Data Analysis

Demand curve under the same experimental sessions was modeled using a normalized version of the Zero-Bounded Exponential (ZBEn) model provided by Gilroy et al. (2021), implemented using the GraphPad version 9:

where is the consumption of commodity A, IHS is a log-like scale (, denotes the level of demand at zero price, denotes the rate of decline in relative consumption with increases in price (FR), and denotes the price (FR) of the commodity A. The ZBEn model provided an estimation of relative changes in consumption and accommodates zero consumption values; lower bound cannot be at zero in the log scale used in Exponential Model (Hursh and Silberberg, 2008) and cannot be asymptotic at zero in the log-based span used in Exponentiated Model (Koffarnus et al.,2015) because zero is undeﬁned on the log scale. was deﬁned as the price at which the slope of the demand equaled -1 and demand becomes elastic from inelastic. α determines the essential value (EV) of the commodity (), or the sensitivity of consumption to changes in price. Breakpoint was deﬁned as the price point at which consumption was zero. Differences in α between conditions were compared using extra sums of squares F-tests with a signiﬁcance level of P < 0.05.

In order to model the demand for substitution, a simple linear regression model and an exponential cross-price elasticity model provided by Hursh (2014) were performed for each subject in each session, implemented using the GraphPad version 9. The simple linear regression model can be represented by:

where denotes the consumption of fixed-price commodity B, denotes the slope, denotes the price (FR) of the commodity A, and is the quantity demanded for the constant-price commodity B at the infinite price for commodity A (zero consumption of commodity A). A positive slope, , indicates a substitution relationship between consumptions of the two commodities, and a negative slope indicates a complementary relationship between consumptions of the two commodities. The exponential cross-price elasticity model can be represented by:

where denotes the consumption of fixed-price commodity B, the Qalone denotes the quantity demanded for the constant-price commodity B at the infinite price for commodity A, I denotes the interaction constant, denotes the sensitivity of commodity B consumption to the price of commodity A, and denotes the price of commodity A. A negative interaction term, I, indicates a substitution relationship between consumptions of the two commodities, and a positive interaction term indicates a complementary relationship between consumptions of the two commodities.

The estimated number of effective total responses (responses that led to reinforcements) to produced commodity A, , was obtained by multiplying the estimated consumption of commodity A, , by the price (FR) of commodity A, :

where the was obtained from the antilog of IHS() based on equation 1 (, where -1 is to permit the estimated consumption to be zero).