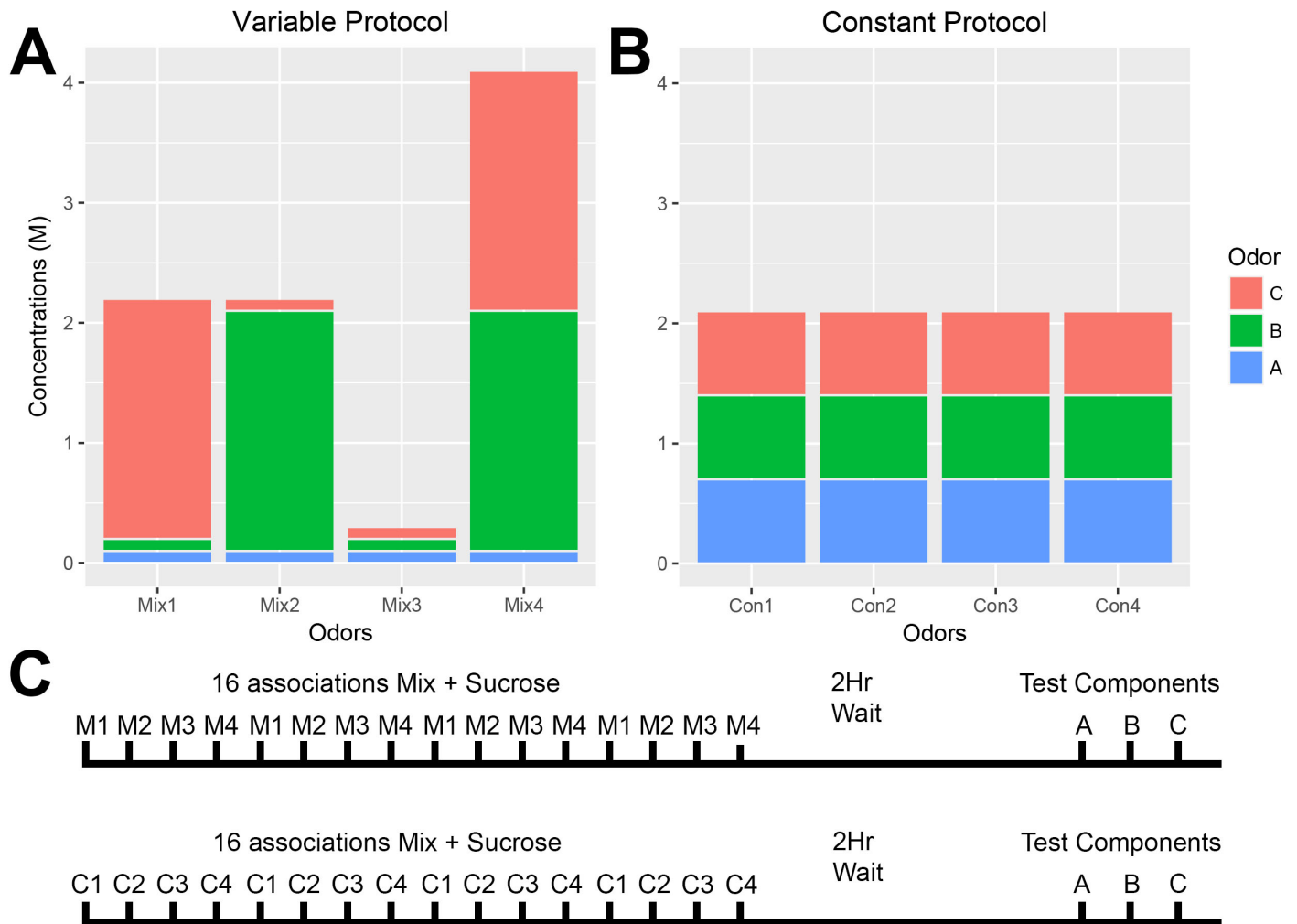
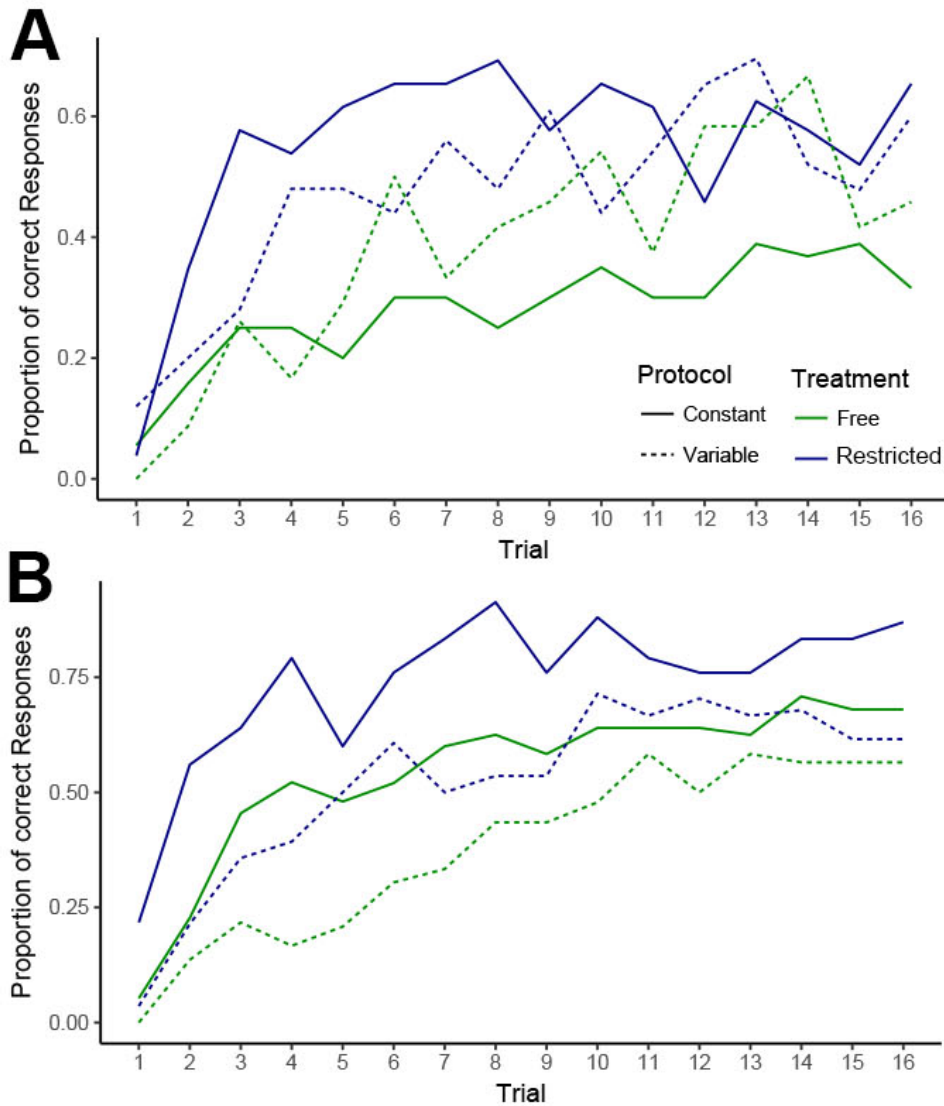


**Figure S1. Calcium imaging data collection and processing protocol.** Example data from a single free-flying worker bee. **(A)** Response of 23 identified glomeruli to Mix1 over time. Shaded region denotes odor stimulation. **(B)** Averaged response during odor stimulation (shaded region in a) for each glomerulus. **(C)** Example false colored average response, over the 1 second odor stimulation window, of the honey bee AL to each odor stimulus presented. Schematic reconstruction of the rostral portion of the AL and the 23 identified glomeruli analyzed in this experiment in top right panel. Odors labels: HEX1 =  $2 \times 10^{-2}$  M 1-Hexanol, HEX2=  $1 \times 10^{-2}$  M 1-Hexanol, HEX3=  $1 \times 10^{-3}$  M 1-Hexanol, MIX1=  $2 \times 10^{-2}$  M 1-Hexanol and  $1 \times 10^{-2}$  M Acetophenone, MIX2=  $1 \times 10^{-2}$  M 1-Hexanol and  $1 \times 10^{-2}$  M Acetophenone, MIX3=  $1 \times 10^{-3}$  M 1-Hexanol and  $1 \times 10^{-3}$  M Acetophenone, ACE2=  $1 \times 10^{-2}$  M Acetophenone, ACE3=  $1 \times 10^{-3}$  M Acetophenone, OCT2=  $1 \times 10^{-2}$  M 2-Octanone, Oct3=  $1 \times 10^{-3}$  M 2-Octanone, GER=  $1 \times 10^{-2}$  M Geraniol, LEM=  $1 \times 10^{-2}$  M Lemon oil, LIN =  $1 \times 10^{-2}$  M Linalool. All odors dissolved in mineral oil (M.OIL).

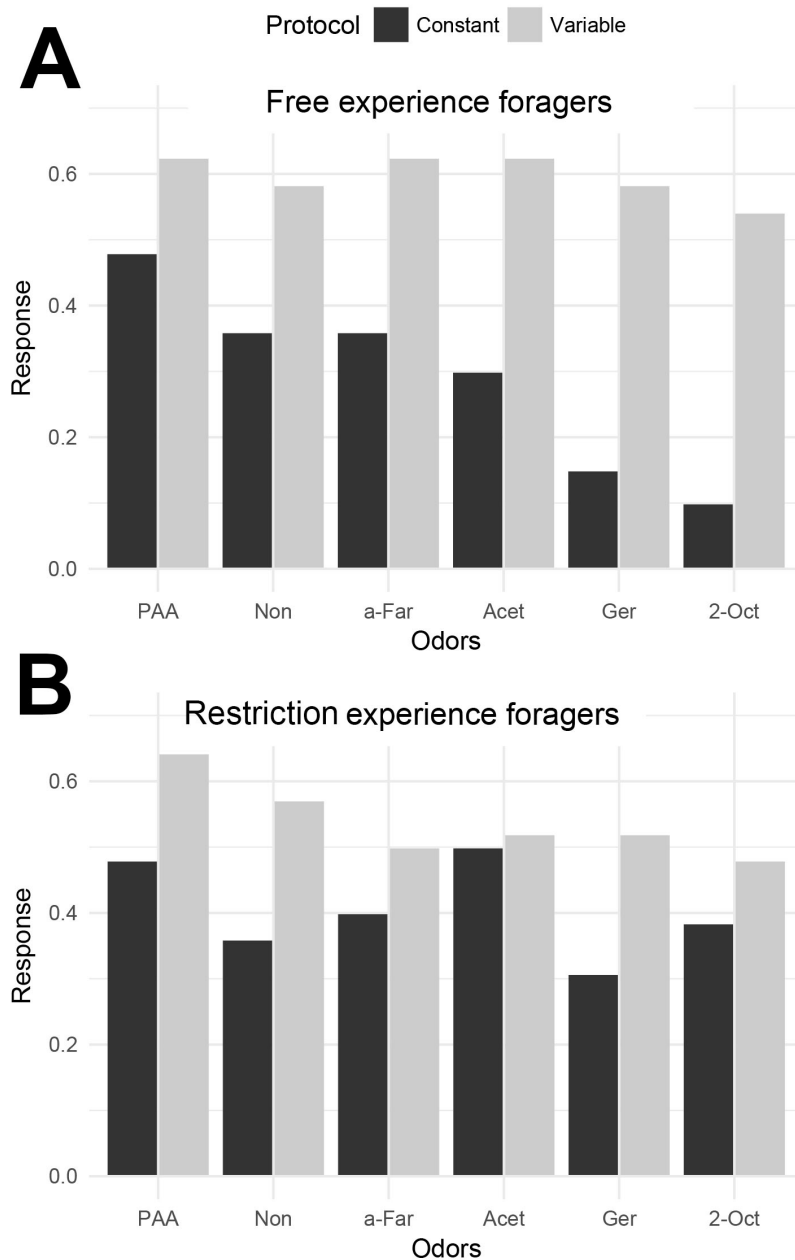


**Figure S2. Odor mixture component learning protocol**

The odor mixture component concentrations used during the (A) variable mixture protocol (B) the constant mixture protocol. (C) A schematic of the associative conditioning and component memory testing procedures. Bees that received the variable protocol received different mixtures (M1, M2, M3 or M4) in a pseudorandomized order over 16 associative acquisition trials. Bees that the constant protocol received identical mixtures (Co) over 16 associative acquisition trials. Mean total odorant exposure was equivalent across the two protocols. Memory test component order was randomized between bees for both protocols. We used a mixture blend made of three components: A=Acetophenone, B=Geraniol and C=2-Octanone. Acetophenone (A, the target odor) is held at a constant intensity even in the variable protocol. Across trials, the average mixture intensity is the same for both the constant and the variable protocols. We also tested a second mixture blend see methods and Wright and Smith (2004) for more details.



**Figure S3. Acquisition of odor mixture blend 1 across freely foraging (green) and restricted bees (blue) which received either a constant (solid line) or a variable (dashed line) mixture protocol. (A) Mixture blend 2 odors (B) mixture blend 1 odors. Sample Sizes: free blend 2 constant N=20, free blend 2 variable N=24, free blend 1 constant N=25, free blend 1 variable N=24, restricted blend 2 constant N=26, restricted blend 2 variable N=25, restricted blend 1 constant N=26, restricted blend 1 variable N=28.**



**Figure S4. The memory response rates for bees 2hrs after receiving the acquisition protocol.** Bees received either the constant protocol (black) or the variable protocol (gray) and had one of two prior experience treatments (**A**) a free-flying experience or (**B**) a restricted foraging experience. Sample Sizes: free blend 2 constant N=20, free blend 2 variable N=24, free blend 1 constant N=25, free blend 1 variable N=24, restricted blend 2 constant N=26, restricted blend 2 variable N=25, restricted blend 1 constant N=26, restricted blend 1 variable N=28. PAA= phenylacetaldehyde, Non= nonanal, a-Far= a-farnesene, Acet= acetophenone, Ger= geraniol, 2-Oct= 2-octanone.