Social Anhedonia in Schizophrenia: A Meta-Analytic Synthesis of the Literature

by

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Abstract

Social anhedonia, or lack of pleasure from social situations, is a common feature among different forms of psychopathology. Specifically, social anhedonia appears in individuals with a schizophrenia spectrum disorder as well as those at genetic and/or psychometric risk for the later development of a schizophrenia diagnosis. Social anhedonia is a negative symptom that is not specified currently in the DSM-5. Research shows that we see higher levels of social anhedonia in individuals with schizophrenia spectrum disorders compared with controls regardless of age or gender of the sample. Given these differences, this meta-analysis examined the role of social anhedonia in schizophrenia to see if it may be better described as a core characteristic or symptom of the disorder rather than a common feature. I conducted a meta-analysis of 45 studies looking at social anhedonia scores in schizophrenia spectrum patients and psychometric and genetic high-risk samples compared with controls. The overall effect size was very large, $g = 1.14$, across all studies, revealing that individuals in the schizophrenia risk group scored higher on measures of social anhedonia than did those in the control group, by a substantial amount. Although some moderators showed significant effects, all effect sizes in all categories of studies were large. These findings suggest that social anhedonia is a core characteristic or symptom of a schizophrenia spectrum diagnosis and could be a useful target for treatment and prevention strategies. Further implications of the findings are discussed.

Chapter 1: Introduction: Social Anhedonia in Schizophrenia

Most people find pleasure from social interactions with others be it with people they just met or people they have known for years. The human contact that these interactions provide allows people to feel connected with others. Research reveals the importance of social support for physical and mental health (Kawachi & Berkman, 2001; Feeney & Collins, 2015). One common theme across different forms of psychopathology is interpersonal difficulties. Challenges with interpersonal relationships are a core characteristic of many disorders including schizophrenia, depression, and personality disorders. One particularly relevant facet of these difficulties within interpersonal relationships occurs when an individual does not enjoy these social interactions, i.e. social anhedonia. The goal of this dissertation is to examine the relationship between social anhedonia and schizophrenia quantitatively, using meta-analysis. To understand this relationship to the fullest extent, schizophrenia spectrum disorders and schizophrenia risk are also included.

Social Anhedonia

Social anhedonia is defined as a reduction or lack of pleasure from social interactions. Social anhedonia can negatively affect social relationships and interpersonal functioning. By not experiencing pleasure from social situations, one may not seek out relationships and/or have difficulty interacting within social settings (Green et al. 2015). Social anhedonia is associated with fewer close relationships and romantic relationships as well as decreased satisfaction within a romantic relationship (Blanchard et al., 2011; Kwapil, 1998; Assad & Lemay, 2018). Social anhedonia is related to individuals with schizophrenia having less social support and that social anhedonia leads to problematic

family relationships (e.g. individuals with social anhedonia reported more conflict and less cohesion among family members; Blanchard et al., 2011). Social anhedonia is also associated with poorer social functioning (Green et al., 2015).

Social anhedonia is not the same as social anxiety nor is it simply a tendency towards shyness or introversion that leads one to a life of solitude (Aldren & Auyeung, 2014; Silvia & Kwapil, 2011; Martin et al., 2016; Kwapil et al., 2014). Social anhedonia, as measured indirectly via the Anticipatory and Consummatory Pleasure Scales (ACIPS; Gooding & Pflum, 2014a) is distinct from social anxiety as measured by the Mattick and Clark (1998) Social Interaction Anxiety Scale (Gooding et al., 2015). Others have found that social anhedonia as measured by the Chapman Psychosis Proneness Scales is distinct from social anxiety (Cicero et al., 2016). Social anhedonia presumably involves disruption in the positive valence system; typically, individuals experience reward when they engage in a social interaction. Social anxiety is thought to implicate the negative valence system in which an individual experiences fear from social interactions (Olino, 2016; Paulus et al., 2017).

Social anhedonia is seen in several forms of psychopathology, including schizophrenia, Major Depressive Disorder (Blanchard, Horan & Brown, 2001; Atherton et al., 2015), Autism Spectrum Disorders (see Chevallier et al., 2011, Foulkes, 2015), substance use disorders (Zhornitsky et al., 2012; Garfield et al., 2014), and eating disorders (Harrison et al., 2014; Tchanturia et al., 2012). As the current diagnostic system attempts to move away from a purely categorical approach towards one of assessing behaviors associated with mental illness on a continuum (Krueger & Eaton, 2010), it may be particularly useful to include social anhedonia as a construct for assessment, given its

presence throughout psychopathology. As it stands, social anhedonia is not a specific diagnostic criterion for any of the disorders outlined in the DSM-5 (APA, 2013). This meta-analysis examines the relationship between social anhedonia and schizophrenia spectrum disorders. Specifically, this project aims to examine the developmental trajectory of social anhedonia in schizophrenia spectrum disorders and degree to which social anhedonia occurs among individuals with a schizophrenia spectrum disorder diagnosis as well as those at genetic and psychometric risk for the disorder.

Social Anhedonia and Schizophrenia Spectrum Disorders

Schizophrenia is a complex mental illness that affects 1% of the population (World Health Organization, 2018). Schizophrenia is a neurodevelopmental disorder that typically manifests in early- to mid-adulthood. It affects males approximately 1.4 times more than females (Aleman et al., 2003; McGrath et al., 2004). Individuals who suffer from schizophrenia and schizophrenia spectrum disorders experience a number of symptoms that affect most aspects of their lives (e.g. social, emotional, and occupational functioning). These symptoms include excess behaviors (e.g hallucinations and delusions) as well as a loss of normal functioning (APA, 2013). The most well-known symptoms are the positive symptoms, namely hallucinations and delusions, which are often alleviated with antipsychotic medications. Thought disorder and cognitive disorganization are also positive symptoms of schizophrenia that cause significant impairment (Andreasen, 1982). Individuals with schizophrenia have working memory deficits and difficulty switching attention. Other symptoms include anhedonia, alogia (poverty of speech), affective flattening, and avolition (lack of motivation). All of these

negative symptoms are more resistant to pharmacological interventions yet are just as detrimental to an individual's overall functioning as are the positive symptoms (Galderisi et al., 2018).

Despite its omission from the diagnostic criteria, social anhedonia is commonly regarded by researchers as a core feature of schizophrenia. Rado (1953) characterized social anhedonia in schizotypal individuals by stating, "because his (sic) capacity for affection and human sympathy is reduced he cannot reciprocate when receiving them, still less elicit them" (p. 411). Meehl continued with that conceptualization and asserted that "schizoid anhedonia is mainly interpersonal" (1962; p. 833). That is, individuals with schizophrenia do not experience a generalized lack of pleasure but rather, the lack of pleasure is specific to social situations. Yet, despite scientific recognition of the role of social anhedonia, neither DSM III, nor DSM IV, nor DSM 5 have not included social anhedonia as a core feature of schizophrenia. As the field of psychopathology moves towards the National Institute of Mental Health's Research Domain Criteria (RDoC), social anhedonia may be an important construct for consideration.

The DSM 5 (APA, 2013) defines asociality as a lack of interest in social interactions, which is a negative symptom in individuals with schizophrenia but suggests that it may be due to avolition, or a lack of motivation, to interact or a lack of interactions available to them. However, it may be that the asociality and anhedonia (another negative symptom of schizophrenia) are more connected and are better captured by one construct, namely *social anhedonia.* Most of the research surrounding social anhedonia has been done in patients with schizophrenia.

Individuals with schizophrenia experience higher levels of social anhedonia compared with age-matched controls (Chapman et al. 1976; Berenbaum & Oltmanns, 1992; Blanchard et al., 1998). In individuals with schizophrenia, social anhedonia is associated with experiencing less social support and having poorer functioning in social situations (Green et al., 2015). However, social anhedonia is also reported in relatively healthy individuals presumably without a genetic risk for a schizophrenia spectrum disorder. Additionally, social anhedonia occurs at a higher rate in first-degree relatives of individuals with schizophrenia, suggesting a genetic component to the disorder (Docherty et al., 2015; Docherty & Sponheim, 2014; Asarnow et al., 2001; Carver & Pogue-Guile, 1999; Kendler et al., 1996).

Schizotypy, a latent personality construct posited by Meehl (1962), leads to three outcomes, namely, deviance on personality measures/lab indicators, schizophrenia spectrum disorders, or schizophrenia, depending on a combination of stressors and compensatory factors. Negative schizotypy can be thought of as attenuated negative symptoms of schizophrenia, such as social anhedonia and physical anhedonia. Negative schizotypy, as measured by social anhedonia, appears to be a risk factor for the later development of schizophrenia and schizophrenia spectrum disorders (Gooding et al. 2005; 2007; Kwapil, 1998). Positive schizotypy can be thought of as attenuated positive symptoms, i.e. sub-threshold psychotic-like experiences involving aberrant perceptions, delusional thinking, and disorganization. Individuals who score high on measures of positive schizotypy appear to be at heightened risk for the later development of a psychotic disorder, including schizophrenia (Chapman et al., 1994).

Individuals at heightened risk for schizophrenia show subtle signs before they manifest full-blown schizophrenia. That is, they show similar clinical characteristics and symptoms as individuals with schizophrenia, but to a lesser degree. Studying psychometric schizotypes also eliminates the potential confounds of hospitalization and medication side effects seen in individuals with schizophrenia. Nonclinical schizotypes have less social support and score as less competent in their ability to interact socially compared with controls (Llerena et al., 2012). Therefore, researchers should investigate not only those with a schizophrenia spectrum diagnosis, but also those at heightened risk for the later development of a schizophrenia-spectrum disorder. These at-risk individuals may reveal a developmental pathway specific to schizophrenia. Studying individuals at risk for the later development of schizophrenia may lead to insights about precursors and risk factors of the disorder. Therefore, this meta-analysis includes research sampling both individuals with a schizophrenia spectrum disorder and those at risk for the later development of a schizophrenia spectrum disorder as measured by their scores on a psychometric measure of schizotypy or their risk based on genetic associations with schizophrenia patients.

Measures of Social Anhedonia

Social anhedonia is most commonly assessed using self-report measures. These measures tap an individual's inability to receive pleasure from social interactions. One direct measure, the Revised Social Anhedonia Scale (RSAS: Eckblad et al., 1982) is a 40-item questionnaire that assesses an individual's lack of interest and/or pleasure in social interactions. Higher scores indicate greater social anhedonia. An example item is "I sometimes become deeply attached to people I spend a lot of time with" (keyed false).

Other self-report measures may serve as an indirect assessment of social anhedonia by measuring social hedonic capacity. That is, rather than asking a true/ false question of *if* someone likes a social situation, one uses a Likert scale to measure how much a person enjoys a social situation. One example of an indirect measure is the 17-item Anticipatory and Consummatory Interpersonal Pleasure Scale (ACIPS; Gooding and Pflum, 2014a). This measure assesses an individual's ability to experience pleasure from social interactions. Higher scores on the ACIPS indicate lower levels of social anhedonia. An example item is "I look forward to seeing people when I'm on my way to a party or get-together " (keyed true).

Several measures assess schizotypy broadly, but have subscales for social anhedonia. The Schizotypal Personality Quotient (SPQ; Raine, 1991) assesses the symptoms of schizotypal personality disorder, which is a schizophrenia spectrum disorder. The No Close Friends subscale, includes 9 items that assess social anhedonia. A sample item is "I have little interest in getting to know other people" (keyed true). For this meta-analysis only the subscale score was used as a measure of social anhedonia.

The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason, Claridge, & Jackson, 1995) is another schizotypy assessment that includes the Introverted Anhedonia subscale with six items. An example item is "Do you feel very close to your friends?" (keyed yes). For this meta-analysis, only the Introverted Anhedonia subscale score was used as a measure of social anhedonia.

Interviews are also suitable for assessing social anhedonia, and are often done with patient samples. For example, The Scale for Assessment of Negative Symptoms (SANS; Andreasen, 1983) includes an Anhedonia /Asociality subscale, and the Clinical

Assessment Interview of Negative Symptoms (CAINS; Kring et al, 2013; Forbes et al., 2010) includes a set of questions assessing social anhedonia. For a full list and description of anhedonia assessments, see Fonseca-Pedrero et al. (2014). However, these interviews have been designed exclusively for patient samples and therefore would not be administered to a control or comparison group, which is necessary for this meta-analysis.

Studies using specific self-report measures of social anhedonia were included. Studies based on clinical interviews were not included, as they would not include a comparison sample. Therefore, the final literature search included studies that used the revised Social Anhedonia Scale (Eckblad et al., 1982), the Anticipatory and Consummatory Pleasure Scale (Gooding & Pflum 2011), the Schizotypal Personality Questionnaire (No Close Friends subscale; Raine, 1991), and the Oxford-Liverpool Inventory of Feelings and Experiences (Introverted Anhedonia subscale; Mason et al. 1995). See Appendix A for a list of items from these questionnaires. All of these psychometric assessments are appropriate to use with individuals at risk for the later development of schizophrenia as well as with patient populations; they are therefore appropriate to use in this meta-analysis for comparing two groups in quasi-experimental designs.

The Present Study

The goal of my dissertation was to assess the magnitude of the relationship between social anhedonia and schizophrenia and schizophrenia spectrum disorders including individuals at risk for the later development of a schizophrenia spectrum disorder (i.e. those with schizotypy). To accomplish this goal, I conducted a meta-

analysis of studies that included either (a) a two-group design using a schizophrenia risk sample (i.e., those with a schizophrenia spectrum disorder and/or those at risk for the later development of a schizophrenia spectrum disorder based on genetic risk or psychometric risk) compared with a control group, or (b) correlational studies that included a measure of schizophrenia risk and a measure of social anhedonia. For the sake of simplicity, in what follows, predictions are stated in terms of two-group designs. Mean differences between groups in two-group designs and correlations between predictors and outcomes in individual differences designs can both be quantified using the standardized effect size *d*. It was hypothesized that individuals with schizophrenia and schizophrenia spectrum disorders would endorse higher levels of social anhedonia compared with controls, consistent with previous research (Andreasen, 1982; Blanchard et al., 1998). Second, it was hypothesized that the effect size of this relationship would be stronger for individuals with a diagnosis of schizophrenia compared with those at heightened risk who experience attenuated symptoms but do not meet diagnostic criteria (e.g. those with schizotypy). The major goal of this meta-analysis is to estimate the strength of the relationship between social anhedonia and schizophrenia. Moreover, the goal is to better define the role of social anhedonia in schizophrenia to highlight the construct as a core symptom important in the diagnostic criteria and treatment of the disorder. Additional hypotheses pertain to moderators, as described below. This information can then assist with diagnosis and, potentially, treatment of schizophrenia.

Potential Moderators

One potential moderator is gender. Schizophrenia is more prevalent in males than

females (Aleman et al., 2003; McGrath et al., 2004). Overall, males in general typically score higher on measures of social anhedonia than females (Miettunen et al., 2010; Gooding & Pflum 2014a). It was hypothesized that the difference in social anhedonia between schizophrenia risk group and control would be larger in males than in females.

A second potential moderator is age. Social anhedonia has been observed in children and adolescents ages 6-18 (Gooding et al., 2016; Gadow & Garman, 2018). Dodell-Feder and Germine (2018) found that social anhedonia exhibits two major transition periods throughout the lifespan in the general population, with a steady increase from ages 9 to 15, a smaller increase until age 43 where it peaks, and then a steady decline. However, given that it is hypothesized that social anhedonia is a core characteristic or symptom, and observed in first-degree relatives as well as those at psychometric high risk, it was hypothesized that age would not affect the strength of the association between schizophrenia risk and social anhedonia.

Symptom severity as measured by sample type is a third potential moderator. The hypothesis was that the strength of the relationship between schizophrenia risk and social anhedonia would increase as severity increases. Therefore, it was hypothesized that the difference in social anhedonia between schizophrenia risk group and control would be strongest in inpatient samples followed by outpatient/community samples. First degree relatives and undergraduates would show weaker relationships, as they would not currently meet diagnostic criteria for a schizophrenia spectrum disorder.

Phenomenological subtype (schizophrenia only, schizoaffective disorder, schizotypy) is a fourth potential moderator. Phenomenological subtype reflects a level of symptom severity, and the hypotheses assume that as symptom severity decreases, so

does the strength of the relationship between schizophrenia risk and social anhedonia. Ritsner and colleagues (2018) found that individuals with schizoaffective disorder scored higher on measures of social pleasure, and therefore less social anhedonia, than did individuals with schizophrenia. Therefore, it was hypothesized that the difference in social anhedonia between schizophrenia risk group and controls would be stronger for those individuals diagnosed with schizophrenia or schizoaffective disorder than those samples with mixed diagnoses that include schizophrenia spectrum disorders (e.g. schizotypal or paranoid personality disorder).

Medication status is a fifth potential moderator. Social anhedonia is a negative symptom of schizophrenia, which is not treated by psychotropic medications. It is not a symptom that is secondary to the medication. Cohen and Minor (2010) found no effect of medication status in their meta-analysis on emotional experience in patients with schizophrenia. Therefore, it was hypothesized that medication status would not be a significant moderator of the strength of the relationship between schizophrenia risk and social anhedonia.

Measurement of social anhedonia is a sixth potential moderator. Different scales include social anhedonia questions only or include social anhedonia items in a larger scale measuring negative schizotypy in general. It was hypothesized that scales designed specifically to capture social anhedonia (e.g Chapman's Social Anhedonia Scale and the Anticipatory and Consummatory Interpersonal Pleasure Scale) would reveal a stronger relationship between schizophrenia risk and social anhedonia than those subscales of broader measures that include other subscales not intended to measure social anhedonia (e.g., Schizotypal Personality Questionnaire and O-LIFE). This is because measures

assessing schizotypy broadly, may include items not relevant to social anhedonia within their subscale. Therefore, the ACIPS and RSAS have more content validity.

Additionally, while most researchers have participants complete social anhedonia assessments in person, there has been some push to conduct the assessments on large groups of individuals via online platforms (e.g., MechanicalTurk). Although current findings suggest no differences in responses for online versus laboratory studies for general heath data (Lewis et al., 2009), less is known about potential complications for assessing psychological symptomatology. Given the nature of the schizotypy questions, it is encouraged that participants come into a laboratory to complete these specific questionnaires in order to increase experimental control, eliminate potential distractions, and avoid other complications associated with online testing (Birnbaum, 2004). It was hypothesized that the strength of the relationship would be stronger for those studies in which social anhedonia was assessed in a lab setting compared with those completed online.

Chapter 2: Methods

Literature search

A comprehensive literature search was conducted for published journal articles and unpublished dissertations indexed in the following databases: PsycINFO, MEDLINE, Web of Science, and SCOPUS. The goal was to identify studies examining the relationship between social anhedonia and schizophrenia. To ensure that we did not miss relevant articles, we used the broad search terms "anhedonia" and "schiz*". Articles were limited to English-language papers but no limitations were made in regards to publication date or publication status (e.g., dissertations were included).

Study Designs

In terms of study design, this meta-analysis included two-group quasi experiments with a schizophrenia spectrum risk group and comparison group, as well as single-group correlational studies using an assessment of social anhedonia and an assessment of schizotypy.

Inclusion/Exclusion Criteria

Correlational studies were retained if the association between social anhedonia and schizophrenia spectrum disorder was reported in either a cross-sectional or longitudinal design. Necessary correlation coefficients were requested from authors if they were not reported. Additionally, if the measure of social anhedonia was from a broad anhedonia measure, means and standard deviations from the social anhedonia questions only were requested from the authors. Two-group experimental designs were included when both a control group and schizophrenia risk group were given the same

social anhedonia measure. The same statistics were requested from authors if not originally provided.

For studies that included both positive and negative schizotypy samples, this analysis only included the positive schizotypy group because the negative schizotypy group is typically derived from scores on a measure of social anhedonia. For this meta-analysis, the inclusion of negative schizotypy samples, in which the group was selected specifically for their high social anhedonia score would result in bias findings and therefore seemed circular.

Search Results

The final search was conducted in June 2018. Overall the literature search yielded a total of 4005 articles of which 2356 were duplicates, and a further 1416 were excluded as they did not include a schizophrenia risk sample. Finally, of the 223 full texts read, 176 were excluded as they did not include a measure of social anhedonia, 10 were excluded for incomplete data, and 4 were excluded for repeated data. This resulted in 43 full text articles included with a total of 46 independent samples in this meta-analysis (see Figure 1 and Table 1).

Coding of Moderators

The following information was coded for each study: (a) type of measurement for social anhedonia; (b) the research design (quasi-experimental or correlational); (c) the type of sample (patient, outpatient/community, undergraduate, family, i.e., genetic risk) (d) statistics on group differences or correlations including means, standard deviations, and *r* values; (e) mean age of the participants; (f) date of publication; (g) publication status (peer reviewed or unpublished); (h) focus of the article (social anhedonia,

schizophrenia, or schizotypy); (i) phenomenology of diagnosis (mixed diagnoses, spectrum diagnoses, schizotypy); (j) online vs. in-person administration of social anhedonia assessment; (k) medication status; and (k) demographic information from the samples (age, race, SES, education, nation, and percentage of males in patient and control groups).

Sample Characteristics

An overview of the studies included in the meta-analysis is presented in Table 1. Descriptives of the studies are presented in Table 2. Demographic data of the samples are presented in Table 3. See Appendix B for a sample coding sheet. See Appendix C for the coding manual, which includes exactly how articles were coded, including what information took priority (e.g., Focus of article) as well as details about each moderating variable.

Analytic Plan

The meta-analysis was conducted to assess the magnitude of the relationship between social anhedonia and schizophrenia risk in schizophrenia spectrum disorders. Follow-up analyses were conducted to assess potential moderators. All analyses were performed using Comprehensive Meta-Analysis, Version 3 (2014). For correlational designs, effect sizes expressed as a Pearson's product-moment correlation (r) were converted to *d*. Effect sizes were used in the overall meta-analyses to assess the magnitude of the difference between schizophrenia risk group and control groups on social anhedonia (the magnitude of the correlation for correlational designs). The magnitude of effect size estimates is interpreted using Cohen's (1988) guidelines: d = 0.20 is a “small” effect, 0.50 is a “medium” effect, and 0.80 is a “large” effect.

When examining effect sizes, two types of models are typically used, fixed effects models and random effects models, which differ in their assumptions (Borenstein et al., 2009). The fixed effects model assumes that one true effect size exists and that all differences in the effects are due to sampling error. The random effects model assumes that the true effect may vary from study to study, based on many different participant factors (age, gender, location) and that the model attempts to distribute the effects around some mean.

For the purposes of this dissertation, all models were run using both the fixed effects model and the random effects model. However, given the number of studies included, I likely did not have enough power for the random effects model to yield significant results. Overall, when the fixed effects model was significant, the random effects model was not, but individual effect sizes were all relatively large. Interpretations are discussed in the follow sections.

Chapter 3: Results

Effect Size Computation

Effect sizes were calculated for each study as a Cohen's *d* (Cohen, 1988). Quasi-experimental studies had *d* scores calculated from the means and standard deviations of the patient group and control group. Correlational studies had *r* values converted to *d*. The *d* for each sample was computed such that positive values indicated schizophrenia risk groups had higher levels of self-reported social anhedonia than controls. Given that *d* has a slight bias, tending to overestimate the population value in small samples, we used the correction that yields an unbiased estimate, Hedges' *g* (Hedges, 1981), which was the effect size used for the meta-analyses. I corrected from Cohen's *d* to Hedges' *g* and reported effect sizes as *g* throughout.

Analyses for Possible Bias and File Drawer Effects

I guarded against publication bias and file drawer effects (Rosenthal, 1979) in several ways: (1) I coded articles based on the focus of the article to determine whether studies focused on social anhedonia showed larger effect sizes than articles with another focus (e.g., schizophrenia or schizotypy) (2) I followed up with authors to retrieve unpublished data on social anhedonia scores in schizophrenia risk samples and moderating variables when these were not reported adequately in the article. (3) Unpublished studies were included to guard against the possibility of only having studies that reported on significant group differences. Overall, 2% percent of the studies included in the meta-analysis were unpublished.

A funnel plot analysis (see Figure 2) revealed a generally symmetrical pattern, which was confirmed by the nonsignificance of the Eggers test, $t(42) = 1.34$, $p = 0.09$.

However, the Eggers test could also be interpreted as being marginally significant, providing marginal evidence of bias in the sampling of studies. Inspection of the funnel plot does show an absences of studies in the lower left, suggesting that there are smaller effect sizes or non-significant findings that are missing from this meta-analysis (Borenstein et al., 2009; Eggers et al., 1997).

Magnitude of the Association between Social Anhedonia and Schizophrenia Spectrum Risk

The random-effects estimate of the weighted mean effect size for differences in social anhedonia scores for differences between schizophrenia risk groups and controls was g=1.14, CI [0.98, 1.31], p <0.001. This value of g is equivalent to r = 0.50. The random effects variance component was 0.007. The set of effect sizes using the fixed effects model was significantly heterogeneous, $Q(44)=414.91$, p <0.001. Thus, moderator analyses were appropriate. See Figure 3 for a forest plot of effect sizes and confidence intervals for each study.

Moderators

Gender. Given that very few samples were all-male or all-female samples, gender was examined as a continuous variable, based on the percentage of male participants. Using a meta-regression analysis, gender did not account for significant variation in the strength of the relationship of social anhedonia and schizophrenia risk, ß = -0.006, p = 0.89. Contrary to the hypothesis, the relationship was not stronger in samples with a higher percentage of males.

Age. Age was grouped into 4 categories; <18, 18-29, 30-39, >40 years of age. Contrary to hypotheses, the age of the sample accounted for significant variation in effect size using the fixed effect model, $Q_B = 36.99$, $p < 0.001$ (see Table 3). Follow-up analyses indicated that the effect size was stronger for those in the 18-29 age group, $g = 1.21$, $p < 0.001$, 30-39 age group $g = 1.16$, $p < 0.001$, and the under-18 group $g = 1.16$. Those samples of participants over age 40 had a significantly smaller effect size, $g = 0.92$, $p < 0.001$. Results were similar for the random effects model, $Q_B = 20.35$, $p < 0.001$.

Sample Type. Sample type accounted for significant variation in effect size using the fixed effects model, $Q_B = 24.82$, $p < 0.001$. Follow-up analyses revealed that patient samples had the strongest effect, $g = 1.43$, followed by undergraduates, $g = 1.29$, and other samples (including first-degree relatives) $g = 1.19$. As predicted, community/outpatient samples had less strong effects, $g = 1.08$, than did inpatients. However, contrary to hypotheses, the community samples revealed less strong relationship than the at-risk samples. Sample type did not account for significant variation in effect size using the random effects model, $Q_B = 0.09$, $p = 0.92$. Regardless of fixed or random effects analyses, each effect size was greater than 1.0, indicating a very large overall effect.

Schizophrenia Subtype. The phenomenology of the diagnosis accounted for significant variation in effect size, using the fixed effects model, $Q_B = 29.52$, $p < 0.001$. Follow-up analyses revealed that samples that did not report any subtypes, $d = 1.36$, and undergraduate samples, $g = 1.29$, showed the strongest effects. Samples that did and did not include subtypes (e.g., those with schizoaffective disorder diagnoses as well as schizophrenia) showed less strong effects, $g = 0.81$, $p < 0.001$ for mixed samples, and $g =$

0.88, p <0.01 for non-mixed samples. Schizophrenia subtype did not account for significant variation in effect size using the random effects model, $Q_B = 1.28$, p = 0.86, but again all effect sizes were greater than 0.88, indicating large effects for all categories.

Type of Assessment. Using a fixed effects model, type of assessment accounted for significant variance in effect size, $Q_B = 31.52$. As expected, follow-up analyses revealed that the RSAS and ACIPS had larger effect sizes $g = 1.12$ and $g = 1.34$ respectively, than did the SPQ, $g = 0.40$, $p = 0.10$. Type of assessment was marginally significant using the random effects model, $Q_B = 9.38$, p = 0.052. Note in Table 2 that there was only one study for each the SPQ, the O-LIFE, and Other category, which is not ideal for a meta-analysis. The moderator analysis was re-run combining those 3 categories and the results did not change.

Use of Online Assessment. Administering a measure of social anhedonia online or in person did not account for significant variation in effect size for the fixed effects model, $Q_B = 1.49$, $p = 0.22$, or the random effects model, $Q_B = 0.02$, $p = 0.8$. Contrary to the hypothesis, the use of online administration of the social anhedonia measure did not change the strength of the relationship between social anhedonia score and schizophrenia risk. These results should be interpreted with caution, though, because only 3 studies used online assessment.

Medication Status. Analyses were not performed as not enough studies reported information on duration or type of medication.

Focus of Article. To test for possible publication bias, a moderator analysis examined differences in effect sizes between articles that focused on social anhedonia (typically large undergraduate samples), compared with articles that focused on

schizophrenia or schizotypy. The effect for focus of article was significant, using the fixed effects model, $Q_B = 100.34$, such that articles focused on social anhedonia, $g = 1.41$ or schizotypy $g = 1.23$, yielded larger effect sizes than articles that focused on schizophrenia $g = .91$. Focus of article did not account for significant variation in effect size using the random effects model, $Q_B = 4.75$, $p = 0.19$.

Type of Study Design. Using a fixed effects model, type of design accounted for significant variance in effect size, $Q_B = 40.05$. Follow-up analyses revealed that correlational designs had stronger effect sizes, $g = 1.36$, than did two-group designs, $g = 1.04$. Type of design did not account for significant variation in effect size using the random effects model, $Q_B = 0.61$, $p = 0.43$.

Chapter 4: Discussion

The overall goal of this dissertation was to estimate the strength of the relationship between social anhedonia and schizophrenia risk as well as to determine if that relationship varied as a function of several moderators: gender, age, sample, schizophrenia subtype, type of social anhedonia assessment, format of assessment, medication status, and study design. The overall effect size was very large, $g = 1.14$. Age, sample, schizophrenia subtype, assessment type, and study design were all significant moderators. However, in all moderator analyses, all effect sizes were very large.

These large effect sizes suggest that social anhedonia is a core characteristic of schizophrenia risk, regardless of age, gender, or level of risk (e.g. psychometric risk or genetic risk). The majority of studies were two-group designs comparing a schizophrenia risk group with a control group. All of the studies had a positive effect size, indicating that schizophrenia risk groups very consistently showed higher social anhedonia scores than controls. This meta-analysis indicated that individuals with schizophrenia as well as those at heightened risk for the later development of schizophrenia have higher social anhedonia scores, consistent with observations of clinicians and theories of the disorder.

Moderator Analyses

When examining the strength of the relationship between social anhedonia and schizophrenia risk, a number of potential moderator variables were also assessed.

Gender. Although gender differences in social anhedonia have often been reported, with males showing higher scores than females, gender did not impact the strength of the relationship between social anhedonia scores and schizophrenia risk

group. Contrary to the hypothesis, studies with larger percentages of male participants showed no difference in the strength of the relationship compared with those with higher percentages of female participants. However, this finding should be interpreted with caution because the Chapman Social Anhedonia scale uses different means and standard deviations for males and females to set cutoff scores, as opposed to a uniform cutoff score for both groups. Therefore, there could be a restricted range of scores, which would weaken the correlation.

The hypothesis about gender was framed based on the reasoning that, if males score higher than females on social anhedonia, the correlation between social anhedonia and schizophrenia should be higher for males. In retrospect, this reasoning was statistically flawed; if one group scores higher on a variable that does not imply that the group will display a higher correlation between that variable and another variable.

Age. Another potential moderating variable was age. It was hypothesized that there would not be age differences in effect sizes, as social anhedonia is a core characteristic observed in individuals before a diagnosis, as well as in first-degree relatives without a diagnosis of schizophrenia. However, results indicated that the relationship between social anhedonia and schizophrenia risk does vary depending on age. Specifically, the relationship is strongest for those individuals younger than 30 and is weaker for older individuals. This finding is in line with the results of Dodell-Feder and Germine (2018), which indicate that social anhedonia increases steadily in adolescence, but continues to increase although less sharply until the age of 43. These results suggest that when near the average age of disorder onset (20-30) the relationship between self-reported social anhedonia and schizophrenia risk is strongest. This could be

due to the fact that individuals in this age range are experiencing marked symptoms associated with a schizophrenia diagnoses. It could also be due to the timing of social relationships in young adults. Late adolescence and early adulthood is a time associated with a shift towards independence in relationships, exploring new roles in relationships, and experiencing newer intimate relationships (Zarrett & Eccles, 2006). As adults age, they have fewer social relationships but report enjoying those relationships more (Luong et al., 2011). Most research currently conducted on social anhedonia in schizophrenia spectrum disorders looks at the ages in which the symptoms are most apparent (i.e., 18-40). This meta-analysis included only one study with a sample of individuals younger than 18; however, more work is being done to assess social anhedonia in children and adolescents.

Sample subtype. Sample subtype, reflecting symptom severity, was a potential moderating variable. I hypothesized that the difference in social anhedonia between schizophrenia risk group and control would be strongest in inpatient samples followed by outpatient/community samples given that inpatient samples likely experience the most intense symptoms including social anhedonia. Undergraduates and first-degree relatives were expected to have less strong relationships. As predicted, the inpatient sample had the strongest effect size, suggesting that inpatients have the largest differences from controls in social anhedonia. However, contrary to expectations, undergraduate samples and those samples that included first-degree relatives also showed stronger effects compared with outpatient/community samples. This suggests that even without experiencing symptoms of schizophrenia, individuals at risk show a strong association between social anhedonia and their schizophrenia risk. Interestingly, looking at the

mixed effects estimates rather than the random effects model, the strength of the relationships between social anhedonia and schizophrenia risk group is largest for the inpatient samples, followed by outpatient samples, followed by all other samples, which is exactly what was predicted.

Phenomenological subtype. Similarly, schizophrenia subtype, that is, whether samples had just schizophrenia, or a mixture of schizophrenia spectrum disorder diagnoses was hypothesized to be associated with symptom severity. Specifically, it was hypothesized that the difference in social anhedonia between schizophrenia risk group and controls would be stronger for those individuals diagnosed with schizophrenia compared with samples with mixed diagnoses that included schizophrenia spectrum disorders (e.g. schizotypal or paranoid personality disorder). Contrary to hypothesis, despite not meeting any diagnostic criteria for a schizophrenia diagnosis, those at psychometric risk for the later development of schizophrenia had the strongest relationship. It should be noted that those studies that did not report diagnostic information on their schizophrenia sample (13%) revealed the strongest relationship. Nonetheless, all effect sizes were large. Results of these analyses should be interpreted with caution, though, due to the small number of studies in the schizophrenia and schizoaffective diagnosis categories.

Measure of social anhedonia. Given that some measures of social anhedonia were created specifically for that purpose whereas other measures are subscales from larger assessment tools that do not directly measure social anhedonia, it was hypothesized that measures solely assessing social anhedonia would show a stronger relationship compared with measures that were part of a larger questionnaire. As expected, those

measures assessing social anhedonia only (namely the RSAS and the ACIPS) had a stronger relationship than those measures that included a smaller subscale addressing social/interpersonal pleasure. This suggests that when measuring social anhedonia, it is advantageous to include a measure designed specifically for that purpose, rather than using a schizotypy scale that may include some items associated with social anhedonia.

Online assessment. It was hypothesized that assessing for social anhedonia in the laboratory would show a stronger relationship between social anhedonia and schizophrenia risk compared with those studies that used online assessment. Results indicated that the mode of administration (online vs. in-person) did not impact the effect size, suggesting that it does not matter how individuals competed self-report assessments of social anhedonia. However, a majority (93%) of the studies were conducted in-person, so this finding should be interpreted with caution given that only three studies used online assessment.

Focus of article. To test for possible publication bias in the social anhedonia studies included in this meta-analysis, focus of article was tested as a moderator. There was a significantly stronger effect size for those studies that focused on social anhedonia or schizotypy compared with those studies that focused on schizophrenia. It may be that there is a sampling bias such that those studies based on social anhedonia were looking specifically for those group differences, and studies that failed to find group differences in social anhedonia were unlikely to be published, reflecting the file drawer effect. This finding may also be due to the methodology in schizotypy research that identifies negative schizotypes based upon their social anhedonia scores. The studies that focused

on schizophrenia may incidentally incorporate social anhedonia while looking for other symptoms of the disorder.

Social Anhedonia's Position in Research Domain Criteria and Hierarchical Taxonomy of Psychopathology

Research Domain Criteria (RDoC) is a research framework, outlined by NIMH, to study mental heath disorders using a dimensional approach rather than a categorical one. It integrates information including behavior and neurobiology across diagnoses to better understand mental illness. RDoC outlines six major domains (Negative Valence Systems, Positive Valence Systems, Cognitive Systems, Systems for Social Processes, Arousal/Modulatory Systems, and Sensorimotor Systems), which are studied using different levels of analysis (e.g. genes, circuits, self-reports).

Given that social anhedonia is present in other forms of psychopathology, and that it is experienced as both a trait and state of mental illness, it seems necessary to examine it further in other forms of psychopathology (Barkus and Badcock, 2019). Social anhedonia has been proposed as a transdiagnostic construct (Bedwell et al., 2014) that fits RDoC criteria. RDoC not only has the promise to elucidate a more reliable and valid psychiatric nosology, which allows us to tailor treatments, but also allows a better understanding of pathological processes and mechanisms, thereby enabling greater focus on primary prevention strategies (Insel, 2011). Currently, it is unclear whether social anhedonia would fit best under the social processes or positive valence domain.

Although some (Bedwell et al., 2014) have already posited that anhedonia broadly fits under the positive affect domain, social anhedonia likely can be separated and studied independently of general anhedonia. One domain in the RDoC matrix that is relevant to

social anhedonia is the Systems for Social Processes domain. Specifically, this domain assesses attachment formation and maintenance, which suggests that self-report measures that include social anhedonia scales would be appropriate. This particular construct of both the formation and maintenance of social processes shows promise for a variety of reasons.

First, as previously mentioned, social anhedonia is present in a variety of disorders. It appears to be manifested for different reasons within these disorders, suggesting a multitude of causes, but RDoC provides several potential circuits, as studied in animal models, that may best explain social anhedonia. Using these models we can elucidate the unique causes for the development of and motivations for maintenance of social anhedonia. Second, given that the experience of social anhedonia appears to be heterogeneous (e.g., varies in stability and intensity) it may be likely that multiple pathways interact with multiple environments and temperaments to produce different experiences.

As stated by the National Institute of Mental Health, "affiliation and attachment include both the positive physiological consequences of social interactions and the behavioral and physiological consequences of disruptions to social relationships. Clinical manifestations of disruptions in Affiliation and Attachment include social withdrawal, social indifference and anhedonia, and over-attachment" (n.d.) It appears that social anhedonia is an ideal candidate for continued study under the NIMH's initiative specifically to strengthen the literature as well as implement intervention and prevention strategies earlier in the course of development.

Another dimensional approach is the Hierarchical Taxonomy of Psychopathology (HiTOP; Kotov et al., 2017), which aims to address complications of RDoC by characterizing psychopathology based on observed covariation of symptoms. This approach may be particularly relevant given that social anhedonia appears in other forms of psychopathology and therefore may be best studied from this dimensional approach rather than specifically in a schizophrenia spectrum disorder. The results of this meta-analysis suggest that social anhedonia could become another dimensional indicator of psychopathology that characterizes schizophrenia spectrum disorders and other disorders as well. HiTOP also aims to improve clinical practice more immediately than RDoC, which focuses on more basic levels of analysis (Kotov et al., 2018). Considering the implications of poorer quality of life and less social interaction seen in individuals with social anhedonia, improvements in clinical practice will be especially important.

Given the overwhelming effect of the negative symptoms, including social anhedonia, on schizophrenia and other disorders, social anhedonia appears a likely target for treatment intervention. Compared with positive symptoms of schizophrenia, less evident findings have appeared from the literature in terms of treating negative symptoms of schizophrenia (Galderisi et al., 2018; Remington et al., 2016). Studies have used social skills training for psychotic disorders; however, because social anhedonia represents more than simply deficits in social skills, personality traits must be taken into account.

Implications for Psychopathology Research

The body of research on the relationship between social anhedonia and schizophrenia is substantial. However, it will be important to continue to refine the study

of social anhedonia using additional assessments beyond self-report measures. Laboratory measures of social anhedonia as well observational studies could potentially elucidate more subtle differences.

Continued examination of social anhedonia throughout the lifespan will also be informative. Currently, child and adolescent versions of the ACIPS are available. Given the change in number and type of relationships as individuals age beyond adulthood, social anhedonia measures used specifically for elderly populations may also be helpful in healthy populations as well as in populations with mental health diagnoses.

Methodological Implications

Among the studies included in this meta-analysis, many failed to report important descriptive data from their samples, reducing the potential for moderator analyses. For example, hypotheses were formulated about medication status, yet a majority of studies did not report whether individuals with a schizophrenia spectrum diagnosis were taking medication. If the information was included, specific details on type and duration of medication were not provided. As a second example, very few studies detailed the specific diagnoses of their patient samples and the percentages for each diagnosis. Social anhedonia scores were typically not reported separately for males and females. Finally, for assessments that have multiple subscales, it would be particularly helpful to report statistics on each subscale. For the purposes of this study, measures like the Schizotypal Personality Questionnaire and the Oxford-Liverpool Inventory of Feelings and Experiences are used to assess schizotypy broadly but also have subscales tapping social anhedonia. Several studies could not be included because they did not report specific subscale scores.

Strengths and Limitations

This is the first meta-analysis on the relationship between social anhedonia and schizophrenia risk. It examined a large body of work in order to elucidate the role that social anhedonia may play in schizophrenia. Despite this accomplishment, there are limitations that must be acknowledged.

First, several moderating variables had only one study in a given category, which does not allow a strong estimate of the effect size and comparison to the effect size for other categories of the moderator. This is particularly relevant for age. Only one study was done with adolescents despite the fact that individuals younger than 18 can be diagnosed with schizophrenia and certainly can be at risk. Additionally, individual studies indicate that individuals who score high on measures of social anhedonia earlier in life (large college-age samples) are at greater risk for the later development of schizophrenia (Gooding & Tallent, 2005; 2007). Currently, only one assessment of social anhedonia has been modified to be appropriate for adolescents and children (Gooding et al., 2016). More research needs to be done looking at social anhedonia in adolescents and children.

Another limitation is the lack of power needed to find significant between-category differences for moderators in the random effects model. It would be beneficial to be able to include more studies utilizing younger samples, using a range of social anhedonia measurements, and including relatives of patients to have a larger range. The majority of studies (78%) included in this analysis were two-group designs with smaller sample sizes than correlational studies. The large sample sizes in the correlational studies compared with the two-group designs gave more weight to the larger sample sizes that

typically included psychometrically at-risk samples rather than patient samples. The use of extreme-groups designs is common in schizotypy research. In research with undergraduate samples using a two-group design, schizotypes are selected based on their extreme scores, which will lead to a larger effect size for group differences. Additionally, as apparent from the Eggers test and funnel plot, there is some indication that this meta-analysis is missing studies that yielded small effect sizes. Overall, the $g = 1.14$ may be a slight overestimate of the effect size.

Additionally, meta-analyses are not able to tell us what percentage of people with schizophrenia actually has social anhedonia. Individual studies rarely report this information. Treating social anhedonia as a continuous dimension, we can estimate from $g = 1.14$ that the distributions of social anhedonia scores for schizotypes and for controls showed 49% overlap (from tables in Cohen, 1988).

Lastly, this meta-analysis included only studies based on self-report measures of social anhedonia. Currently, that is the standard practice to assess social anhedonia, as it best taps into the individual's own experiences from social interactions. However, clinical ratings, family interviews, and lab-based assessments are also useful ways to assess social anhedonia. More studies using these other measures are needed.

Conclusion

In this meta-analysis, a very large effect size was observed for differences between schizophrenia risk groups and controls in social anhedonia, $g = 1.14$. This result provides evidence that social anhedonia is a core characteristic or symptom of schizophrenia spectrum disorders despite not being a diagnostic criterion. This large effect size is seen regardless of age, gender, sample type, or schizophrenia subtype. This

finding provides evidence-based information helpful for future DSMs to better diagnose schizophrenia spectrum disorders. This finding should also be useful as RDoC conceptualizations progress. Future meta-analyses could be done on the role of social anhedonia in other major mental health diagnoses including major depression, autism spectrum disorders, and substances use disorders, in order to better understand its function in psychopathology. The results of this meta-analysis indicate that social anhedonia is a core characteristic of schizophrenia that may prove useful as a target for interventions designed for both prevention and treatment.

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Table 1. Studies Included in the Meta-Analysis with Codes for Study Characteristics

Study	g	% M	Age	SES	Ed	F	E	Sample	DA	S	SA	Online
Arnfred & Chen (2004)	1.875	100	30.3	6	2	1	9	3	3	3	1	2
Bedwell, Butler, et al., (2015)	1.875	44	35.88	1	2	4	1	2	3	3	2	2
Bedwell, Cohen, et al. (2014)	2.370	50	20	4	2	3	8	4	5	5	1	2
Bedwell, Compton, et al. (2014)	1.422	23	21.22	4	2	3	1	4	5	5	1	1
Bedwell, Gooding, et al. (2014)	0.987	39	33.59	6	4	1	8	2	3	3	2	2
Blanchard et al. (2015)	1.037	67	46.15	6	2	2	1	2	3	3	1	2
Blanchard et al. (1998)	1.087	73	36.27	6	4	1	1	2	3	4	1	2
Chan et al. (2016)	0.058	20	20.51	4	2	4	4	4	5	5	2	2
Cicero et al. (2014)	0.619	57	18.57	4	2	3	1	4	5	5	1	1
Culbreth et al. (2016)	1.002	67	36.8	6	2	2	1	2	3	3	1	2
Docherty et al. (2014)	0.793	50	46.75	6	4	2	8	5	5	5	1	2
Fonseca-Pedrero et al. (2016)	1.315	56	15.14	6	1	1	6	4	5	5	2	2
Fortunati et al. (2015)	0.848	60	39.2	1	2	1	9	2	3	1	1	2
Gooding & Pflum (2014a)	1.350	44	18.99	1	2	1	1	4	5	5	2	2
Gooding & Pflum (2014b)	1.499	41	18.8	1	2	1	1	4	5	5	2	2
Gooding, Padrutt, et al. (2017)	1.665	46	18.58	1	2	1	1	4	5	5	2	2
Gooding & Pflum (2011)	1.142	64	18.8	4	2	3	2	4	5	5	1	2
Gooding et al. (2010)	1.313	65	19.01	4	2	3	2	4	5	5	1	2
Gooding, Winston, et al. (2015)	1.457	26	19.90	4	2	4	1	4	5	5	2	1
Hillmann et al. (2018)	1.143	59	40.65	6	4	2	8	2	3	3	4	2
Jhung et al. UHR (2016)	1.937	54	21.3	6	2	3	9	5	5	5	1	2
Jhung et al. ROSPR (2016)	1.031	40	21.3	6	2	3	9	5	3	3	1	2
Kadison et al. (2014)	0.118	60	20.37	4	2	4	1	4	5	5	2	2
Kiwanuka et al. (2014)	0.768	68	40.91	6	2	2	1	2	3	3	1	2
Lee et al. UHR (2015)	1.946	10	20.4	6	2	3	9	2	5	5	1	2
Lee et al. FEP (2015)	1.031	33	20.4	6	2	2	9	2	3	3	1	2
McCarthy et al. (2018)	0.397	100	46.72	6	1	1	3	2	3	3	6	2
McCarthy et al. (2015)	1.227	23	19.56	4	2	1	1	4	5	5	3	2
Moran et al. (1996)	1.288	N/R	30.2	6	2	2	8	2	3	3	1	2
Park et al. (2014)	0.883	50	27.35	6	2	2	9	2	4	2	1	2
Park et al. (2018)	1.940	57	20.7	6	2	4	9	2	3	3	1	2
Pflum & Gooding (2018)	0.827	58	18.9	4	2	3	2	4	5	5	1	2
Pflum et al. (2013)	1.123	N/R	19.34	4	2	3	2	4	5	5	1	2
Preti et al. (2018)	0.708	49	42.45	3	1	3	9	2	1	3	1	2
Simon et al. (2015)	1.090	65	26.4	1	2	2	8	3	3	1	1	2

Tremeau et al. (2014)	0.590	80	36.3	6	2	1	1	3	3	1	1	2
Umesh et al. (2018) Patients	1.937	100	29.8	3	2	1	9	2	3	1	1	2
Umesh et al. (2018) Siblings	0.202	100	29.8	3	2	1	9	5	5	5	1	2
Vignapiano et al. (2016)	1.290	63	33.2	6	4	1	9	2	3	4	1	2
Waltz et al. (2015)	0.632	76	38.25	6	2	1	8	2	3	3	1	2
Wang et al. (2014)	1.840	76	32.60	4	2	3	4	1	6	4	1	2
Wang et al, (2015) Neg	0.555	91	19.70	4	1	2	4	5	5	5	1	2
Wang, et al, (2015) Schiz	0.165	39	35.74	4	1	2	4	1	4	4	1	2
Yan et al. (2016)	1.088	52	19.30	4	2	3	4	5	5	5	1	2
Zou, Geng, et al. (2015)	1.203	41	20.94	4	2	3	4	5	5	5	1	2
Zou, Zhou, et al. (2018)	1.203	57	21.4	6	2	1	9	1	3	4	1	2

Note. g= study effect size; %M = % males; Age = mean age; SES; 1= Mixed, 2 = >85% lower, 3 = >85% working, 4 = >85% middle-upper, 5. = Other, 6 = Not reported; Ed = Education: 1 = High School, 2 = Some College, 3 = College, 4 = Not reported; E = ethnicity : 1 = mixed, 2 = > 85% Caucasian, 3 = > 85% African American, 4 = > 85% Asian American, 5 = > 85% Hispanic, 6 = > 85% Native American; F = focus of article: 1 = Social Anhedonia, 2 = Schizophrenia, 3 = Schizotypy, 4 = Other; Sample: 1 = Patient, 2 = Outpatient/Community. 3= Mixed In/Out, 4 = Undergraduate, 5 = Other; DA = Diagnostic Accuracy: 1= Medical record, 2 =Professional judgment, 3= Diagnostic interview, 4 = Not reported, 5 = Not applicable (sx measure); S= Schizophrenia Subtype: 1 = YES, 2 = NO, 3 = Mixed, 4 = Not reported, 5 =Not applicable (sx measure); SA = Measurement of Social Anhedonia: 1 = Chapman Revised SAS**,** 2 = ACIPS**,** 3 = Schizotypal Personality Questionnaire (SPQ)**,** 4 = MAP, 5 = Lab Based Assessment; Online = Online Assessment: 1= YES, 2 = NO

Table 2. Descriptive Statistics for Sample Characteristics

Descriptives	Frequency (%)
Publication Status	
Peer Reviewed Journal	42(98%)
Unpublished / Dissertation	1 (2%)
Ethnicity	
Mixed	12 (27%)
White	8 (18%)
African American	1 (2%)
Asian/ Asian American	13 (29%)
Hispanic	1 (2%)
Bi/Multiracial	0
Other	2 (4%)
Not Reported	9 (20%)
Education	
High School	5 (11%)
Some College	35 (78%)
College	0
Not reported	5 (11%)
SES	
Mixed	3 (7%)
Lower	0
Working	3 (7%)
Middle-Upper	19 (42%)
Not Reported	21 (47%)
Country	
US	24 (53%)
Non-US	21 (47%)

Table 3. Moderator Analyses

		Fixed (Q_B = 24.85*)**	**Random/Mixed (Q_B= 7.40)**
Age of Sample	**Number of Studies**	**g**	**g**
<18	1	1.32***	1.32***
18-29	26	1.29***	1.21***
30-39	13	0.99***	1.04***
>40	5	0.92***	0.92***

		Fixed (Q_B = 24.12*)**	**Random/Mixed (Q_B = 0.09)**
Sample Type	**Number of Studies**	**g**	**g**
Patient	4	1.43***	1.66*
Outpatient/ Community	18	1.08***	1.17***
Patient and Outpatient	3	0.77***	1.09**
Undergraduate	15	1.29***	1.09***
Other (1st degree relatives)	5	1.19***	1.06***

		Fixed (Q_B = 29.52***)	Random/Mixed (Q_B = 1.28)
Phenomenological Subtype	**Number of Studies**	**g**	**g**
Schizoaffective	3	0.81***	1.03**
Schizophrenia only	1	0.88**	0.88*
Mixed	15	1.03***	1.12***
Not Reported	6	1.37***	1.45***
Not Applicable (schizotypy sample)	20	1.29***	1.24***

		Fixed (Q_B = 31.52***)	Random/Mixed (Q_B = 0.5)
Measure of Social Anhedonia	**Number of Studies**	**g**	**g**
SAS	33	1.12***	1.17***
ACIPS	9	1.34***	1.48***
SPQ	1	0.40	0.40
MAP	1	1.14**	1.14
Other	1	1.23***	1.23***

		Fixed (Q_B = 1.49)	Random/Mixed (Q_B = 0.5)
Online Assessment	**Number of Studies**	**g**	**g**
Yes	3	1.32***	1.19***
No	42	1.22***	1.13***

		Fixed (Q_B = 40.05*)**	**Random/Mixed (Q_B = 0.76)**
Study Design	**Number of Studies**	**g**	**g**
Two Group	35	1.03***	1.10***
Correlational	10	1.35***	1.27***

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

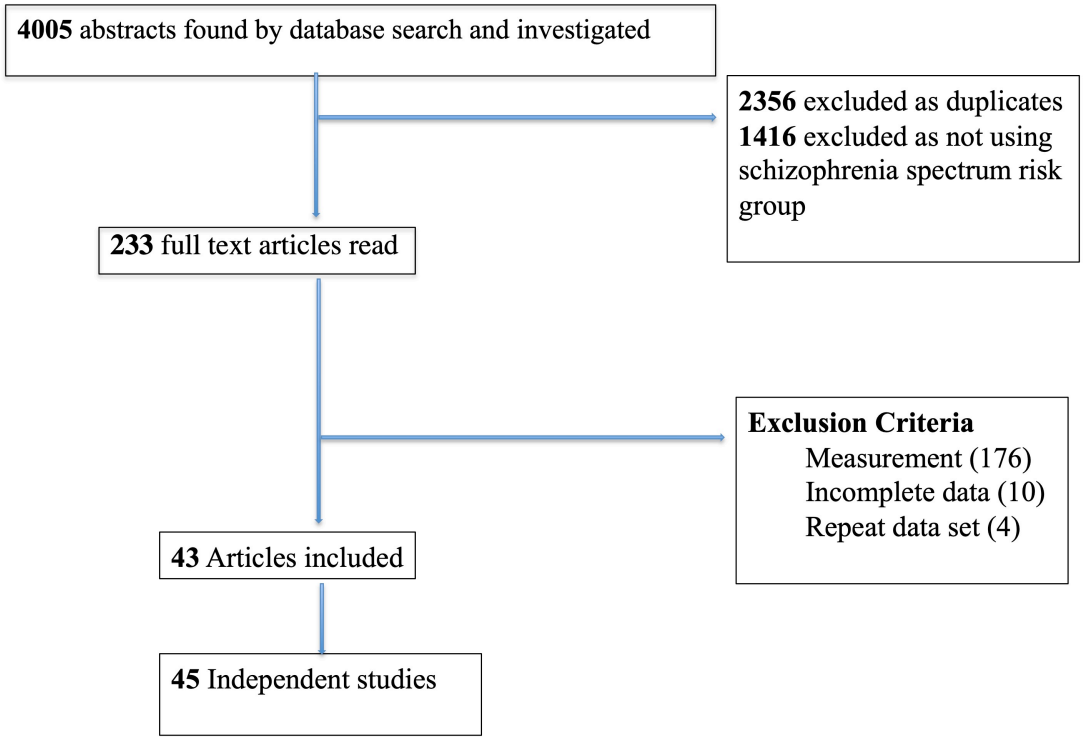

Figure 1. Flowchart of the search and selection procedure.

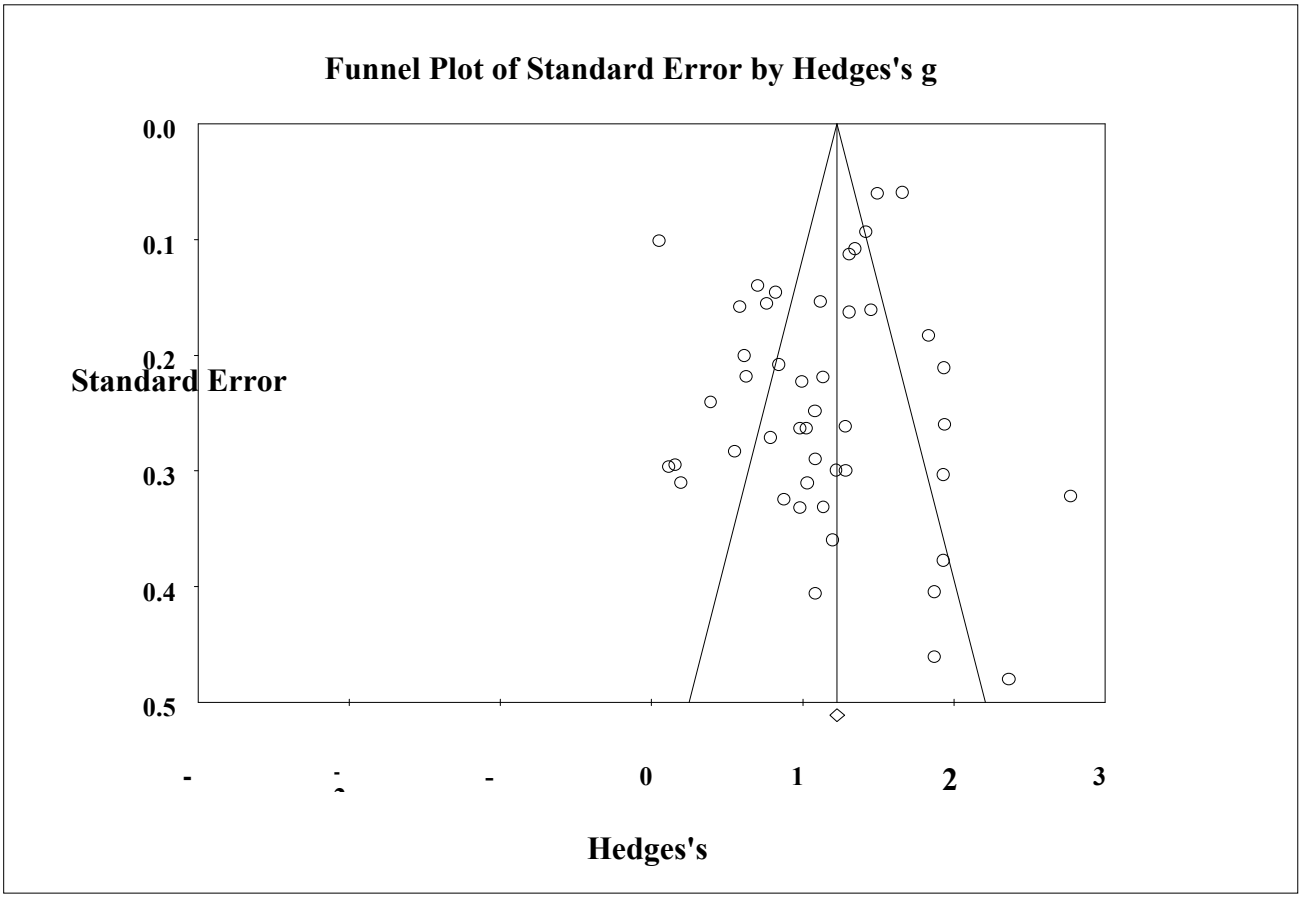

Figure 2. Funnel plot of asymmetry of studies.

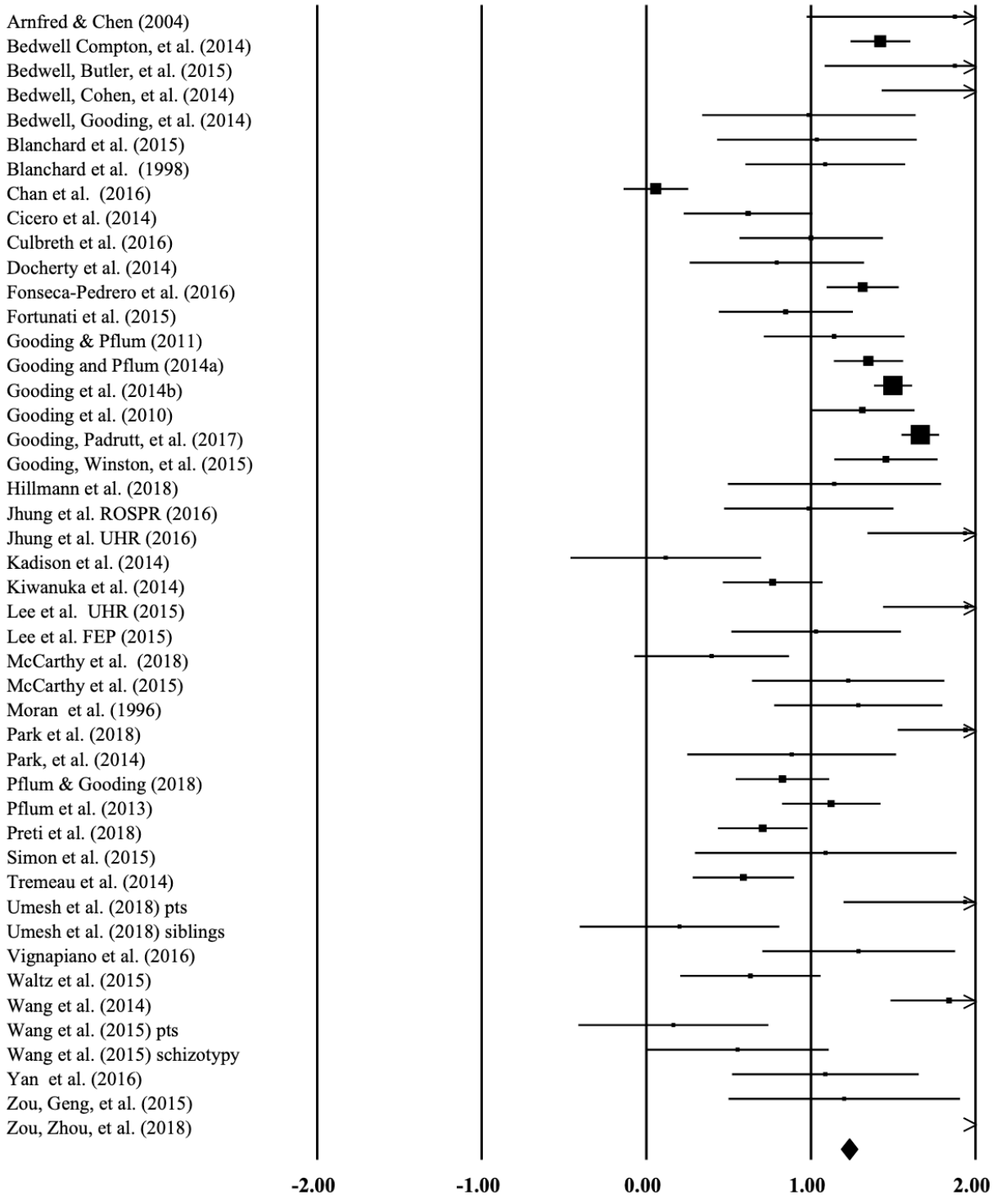

Figure 3. Forest plot of the effect sizes using random effects model. Hedges'g *g* with 95% confidence intervals (bars). The diamond is the overall effect size.

APPENDIX A
Social Anhedonia Questionnaires

Revised Social Anhedonia Scale (Eckblad et al., 1982)

1. Having close friends is not as important as many people say.
2. I attach very little importance to having close friends.
3. I prefer watching television to going out with other people.
4. A car ride is much more enjoyable if someone is with me.
5. I like to make long distance phone calls to friends and relatives.
6. Playing with children is a real chore.
7. I have always enjoyed looking at photographs of friends.
8. Although there are things that I enjoy doing by myself, I usually seem to have more fun when I do thing with other people.
9. I sometimes become deeply attached to people I spend a lot of time with.
10. People sometimes think that I am shy when I really just want to be left alone.
11. When things are going really good for my close friends, it makes me feel good too.
12. When someone close to me is depressed, it brings me down also.
13. My emotional responses seem very different from those of other people.
14. When I am alone, I often resent people telephoning me or knocking on my door.
15. Just being with friends can make me feel really good.
16. When things are bothering me, I like to talk to other people about it.
17. I prefer hobbies and leisure activities that do not involve other people.
18. It's fun to sing with other people.
19. Knowing that I have friends who care about me gives me a sense of security.
20. When I move to a new city, I feel a strong need to make new friends.
21. People are usually better off if they stay aloof from emotional involvements with most others.
22. Although I know I should have affection for certain people, I don't really feel it.
23. People often expect me to spend more time talking with them than I would like.
24. I feel pleased and gratified as I learn more and more about the emotional life of my friends.
25. When others try to tell me about their problems and hang-ups, I usually listen with interest and attention.
26. I never had really close friends in high school.
27. I am usually content to just sit alone, thinking and daydreaming.
28. I'm much too independent to really get involved with other people.
29. There are few things more tiring than to have a long, personal discussion with someone.
30. It made me sad to see all my high school friends go their separate ways when high school was over.
31. I have often found it hard to resist talking to a good friend, even when I have other things to do.
32. Making new friends isn't worth the energy it takes.
33. There are things that are more important to me than privacy.
34. People who try to get to know me better usually give up after awhile.
35. I could be happy living all alone in a cabin in the woods or mountains.
36. If given the choice, I would much rather be with others than be alone.
37. I find that people too often assume that their daily activities and opinions will be interesting to me.
38. I don't really feel very close to my friends.
39. My relationships with other people never get very intense.
40. In many ways, I prefer the company of pets to the company of people.

Anticipatory and Consummatory Interpersonal Pleasure Scale (Gooding and Pflum, 2014a)

1. I look forward to seeing people when I'm on my way to a party or get-together.
2. I enjoy looking at photographs of my friends and family.
3. I don't really look forward to family get-togethers or gatherings.
4. I enjoy joking and talking with a friend or coworker.
5. A good meal always tastes better when you eat it with someone you feel close to.
6. I like it when people call or text me to say hi.
7. When something good happens to me, I can't wait to share the news with others.
8. If I learned of a group where the people shared similar interests as me, I would be interested in joining it.
9. I enjoy watching films about friendships or relationships with my friends.
10. I imagine how much fun it would be to go on vacation with a friend or someone I love.
11. I appreciate being invited to hang out with people I know after school or work.
12. I am pleased when I see a friend or someone I love who I haven't seen for a while.
13. I enjoy going on group activities like attending sports events or concerts with my friends.
14. I look forward to watching my favorite TV shows with my friends.
15. I am excited when a friend that I haven't seen in a while contacts me to make plans.
16. I like talking with others while waiting in line.
17. I enjoy it when a friend and I can discuss important things.

Schizotypal Personality Questionnaire (Raine, 1991) No Close Friends Subscale

1. I have little interest in getting to know other people.
2. I prefer to keep myself to myself.
3. I am mostly quiet when with other people.
4. I find it hard to be emotionally close to other people.
5. Do you feel that there is no one you are really close to outside of your immediate family, or people you can confide in or talk to about personal problems?
6. Writing letters to friends is more trouble than it is worth.
7. I tend to keep in the background on social occasions.
8. I attach little importance to having close friends.
9. Do you feel that you cannot get "close" to people?

Oxford-Liverpool Inventory of Feelings & Experiences (Mason et al., 1995) Introverted Anhedonia Subscale

1. Do you feel very close to your friends?
2. Are you much too independent to really get involved with people?
3. Is trying new foods something you have always enjoyed?
4. Are people usually better off if they stay aloof from emotional involvements with people?
5. Do you enjoy many different kinds of play and recreation?
6. Can you usually let yourself go and enjoy yourself at a lively party?

APPENDIX B
Schizophrenia Meta-Analysis: Coding Sheet

ID# _____ **Usable?** YES NO NEED MORE INFO **Coded by** _____ **Date** _____

Citation: _____

Why not usable? Measurement of Social Anhedonia, abstract exclude,

More info needed:_____

Social Anhedonia			
Measure			
Schiz N =	M (SD)	**Schiz. N =**	
Control N =	M (SD)	**Control N =**	

Computation of d:
Circle: calculated estimated

Sample
1. Patient
2. Outpatient/Community
3. Mixed In/Out
4. Undergraduate
5. Other_____

Mean age _____ SD_____
Range _____ to _____
Whole vs. Control

Year of publication_____

Publication Status
1. Peer reviewed journal
2. Unpublished dissertation
3. Other: _____

Focus of article
1. Social Anhedonia
2. Schizophrenia
3. Schizotypy
4. Other_____

Correlations or Betas:
Circle: calculated estimated

Race (U.S. Studies)
1. Mixed
2. > 85% White
3. > 85% African American
4. > 85% Asian
5. >85% Hispanic
6. >85% Bi/Multiracial
7. Other: _____
8. Not reported

SES
1. Mixed
2. >85% lower
3. >85% working
4. >85% middle-upper
5. Other: _____
6. Not reported

EDUCATION
1. High school
2. Some college
3. College
4. Not reported

Country _____

Region
1. US
2. Canadian
3. European/ Scandinavians
4. Russia/ Former Soviet Countries
5. Australian/ New Zealander
6. Asian
7. African
8. Central/South American
9. Middle Eastern
10. Mixed
11. Other: _____
12. Not reported

Clinical Diagnoses

DSM
1. I
2. II
3. III/ III-R
4. IV/ IV-R
5. 5
6. Other: _____
7. Not reported
8. Not applicable (sx measure)

Duration of Illness
1. _____ months
2. Lifetime
3. Current
4. Other: _____
5. Not reported
6. Not applicable (sx measure)

Diagnostic accuracy
1. Medical record
2. Professional judgment
3. Diagnostic interview
4. Not reported
5. Not applicable (sx measure)

Schizophrenia subtype
1. YES (e.g schizoaffective)
2. NO
3. Mixed
4. Not reported
5. Not applicable (sx measure)

Current Medication
1. Yes
2. No
3. Not reported
4. Not applicable (sx measure)

Gender Breakdown of Sample
% Male of Patients _____
% Male of Controls _____

Measurement of Social Anhedonia:
1. Revised SAS
2. ACIPS
3. Schizotypal Personality Questionnaire
4. Oxford Liverpool Inventory for Feelings
5. Lab Based Assessment_____
6. Other _____

Online administration of Soc Anh
1. YES
2. NO

NOTES:
_____
_____
_____
_____
_____
_____
_____

APPENDIX C
Social Anhedonia Meta-Analysis: Article Coding Manual

ID# _____Usable? YES NO NEED MORE INFO **Coded by _____ Date _____**

Citation: _____

Why not usable? No measurement of social anhedonia, Lack of assessment for schizophrenia, already included dataset, abstract exclude,

More info needed:
_____

-ID# - given by MJP

-Usable YES = Calculated effect side using Means and SD or r

-Usable NEED MORE INFO =
if the study meets all of our criteria but does not provide data to obtain a "calculated" effect size

-"Why not usable" examples- see trouble shooting section for additional details
measurement- e.g., no validated social anhedonia measure, schizophrenia measure
Already included data set: If a particular sample of participants was described in more than one article, we selected the article that had the most complete data, the largest sample size, and/or the most recent publication.
abstract exclude- if the abstract should have been excluded at the abstract stage

-In the "**More info needed**" line add the data we need to obtain a calculated effect size (e.g., M and SD for control and clinical group separately for social anhedonia scores)

Social Anhedonia	
Measure	
Schiz **N =**	M (SD)
Control **N=**	M (SD)

Computation of d:
Circle: calculated estimated

Computation of Odds Ratio:
Circle: calculated estimated

-When recording the **measure** used for **social anhedonia** please include important details (e.g., versions of Chapman Scale (brief vs full version); language of the measure)

-See trouble shooting section for additional details about recording symptoms and diagnoses

-When recording **M** and **SD** for **social anhedonia** , follow these rules:
-if undergraduate sample with positive and negative schizotypy group, include positive group **ONLY**

-For **computation of d and Odds Ratio**, circle whether the effect size is calculated or estimated and provide the number for d and/or the odds ratio

-When calculating **d and Odds Ratio**, use Campbell collaboration:
http://www.campbellcollaboration.org/resources/effect_size_input.php
treatment = schiz control = control
*keep all 4 decimals provided
use the 2x2 frequency table OR the binary proportions table for Odds Ratios

-Effect size reminders (see Troubleshooting for additional details):
-If standard errors are provided, use the M and SE option on Campbell collaboration

Sample
1. Patient
2. Outpatient/Community
3. Mixed In/Out
4. Undergraduate
5. Other_____

Mean age _____ SD_____
Range _____ to _____

Year of publication_____

Publication Status
1. Peer reviewed journal
2. Unpublished dissertation
3. Other: _____

Country _____

Focus of article
1. Social Anhedonia
2. Schizophrenia
3. Schizotypy
4. Other

Race (U.S. Studies)
1. Mixed
2. > 85% White
3. > 85% African American
4. > 85% Asian
5. >85% Hispanic
6. >85% Bi/Multiracial
7. Other: _____
8. Not reported

SES
1. Mixed
2. >85% lower
3. >85% working
4. >85% middle-upper
5. Other: _____
6. Not reported

EDUCATION
1. High school
2. Some college
3. College
4. Not reported

-**Sample** type -Inpatient, Outpatient/Community, Mixed In/Out, Undergraduate Sample; Other (e.g relatives)

-**Mean age** -If only provided at the group level, use control data age; for correlation samples use whole sample; see Troubleshooting for addl. info

-**Year of publication** (studies in this area do not typically provide year of data collection)

-**Focus of article**: Social anhedonia **trumps** everything
-Social anhedonia is focus of article if "social anhedonia" or "anhedonia" or "social" or "hedonic" is in the ***title***
-Schizophrenia is focus if "schizophrenia*" is in ***title***, ***abstract***, or ***keywords***
- Schizotypy is the focus if schizotypy is in ***title***, ***abstract***, or ***keywords***

-SES
1. Mixed (general population)
2. >85% lower (mean in high school)
3. >85% working (trade school graduate)
4. >85% middle-upper (mean in college)

*if college sample (and no SES provided), infer "4" (except if community/technical college)

-Race & SES
*If national data set → infer mixed race and SES if not provided

-Country- Assume country affiliated with author if not explicitly stated

<u>Clinical samples</u>
DSM
1. I
2. II
3. III/ III-R
4. IV/ IV-R
5. 5
6. Other: _____
7. Not reported
8. Not applicable (sx measure)

Duration of Illness
1. _____ months
2. Lifetime
3. Current
4. Other: _____
5. Not reported
6. Not applicable (sx measure)

Diagnostic accuracy
1. Medical record
2. Professional judgment
3. Diagnostic interview
4. Not reported
9. Not applicable (sx measure)

Schizophrenia Subtype
1. YES (e.g. schizoaffective)
2. NO
3. Mixed
4. Not reported
5. Not applicable (sx measure)

Current Medication
1. Yes
2. No
3. Not reported
4. Not applicable (sx measure)

Measurement of Social Anhedonia
1. Chapman Revised SAS
2. ACIPS
3. Schizotypal Personality Questionnaire (SPQ)
4. Motivation and Pleasure Scale (MAP)
5. Lab Based Assessment
6. Other_____

Online Administration of Soc Anh
1. Yes
2. No

Notes: _____

-**DSM:** a common example of "6. Other" is the ICD system
Symptom measure includes measurement of social anhedonia OR symptom measure of a disorder (e.g. BDI)

-Diagnostic Accuracy:
*The article might mention that diagnoses are consistent with a certain DSM. This does not mean that there was a diagnostic interview. The article must mention a diagnostic interview to be coded as such.

- Duration of Illness:
*Articles may include a mean duration of illness, which should be included. If not reported then one can assume "lifetime" if it is a patient sample. Schizotypy studies (undergraduate) will be a "9" as not applicable.

-Online administration of Soc Anh:
"Yes" only if clearly stated that they took it online prior to coming to the session.
If not mentioned, assume took in person and score a NO

-Schizophrenia subtype:
-If an article lumps Schizophrenia with schizoaffective disorder- Use "3. Mixed"
-Only use 1 YES if they discuss or if they specify catatonic, paranoid, etc. subtypes.

-Current Medication Regimen
*If article explicitly states patient sample is taking medication code as 1. If patient sample is included but medication is not discussed code "3". For undergraduate/schizotypy samples use 4.

-Measurement of Social Anhedonia
*As outlined in introduction, using 4 measurements listed on coding sheet but may chose to include a lab based assessment or a newer measure if appropriate (e.g DARS).