SV_S}{SV_L + SV_S}$	(15) $\frac{SV_C - SV_U}{SV_C + SV_U}$	(21) $\frac{SV_R - SV_L}{SV_R + SV_L}$