Relative food preference and hedonic judgments in schizophrenia

Bradley S. Folley *, Sohee Park

Department of Psychology, Wilson Hall, Vanderbilt University, 111, 21st Ave S. Nashville, TN 37240, USA
Kennedy Center for Human Development, Vanderbilt University, MRL Building, 21st and Magnolia Circle Nashville TN 37203, USA

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ABSTRACT

There is a well-documented disruption of the neural network associated with reward evaluation in schizophrenia. This same system is involved in coding the incentive value of food in healthy individuals, but few studies to date have examined anhedonia and its relation to food hedonicity and preference in schizophrenia. Relative preference and hedonic food ratings were examined in schizophrenia patients and healthy controls. In the relative preference task, subjects viewed photographs of food items and selected the one that they most preferred. Hedonic ratings were obtained by asking subjects how much they liked the food stimulus on a scale of 1–5. There were no overall response time differences between the two groups in the relative preference task, but schizophrenia patients showed subtle differences in their hedonic ratings of foods compared with control subjects. Schizophrenia patients gave more positive hedonic ratings for food than did controls, and the use of fewer positive ratings was associated with increased anhedonia, particularly with loss of sexual interest. These results suggest that while making relative preference judgments may be intact, hedonic values attached to food may be altered in schizophrenia, and they may be related to dysfunction in more basic vegetative systems.

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1. Introduction

Although food is a primary reinforcer (Rolls, 1999), and experiencing and consuming food is hedonic (Kringelbach, 2004; McCreadie et al., 1998), individuals with schizophrenia experience anhedonia (dysfunction in experiencing pleasure) and tend to make unhealthy dietary choices (Kraepelin et al., 1919). However, experiencing pleasure is not universally disrupted in schizophrenia (Schurhoff et al., 2003), and it is unclear how dietary food choices are related to clinical anhedonia and to deficits in hedonicity evaluation in schizophrenia.

Food choice and consumption are complex processes based on several integrated factors including content, context, experience, culture, and availability (Mela, 1999). The present study examined two related hedonic decision-making processes: (1) relative reward decisions made when selecting the most preferred food from several competing choices, and (2) liking judgments, which invoke affective discriminations (how much a food is liked). Both of these processes involve hierarchical information likely derived from implicit learning rather than being hard-wired (Greene et al., 1975). There are several reasons to suggest that these systems may be disrupted in schizophrenia. Nutritious food choices in schizophrenia patients tend to be poor (McCreadie et al., 1998; Peet, 2004), and there is evidence for continued disrupted food choice learning following nutrition training (McCreadie et al., 2005).

In addition to loss of food-derived satisfaction (Kovess-Masfety et al., 2006) in schizophrenia, examining food preference and reward decisions may elucidate some of the processes that contribute to overall poor physical health and obesity. Berridge (1996) has separated consummatory "liking" from volitional "wanting" reward mechanisms. These mechanisms are subsumed by related but functionally and anatomically dissociable neural systems (Finlayson et al., 2007) that are also disrupted in schizophrenia (Elman et al., 2006). Dysfunction of the volitional system in schizophrenia has been identified as a salient aspect of anhedonia (Wolf, 2006), and some evidence suggests that schizophrenia patients experience intact consummatory pleasure (Kring and Earnst, 1999), but there is little available information about hedonic decision-making involving relative reward (preference) and hedonic judgment (liking) in schizophrenia.

Based on current evidence, there is reason to believe that schizophrenia patients may have difficulty or show weaknesses in food reward and judgment decisions. In particular, the prefrontal cortex (PFC) is a primary neuroanatomic substrate of food preference decisions, and schizophrenia patients have well-documented PFC abnormalities (Crespo-Facorro et al., 2007; Crespo-Facorro et al., 2000; Goldstein et al., 1999). Individuals with lesions in the ventral region of the PFC display anhedonia (Blumer and Benson, 1975), and human food preference is altered with PFC lesions and dysfunction (Ikeda et al., 2002; Kim and Choi, 2002; Regard and Landis, 1997). Food preference alterations, including incentive value reversal, occur in response to primate ventral PFC damage (Butter et al., 1969), and

* Corresponding author. Department of Psychiatry, Vanderbilt University School of Medicine, 1601 23rd Ave. South, Nashville, TN 37212, USA. Tel.: +1 615 322 3435; fax: +1 615 343 8449.
E-mail address: brad.folley@vanderbilt.edu (B.S. Folley).

there are ventral PFC cells that respond to anticipated food reward and to the changing motivational value of food (Watanabe, 1999). Tremblay and Schultz (1999) demonstrated primate ventral PFC cells that responded to the changing reward value of different foods as they were paired with increasingly preferred ones. These results argue for the functional and physical overlap of food reward systems and schizophrenia pathophysiology.

Previous studies of affective responses to food stimuli in schizophrenia patients have generally revealed subjective experiences comparable to healthy controls even when emotional responsiveness was blunted. When schizophrenia and depressed patients were exposed to pleasant (sugar) and aversive (vinegar) drinks (Berenbaum and Oltmanns, 1992), schizophrenia patients who showed affective flattening also showed reduced facial expression responses to stimuli. However, they did not indicate reduced subjective experiences, and schizophrenia patients without affective flattening were more responsive than depressed patients. A similar result was found in response to graded sugar solutions. Although schizophrenia patients scored higher than controls on a measure of social anhedonia, their hedonic ratings for different concentrations of sucrose water were similar (Berlin et al., 1998), indicating a preserved ability to give positive hedonic evaluations of food while experiencing increased anhedonia. When schizophrenia patients and controls were exposed to pleasant (chocolate cookie, brownie, and ice cream) and neutral (white bread, tortilla, and matzo bread) food stimuli (Horan et al., 2006), patients showed immediate and delayed hedonic responses similar to healthy controls in spite of reporting higher levels of unpleasant emotions on clinical rating scales. These results indicated that food can be experienced positively, even among schizophrenia patients with increased anhedonia, who experience blunted or negative affect; however, relative reward and preference paradigms have not been explicitly examined.

In this investigation, we asked whether individuals with schizophrenia (SZ) make relative reward decisions similarly to healthy controls (CO), and if schizophrenia patients rate the hedonic value of food differently compared with healthy controls. For the relative reward decision, we examined response times for making preference decisions for food choices. We expected to observe increased response time latencies in schizophrenia patients during relative reward decisions that reflected greater difficulty making these decisions. In the hedonicity ratings task, schizophrenia and control subjects rated the hedonic value of food on a scale of 1–5. We expected subjects with schizophrenia to have more difficulty making preference decisions (reflected by slower response times in a relative reward choice decision compared with a control condition) than healthy controls and to give relatively lower hedonic ratings to food images than healthy controls.

2. Method

2.1. Participants

Eighteen outpatients (6 females; mean age=40.5 years, range= 21–58 years) who met the DSM-IV criteria for schizophrenia were recruited from a local clinic. Eighteen healthy control subjects (8 females; mean age=38.9 years, range=20–52 years) were recruited from the community. Exclusion criteria included a history of neurological disorders, brain injury, mental retardation, and a history of mental (major depression, extreme anxiety, or eating disorders) or physical disease (diabetes, oral disease, infections, or current fever) that would compromise healthy appetite and food choices. Controls were excluded if they had a past or present DSM-IV Axis I or Axis II disorder, or a family history of psychosis, and all subjects were excluded if they met DSM-IV criteria for current substance abuse or dependence, or past substance dependence. Diagnoses were verified using the Structured Clinical Interviews for DSM-IV (SCID-IV; First et al., 1996). Although cigarette smoking can alter appetite and food choices (Jo et al., 2002), we did not want to exclude individuals in the schizophrenia group, amongst whom it is most common to smoke (Strassnig et al., 2006). Schizophrenia patients ($M = 20.6$, S.D.=25.4) and healthy controls ($M = 10.6$, S.D.=9.4) did not differ in their average daily cigarette consumption, $t(34) = 1.6$, $P = 0.13$.

Groups were matched for years of education (SZ: $M = 12.4$, S.D.=2.6 years, CO: $M = 13.4$, S.D.=1.9 years, $P = 0.21$) and score on the Wechsler Abbreviated Scale of Intelligence (WASI) FSIQ (SZ: $M = 88.6$, S.D.=14.2; CO: $M = 96.6$, S.D.=14.3, $P = 0.12$). For subjects with schizophrenia, clinical symptoms were assessed with the Brief Psychiatric Rating Scale (BPRS: $M = 27.4$, S.D.=16.9) (Lukoff et al., 1986) and the Scales for the Assessment of Positive (SAPS: $M = 32.4$, S.D.=24.4) and Negative (SANS: $M = 29.1$, S.D.=24.3) Symptoms (Andreasen, 1982; Andreasen and Olsen, 1982). All schizophrenia patients were clinically stable and taking second generation antipsychotic medications at the time of testing, and their mean chlorpromazine-equivalent medication dose (Davis, 1974; Woods, 2003) was $M = 93.6$ mg/day, S.D.= 159.7 mg/day. Mean illness duration was 16.4 years (S.D.=9.6) for schizophrenia patients. In order to obtain a measure of trait schizotypy that could be compared with food ratings, all healthy controls completed the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), a self-report measure with 74 true–false items ($M = 17.6$, S.D.= 7.7). All subjects were screened for food habits and were excluded if they reported major restrictions (vegetarianism, strict dietary rules) that would affect reactions to food. The study was approved by the Vanderbilt University Institutional Review Board, and informed consent was obtained from all participants, who were compensated.

2.2. Apparatus and procedure

Tasks were programmed and presented using E-Prime (Psychology Software Tools, Pittsburgh, PA, USA). Participants viewed images presented 50 cm away on a 17″ computer screen and responded using the keyboard. Images were colored pictures of prepared food from cookbooks that were digitized at high resolution and imported into the presentation software. Colored images were food from one of four categories (desserts, meat, pasta, and vegetables) selected for appetitive quality by 27 separate healthy controls on the same scale (1–5) in a pilot study. A rating of 3 or higher was given to 136 of the images, and from these, 120 with the highest ratings ($M = 3.71$, S.D.=0.39) were chosen for the experiment. Items with the highest average ratings were chosen because relative reward assumes selection from competitively rewarding choices. All subjects were right-handed, completing both tasks in a single testing session prior to eating lunch to provide some control over food satiety.

2.2.1. Food preference decisions

Participants made decisions about food presented in two conditions (preference or control, Fig. 1A). For each condition, three food images from the same category were presented horizontally on a black background, numbered 1 to 3 beneath each image. In the *preference* condition, participants selected the one for which they had the strongest preference. In the *control* condition, participants were asked to select the item made with the most ingredients. The stimulus screen stayed on until subjects pressed a key or 6 s had elapsed. An instruction screen presented before each block indicated which decision to make, and the corresponding decision words "prefer" or "ingredients" appeared at the top of each stimulus screen to remind subjects of the current task. There were 14 preference and control blocks, each containing five trials. The presentation of preference and control blocks was counterbalanced.

2.2.2. Food ratings task

After instruction and practice trials, participants were asked to rate 120 food items chosen equally from the four categories (meat, vegetable, pasta, dessert). For each trial, a color photograph of a prepared food was presented and subjects were asked to rate the food item on a Likert-type scale (Fig. 1B). A trial ended when subjects pressed a key to indicate their ratings, or when 6 s had elapsed. The scale instructed subjects to rate food according to: 1—do not like the food at all, 2—do not really like the food, 3—neither like nor dislike the food, 4—like the food, 5—like the food very much. The rating scale was presented visually beneath each food image. Individual ratings and response times were recorded.

3. Results

3.1. Preference decisions

Using response time as the dependent variable with experimental condition (preference vs. ingredients task) as the within-subjects factor and diagnosis (SZ, CO) as the between-subjects factor, the main effect for experimental condition was significant ($F(1, 34) = 215.64$, $P < 0.001$; $r = 0.96$). Overall, subjects made preference decisions more quickly ($M = 3208.1$ ms, S.D. = 575.6 ms) than number of ingredients decisions ($M = 3241.8$ ms, S.D. = 580.5 ms). The main effect of group was not significant ($F(1,34) = 2.83$, $P = 0.10$). The interaction between group and condition was not significant ($F(1,34) = 0.52$, $P = 0.48$).

3.2. Food ratings

We first examined how different food items were rated. When rating choice was the dependent variable, with food category (vegetables, pasta, desserts, meat) as the within-subjects factor and group (SZ, CO) as the between-subjects factor, the main effect for food category
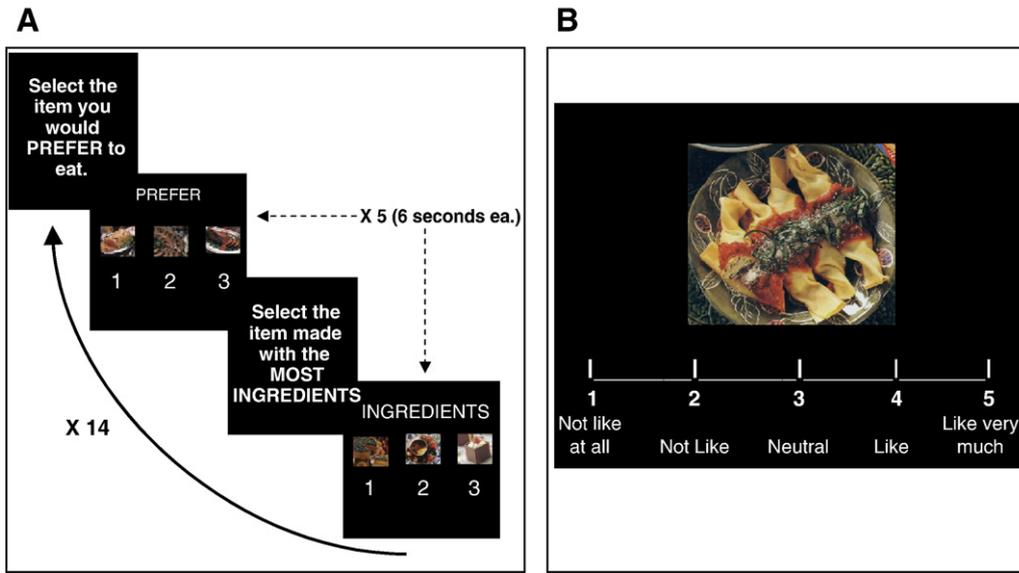
Fig. 1. The (A) relative reward and (B) rating paradigms. In the relative reward paradigm, subjects made 2 decisions about food: to select which of 3 foods they liked most (experimental condition), or to select the food made with the most ingredients (control condition) in alternating blocks. In the rating paradigm, subjects viewed sequential food images and were asked to rate each on a 1–5 scale according to how much they liked the food shown.

was significant ($F(3,102) = 22.12$, $P < 0.001$; $r = 0.73$) (see Fig. 2A). Overall, subjects preferred meat ($M = 3.5$, S.D. $= 0.66$) to vegetables ($M = 2.7$, S.D. $= 0.85$) ($P < 0.01$) and pasta ($M = 2.9$, S.D. $= 1.02$) ($P < 0.01$). They also preferred desserts ($M = 3.4$, S.D. $= 0.59$) to vegetables ($P < 0.001$) and pasta ($P < 0.01$). Pasta and vegetables were rated similarly, as were desserts and meat. The main effect of group was not significant, ($F(1,34) = 1.55$, $P = 0.22$). However, the interaction between group and food category was significant ($F(3,102) = 2.94$, $P = 0.04$; $r = 0.31$), indicating a medium effect. Subjects with schizophrenia ($M = 3.1$, S.D. $= 0.79$) gave higher ratings to the vegetable pictures than did controls ($M = 2.4$, S.D. $= 0.79$) ($P < 0.05$).

We also examined the possibility of an overall negative or positive bias in rating food items. To do this, we grouped the percentage of ratings given by each subject into negative, positive, and neutral categories according to the following system: ratings of "1" and "2" were combined to form a *negative* rating category, ratings of "4" and "5" were combined to form a *positive* rating category and ratings of "3" formed a *neutral* category. There was a main effect for rating category ($F(2,68) = 15.87$, $P < 0.001$; $r = 0.67$) such that subjects in

both groups applied the positive ratings of 4 or 5 ($M = 49.1\%$, S.D. $= 16.5\%$) more often than the neutral rating of 3 ($M = 25.1\%$, S.D. $= 15.5\%$) or the negative ratings of 1 and 2 ($M = 25.8\%$, S.D. $= 18.5\%$) (see Fig. 2B). The main effect for group was not significant ($F(1,34) = 0.0$, $P = 1.0$). The interaction between group and rating was not significant ($F(2,68) = 1.15$, $P = 0.32$); thus, individuals with schizophrenia and healthy controls were more likely to use the positive ratings overall for food compared with the neutral or negative ratings regardless of the food category being rated.

3.3. Rating response times

We also examined subjects' response times to rate individual food items and to determine if there was a difference in decision-making speed to rate different food categories. Overall, individuals with schizophrenia ($M = 1744.8$ ms, S.D. $= 525.9$ ms) and controls ($M = 1888.7$ ms, S.D. $= 611.1$ ms) did not differ in their average response times to rate food images ($F(1,34) = 0.60$, $P = 0.44$). There were also no significant differences in rating response times
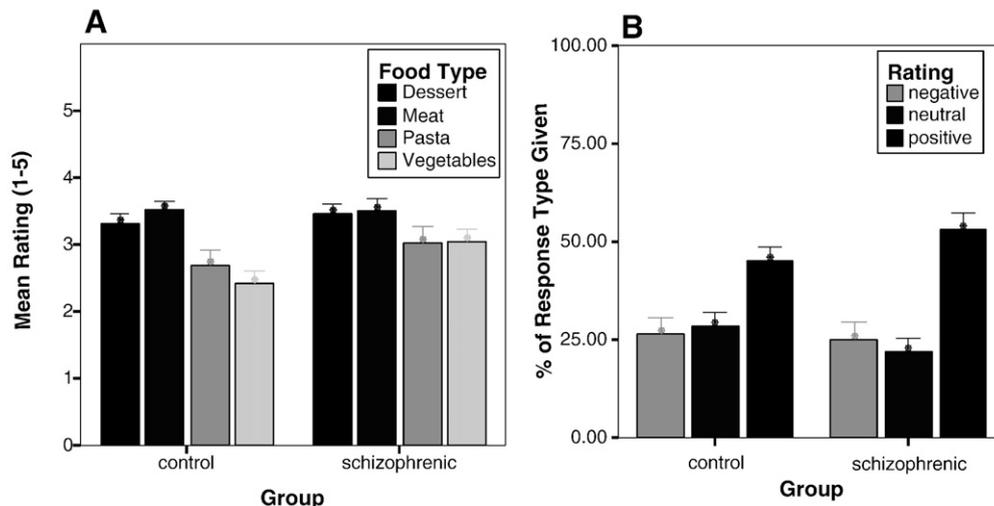

Fig. 2. Food rating responses given by subjects with schizophrenia and healthy controls. From A, subjects with schizophrenia rated the vegetable food images as being more liked than did healthy controls. From B, subjects with schizophrenia used the more positive ratings (4 or 5) to judge food images overall.

Table 1
Relationships between hedonic food ratings from different categories and symptom ratings.

	BPRS			SANS						SAPS
	Total	BA	EW	Total	RI	SI	IC	FP	GAA	Total
Vegetables	0.06	0.3	0.14	0	−0.1	−0.09	0.18	0.29	0.22	0.1
Pasta	−0.18	−0.17	−0.2	−0.25	−0.24	−0.19	0.03	−0.01	−0.17	−0.24
Desserts	0.36	0.13	0.14	0.38	−0.21	−0.37	0.08	0.06	0.04	−0.06
Meat	0.21	−0.19	0.04	0.27	−0.39	−0.58[a]	−0.11	−0.32	−0.28	−0.45
Overall	0.15	−0.24	−0.15	0.21	−0.38	−0.59[a]	−0.18	−0.37	−0.25	−0.4

BPRS (Brief Psychiatric Rating Scale); BA (Blunted Affect); EW (Emotional Withdrawal); SANS (Scale for the Assessment of Negative Symptoms); RI (Lack of recreational interests); SI (Lack of sexual interests and activity); IC (inability to feel intimate and close); FP (relationships with friends and peers); GAA (Global Anhedonia-Asociality); SAPS (Scale for the Assessment of Positive Symptoms).

[a] Correlation is significant at the 0.05 level.

depending on food category, $F(3,102) = 1.45$, $P = 0.24$; and the interaction between group (SZ, CO) and food category was not significant, $F(3,102) = 0.39$, $P = 0.71$. These results indicate that healthy controls and patients took similar amounts of time to rate food items and there were no differences in response times to rate the better liked (desserts and meat) compared with the less favored (pasta and vegetables) food items.

3.4. Relationships with symptoms

Total SANS and SAPS scores were not associated with food ratings or preference decisions. We examined relationships between anhedonia and food preference/rating more specifically using the SANS Anhedonia/Asociality factor ratings (including lack of recreational interests (RI), lack of sexual interests and activity (SI), inability to feel intimate and close (IC), relationships with friends and peers (FP), and the global anhedonia–asociality rating), and the BPRS blunted affect (BA) and emotional withdrawal (EW) items. Please see Table 1 for correlations. Relationships between negative symptoms and food ratings clustered around the SANS SI item. An increase in reported problems with sexual interest and activity was associated with lower positive food ratings in the following areas: average overall rating applied to food images ($rho = -0.59$, $P = 0.02$), ratings of meat dishes ($rho = -0.58$, $P = 0.02$), and the percent of *positive* (using a "4" or "5") ratings applied to food images overall ($rho = -0.58$, $P = 0.02$). There were no significant correlations between SPQ total and Constricted Affect items and food ratings for healthy controls. There were no associations between relative preference and liking dependent variables and the medication dose as indicated by the chlorpromazine binding equivalents.

4. Discussion

Based on previous findings suggesting anhedonia, decreased incentive reward valuation, and functional pathology in schizophrenia in brain regions involved in making preference decisions, we expected subjects with schizophrenia to display slower response times to food preference decisions compared to a control task, thereby indicating relative inefficiency in making relative reward decisions about food items, and we expected them to rate foods as having less hedonic value compared with ratings by healthy controls. The relative preference paradigm did not reveal differences between schizophrenia and control subjects in decision-making response times overall. However, measuring only response time may not capture subtleties in the food preference decision-making process.

For food hedonic ratings, all subjects tended to use the positive ratings overall. This reiterates the overall hedonic nature of the food stimuli and the premise that in the relative reward paradigm, subjects were indeed selecting from a range of preferred stimuli. Subjects with schizophrenia did not exhibit overall decreased hedonic judgments for food, but there were subtle differences in schizophrenia subjects'

food ratings that may be related to particular facets of anhedonia including sexual disinterest. This may speak to the underlying biological mechanisms that subsume similar vegetative processes such as appetite, sexual desire, and motivation to achieve pleasure.

In a similar study using the University of Pennsylvania Smell Identification Test, Doop and Park (2006) found that subjects with schizophrenia judged all odorants to be more pleasant overall and found that schizophrenia subjects used a restricted range of positive ratings. We found a similar phenomenon in schizophrenia where higher hedonic values are given to stimuli that are less appetitive to healthy controls, for example, vegetables. The higher ratings given to vegetables by subjects with schizophrenia probably do not represent an increased preference for vegetables in particular (McCreadie et al., 1998), but the use of higher ratings for all food substances. In other words, individuals with schizophrenia rated the vegetable food class higher than healthy controls did, but by using the positive ratings more often than the neutral or negative ones, both patients and controls showed an overall positive valuation of food images.

Our results do suggest that data showing poor dietary habits and choices in schizophrenia may be due to decreased availability of healthy food rather than to a lack of interest in eating healthier foods. Our results suggest that patients with schizophrenia would be less likely to discriminate between food choices, and that they would enjoy eating healthier vegetable dishes that may not be readily available in institutional settings. Thus, programs directed at offering healthy choices may be met with success and appreciation by patients. Our results suggest that patients enjoy different, and even healthier, foods than they may eat on average. This disconnection between their internal preference state and their behavioral choices may be at least partially explained by Frith's (1992) conceptualization of schizophrenia as a disorder of "willed action", or having difficulty converting internal states to actions when the desire is internally driven rather than imposed by the environment (Langdon et al., 2007).

Kapur (2003) has suggested that dopamine mediates the motivational salience of stimuli. Our results did not indicate a relationship between chlorpromazine dose equivalencies (which index the blockade of dopamine D2 receptors) and the preference or liking measures, but all subjects with schizophrenia were taking atypical antipsychotic drugs which have differential effects on the serotonergic system in addition to the dopamine receptors.

One methodological caveat is that we presented subjects with pictures rather than actual food items; however, cognitive and emotional reactions to food cues have been previously studied using pictures. These studies have shown that food pictures can elicit increased physiological responses and subjective measures of preference (Drobes et al., 2001), and they can be powerful motivational probes in fMRI paradigms, eliciting emotional responses and corresponding limbic activation (LaBar et al., 2001) depending on baseline satiety levels. In this study, all subjects were tested before receiving a meal in an attempt to minimize potential differences in satiety levels, and they were screened for subjective food restrictions (i.e. no vegetarians).

We investigated food preference and liking in schizophrenia, a mental disorder that may represent an ideal population for studying the underlying neurobiology of food valuation and preference based on overlapping brain circuitry of the hedonic system and neuropathology in schizophrenia. Although the relative preference paradigm did not reveal quantitative differences in preference decision-making in schizophrenia, this type of paradigm may be a useful approach to functional neuroimaging studies in the future in order to uncover potential qualitative differences in the underlying neural circuitry that is related to reward function. Our results indicate that there are subtle differences in food liking in schizophrenia, possibly based on a lower hedonic threshold for food, and that these differences may be related to the same processes involved in other vegetative mechanisms in schizophrenia.

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