

Anhedonia in clinical and non-clinical populations

An exploratory meta-analysis of studies using the Snaith-
Hamilton Pleasure Scale

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Submitted as master thesis in psychology at the Department of Psychology

Faculty of Social Sciences

University of Oslo

Spring 2019

Acknowledgements

I would like to thank my supervisors professor Siri Leknes and Dr Marie Eikemo for their invaluable feedback and guidance throughout this project. I would also like to thank Remy Meir, Ingelin Hansen and Sigurd Lerkerød Alnes for their assistance in locating and reviewing the data material for this meta-analysis. Finally, I would like to thank all the authors who kindly provided me with missing data.

Anhedonia in clinical and non-clinical populations – an exploratory meta-analysis of studies using the Snaith-Hamilton Pleasure Scale

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Abstract

Background. Anhedonia, defined as a reduced capacity to experience pleasure, has been associated with many clinical conditions, including major depressive disorder (MDD), schizophrenia (SCZ), substance use disorder (SUD) and Parkinson's disease (PD). Anhedonia symptoms are rarely compared across conditions however, and it is currently unclear whether symptom severity differs between clinical groups. Reference values for hedonic capacity in healthy humans are also missing from the literature. **Objectives.** To generate and compare reference values for anhedonia levels across healthy and clinical groups, we performed a set of meta-analyses of self-reported anhedonia as measured with a widely used questionnaire, the Snaith-Hamilton Pleasure Scale (SHAPS). We also calculated prediction intervals for each group, providing the range of mean SHAPS scores to be expected in future studies. **Methods.** We extracted SHAPS scores from all available studies citing the initial scale development paper (189 papers) and used random-effects models to calculate average SHAPS scores and 95% confidence intervals separately for samples of healthy participants and samples of patients with current MDD, past/remitted MDD, SCZ, SUD and PD. We used meta-regression to compare SHAPS scores between these groups. **Results.** In the available literature, patients with current MDD, SCZ, SUD and PD all scored higher on the SHAPS than healthy participants. SHAPS scores in SCZ, SUD and PD were nevertheless considerably lower than scores in current MDD. **Conclusion.** Our results indicate that the severity of anhedonia differs across disorders that have been associated with anhedonia. Whereas anhedonia in current MDD likely affects multiple domains of pleasure (e.g. food/drink, pastimes/hobbies, social, physical), anhedonia in SCZ, SUD and PD may instead reflect a decrease in projected enjoyment of only a minority of life's many rewards.

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1 Introduction

Pleasure motivates us to pursue rewards necessary for evolutionary fitness. Capacity for normal pleasure is essential to healthy psychological function and well-being (Berridge & Kringelbach, 2015). This function is often impaired in mental illness. Motivational and hedonic impairments have been associated with a variety of psychiatric disorders, including major depression (MDD), schizophrenia (SCZ) and substance use disorders (SCZ; Shankman et al., 2014) and are currently recognized collectively as one of the seven major domains of psychopathology (i.e. positive valence systems) by the National Institute of Mental Health's Research Domain Criteria Initiative (Morris & Cuthbert, 2012).

The term anhedonia was first introduced by the French psychologist Théodule Armand Ribot in 1896 to denote a reduced ability to derive pleasure from usually enjoyable experiences (Ribot, 1896). Symptoms of reduced wanting/motivation on the other hand have traditionally been given terms such as amotivation, apathy and avolition (Foussias & Remington, 2008). Anhedonia and amotivation have typically been considered trait-like phenomena that are more or less stable over longer periods of time, rather than short-term states induced by concrete events (Horan, Kring, & Blanchard, 2006; Treadway & Zald, 2011). These clinical symptoms are thought to stem from deficits in the reward system and its function in responding to acute rewards (Rømer Thomsen, 2015; Strauss, Waltz, & Gold, 2014; Whitton, Treadway, & Pizzagalli, 2015).

While the term “anhedonia” means lack of pleasure, it is sometimes used more generally to refer to impairment of any part of the reward process including wanting, reward learning/decision making in addition to the pleasure/*liking* experience (Shankman et al., 2014). In Berridge and Robinson's (2003) framework for reward, the liking component covers the affective reactions to rewards and the conscious experience of pleasure while the wanting/motivation component is concerned with conscious and unconscious desires for reward. Learning on the other hand, refers to the generation of implicit and explicit knowledge of past rewards and how this knowledge influences future behavior.

1.1 Anhedonia in clinical populations

Altered reward processing and symptoms of anhedonia have been reported in a range of different psychiatric conditions including major depressive disorder, schizophrenia and substance

use disorder (for a review, see Shankman et al., 2014). While current diagnostic systems such as the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association [APA], 2013) and International Classification of Diseases (ICD; World Health Organization [WHO], 2018) put little emphasis on anhedonia as a clinical feature of schizophrenia and substance use disorders, symptoms of anhedonia, together with amotivation, form a central component in the diagnosis of major depression.

1.1.1 Anhedonia in major depression

Although not necessary for a diagnosis of major depressive disorder, anhedonia is considered a core symptom of depression by the American Psychiatric Association (APA; American Psychiatric Association, 2013). Current and previous editions of both the DSM (APA, 1980, 2013) and the ICD (WHO, 2003; 2018) define anhedonia in depressive disorders broadly as loss of pleasure or reduced interest in activities. While recent reviews conclude that evidence for loss of pleasure in depression is mixed, there is mounting evidence consistent with reduced motivation and reward learning in people with depression (Barch, Pagliaccio, & Luking, 2015; Pizzagalli, 2014; Shankman et al., 2014; Treadway & Zald, 2011; Whitton et al., 2015). For example, studies using behavioral tasks have shown that patients with MDD are less willing to work for rewards than healthy controls (Hershenberg et al., 2016; Treadway, Bossaller, Shelton, & Zald, 2012), and they develop less bias towards rewarding alternatives in learning-based tasks (Cella, Dymond, & Cooper, 2010; Pizzagalli, Iosifescu, Hallett, Ratner, & Fava, 2008). A meta-analysis by Bylsma, Morris, and Rottenberg (2008) found that patients with MDD generally display reduced positive reactivity to pleasant images and films compared to healthy controls. However, studies using odors and sweet solutions as stimuli have not found similar effects (e.g. Berlin, Givry-Steiner, Lecrubier, & Puech, 1998; Pause, Miranda, Göder, Aldenhoff, & Ferstl, 2001; Swiecicki et al., 2009).

At the neural level, depression is linked to blunted striatal responses to reward and reward cues, possibly due to dysfunction of the mesolimbic dopamine system. Consequently, reduced reward anticipation has been proposed as a reward system impairment underlying clinical symptoms of anhedonia in major depressive disorder (Barch et al., 2015; Pizzagalli, 2014; Treadway & Zald, 2011).

1.1.2 Anhedonia in schizophrenia

Anhedonia has been considered a clinical feature of schizophrenia for a century (B. Kirkpatrick, Fenton, Carpenter, & Marder, 2006; Kraepelin, 1919; Meehl, 1962; Rado, 1953) and is currently recognized as a negative symptom by the American Psychiatric Association (APA; 2013). On clinical and self-report measures of anhedonia, patients with schizophrenia usually score higher than healthy controls (Horan et al., 2006). While clinical symptoms of anhedonia are elevated in schizophrenia, recent reviews (e.g. Barch et al., 2015; Cohen, Najolia, Brown, & Minor, 2011; Strauss & Gold, 2012; Strauss et al., 2014; Whitton et al., 2015) broadly agree that patients with schizophrenia are as capable as healthy individuals of deriving pleasure from a variety of stimuli, including sweet taste, odors, faces, pictures and films (for an overview of individual studies, see Kring & Moran, 2008). Instead, some authors argue that anhedonia in schizophrenia results from impairments in the ability to use reward information to guide motivated behavior (Barch et al., 2015; Strauss et al., 2014). Others suggest that the self-reported anhedonia symptoms in schizophrenia result from a reduced capacity to downregulate co-occurring negative emotions during exposure to pleasurable stimuli (Cohen et al., 2011). In a meta-analysis of studies assessing valence ratings of various types of stimuli, Cohen and Minor (2010) found that although patients with schizophrenia and controls tended to rate positive stimuli as equally pleasant, the patients also rated the positive stimuli as significantly more aversive.

At the neural level, anhedonia in schizophrenia is linked to reduced activity in the prefrontal cortex and in striatal areas, especially during anticipation of reward, and to altered prediction errors in the striatum (Barch et al., 2015; Strauss et al., 2014; Waltz & Gold, 2016).

1.1.3 Reward hypersensitivity in bipolar disorder

Unlike major depressive disorder and schizophrenia, bipolar disorders (BD) have been associated hypersensitivity to reward. According to the reward hypersensitivity model of bipolar spectrum disorders (Alloy, Nusslock, & Boland, 2015), people with bipolar disorder have a hypersensitive reward system that generates excessive reward motivation in response to reward-related cues and excessive demotivation upon failure to obtain rewards. Thus, while depressive episodes would be characterized by marked reduction in reward motivation, bipolar patients would display great increases in motivation during hypomanic or manic episodes (for reviews,

see Alloy, Olino, Freed, & Nusslock, 2016; Johnson, Edge, Holmes, & Carver, 2012; Urošević, Abramson, Harmon-Jones, & Alloy, 2008).

The hypersensitivity to reward has been hypothesized to arise from increased activity level in the striatum and in prefrontal regions in the left hemisphere (Alloy et al., 2015; Urošević et al., 2008; Whitton et al., 2015).

1.1.4 Anhedonia in substance use disorders

Several neurobiological theories of drug addiction posit that prolonged substance use, and dependence, alters mesolimbic reward processing. According to the allostatic model of addiction (Koob & Le Moal, 2001), substance use can trigger counteradaptive mechanisms such as neuroadaptation that oppose the hedonic effects of the drugs. Similarly, Zald and Treadway's (2017) maladaptive scaling hypothesis posits repeated use of highly rewarding and addictive substances results in downscaling of the hedonic impact of non-drug rewards. According to Robinson and Berridge's (1993) incentive-sensitization theory of addiction, repeated drug use causes neuroadaptations that render the neural system highly sensitive to the drugs. Due to this heightened sensitivity, drugs become highly attractive and therefore incentivizes compulsive seeking and consumption of these drugs. Instead of directly affecting the hedonic 'liking' component of reward processing, this model posits that substance use disrupts the 'wanting' component.

Anhedonia in substance use disorders has usually been associated with acute drug withdrawal (Hatzigiakoumis, Martinotti, Di Giannantonio, & Janiri, 2011). In a recent systematic review of studies using self-report measures of anhedonia, Garfield, Lubman, and Yücel (2014) found evidence for elevated anhedonia in current substance use and very recent abstinence of various drugs, including alcohol, amphetamines and cocaine, cannabis, opioids and nicotine. They also found evidence that longer periods of successful abstinence reduced anhedonia.

1.1.5 Anhedonia in Parkinson's disease

Parkinson's disease (PD) is caused by depletion of dopamine neurons and treated with dopaminergic drugs. Given the importance of dopamine signaling for reward motivation and learning processes (Wise, 2004), and that depression (Reijnders, Ehrt, Weber, Aarsland, & Leentjens, 2008) and apathy (Leentjens et al., 2008) are relatively common in Parkinson's

disease, several studies have examined anhedonia in this patient population (for reviews of early studies, see Assogna, Cravello, Caltagirone, & Spalletta, 2011; Loas, Krystkowiak, & Godefroy, 2012). These studies generally find that anhedonia in Parkinson's disease is related to depression and apathy (Fujiwara et al., 2011; Jordan, Zahodne, Okun, & Bowers, 2013; M. R. Lemke, Brecht, Koester, Kraus, & Reichmann, 2005; Matsui et al., 2013; Mrochen et al., 2016; Nagayama et al., 2012; Nagayama et al., 2017; Santangelo, Morgante, et al., 2009; Santangelo, Vitale, et al., 2009; Spalletta et al., 2013; Zahodne, Marsiske, Okun, & Bowers, 2012).

1.2 Measuring anhedonia

Reward processes in humans can be measured using both behavioral tasks and questionnaires. Many of these tools are designed to tap into specific aspects of the reward process, such as liking and consumption, effort, motivation and learning. Although an extensive review of these measures is beyond the scope of this thesis, the following section will give a brief overview and some examples of tests and questionnaires typically used in the anhedonia literature.

1.2.1 Behavioral tasks

The classical method of measuring pleasure or liking in a behavioral task is to collect subjective pleasure ratings after stimulus presentation. Other measures rely on facial expressions and have typically been validated by subjective pleasure ratings, for instance using video recording and coding of facial movements, or electromyography (EMG) recordings of facial muscle activity (K. C. Berridge, 2000; Mauss & Robinson, 2009; Pool, Sennwald, Delplanque, Brosch, & Sander, 2016). These subjective and objective pleasure-related measures can be obtained for all sorts of stimuli, including sweet taste, odors, music, pictures, and films.

Behavioral tasks such as the progressive ratio task (Hodos, 1961), the grip force task (Schmidt et al., 2008) and the Effort-Expenditure for Rewards Task (EEfRT; Treadway, Buckholtz, Schwartzman, Lambert, & Zald, 2009) require participants to actively work for rewards. The physical effort exerted in these tasks is used as a proxy for motivation and wanting. Reward motivation has also been assessed in tasks where participants get the opportunity to actively extend or shorten the exposure duration of stimuli by pressing buttons (Aharon et al., 2001; Chelnokova et al., 2014).

In learning-based reward tasks, participants often repeatedly choose between two or more stimuli with different reward contingencies (e.g. Bechara, Damasio, Damasio, & Anderson, 1994; Frank, Seeberger, & Reilly, 2004; Rolls, Hornak, Wade, & McGrath, 1994). This type of tasks may be used to assess the immediate effects of reward feedback on a trial-by-trial basis such as tendencies to repeat or switch responses following feedback. However, they can also provide information on changes in behavior over time as a function of reward feedback, such as development of response biases towards beneficial stimuli (e.g. Pizzagalli, Jahn, & O'Shea, 2005; Tripp & Alsop, 1999).

There are several limitations to conclusions that can be drawn from behavioral reward tasks with respect to hedonic capacity. Because many behavioral tasks do not incorporate self-report measures, they do not capture subjective experiences such as conscious desires or feelings of pleasure. Also, the use of behavioral tasks typically limits the type of contexts and rewarding stimuli that can be measured. This may reduce the generalizability of the results to other contexts and rewards (Berkowitz & Donnerstein, 1982). Another limitation of behavioral tasks is that they often require substantial time and effort both from participants and researchers. Long behavioral tasks sometimes also lead to fatigue or boredom (van der Linden, Frese, & Meijman, 2003), likely affecting measures of hedonia.

1.2.2 Anhedonia questionnaires

Questionnaires have a different set of qualities and limitations for measuring anhedonia. Since they can use hypothetical examples, researchers can collect questionnaire data on human reward processing across a large variety of rewards and contexts. Anhedonia questionnaires specifically provide information about the subjective experiences of rewards and reward-related behaviors. Questionnaires often require little time and effort to obtain data compared to behavioral tasks, allowing data collection from large samples in relatively short amounts of time. A clear limitation is the reliance on memory and imagination to respond to the various hypothetical or remembered scenarios described in anhedonia questionnaires. Thus, impairments in cognitive function could in theory lead to evidence of anhedonia in clinical groups that could be unrelated to reward system function (Cohen et al., 2011).

A variety of questionnaires have been developed to measure anhedonia. Several subscales and items on scales assessing symptom severity in depression (e.g. Beck Depression Inventory;

Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and schizophrenia (e.g. Scale for the Assessment of Negative Symptoms [SANS]; Andreasen, 1982) tap into reward-related impairments and are closely related to anhedonia questionnaires. The most commonly used self-report measures designed specifically to measure anhedonia are the Chapman Physical and Social Anhedonia Scales (Chapman, Chapman, & Raulin, 1976), the Fawcett-Clark Pleasure Scale (Fawcett, Clark, Scheftner, & Gibbons, 1983), the Temporal Experience of Pleasure Scale (Gard, Gard, Kring, & John, 2006), and the Snaith-Hamilton Pleasure Scale (Snaith et al., 1995). Each scale provides somewhat different information about the respondents' capacity for pleasure. For example, while some scales (e.g. SAS/PAS) ask for general tendencies, other scales (e.g. FCPS, SHAPS) survey imagined or remembered pleasure. The Temporal Experience of Pleasure Scale is designed to capture two aspects of imagined/remembered pleasure, as experienced when either consuming or anticipating rewards.

1.2.2.1 Chapman scales

The Chapman Physical (PAS) and Social (SAS) Anhedonia Scales (Chapman et al., 1976) and their revised versions (RPAS; Chapman & Chapman, 1978; RSAS; Eckblad, Chapman, Chapman, & Mishlove, 1982) were some of the earliest scales developed specifically to measure anhedonia. These questionnaires ask respondents to agree or disagree with statements about their general tendencies to enjoy a variety of physical and social experiences. Despite their popularity, these scales have several limitations. Firstly, neither the original nor the revised scales have been published in their entirety, making them less accessible for researchers to use. Secondly, each scale contains a large number of items (40 or more). While this provides a rich dataset, it can become cumbersome for participants and lead to fatigue as well as inaccurate or missing responses. Lastly, some of the items, such as “The sound of organ music has often thrilled me” and “Poets always exaggerate the beauty and joys of nature” may be culturally biased and be less representative of experiences that most people would find enjoyable.

1.2.2.2 Fawcett-Clark Pleasure Scale

The Fawcett-Clark Pleasure Scale (FCPS; Fawcett et al., 1983) is a 36-item questionnaire that asks respondents to imagine to what extent they would experience pleasure from various stimuli and events on a five-point scale ranging from ‘no pleasure at all’ to ‘extreme and lasting

pleasure'. FCPS is somewhat shorter than the Chapman scales and therefore quicker for respondents to complete. Like the Chapman scales, the FCPS has not been published in its entirety, and it has also been criticized for being culturally biased (Snaith et al., 1995) with items so specific they are not readily available to most people (e.g. "While fishing you feel a tug on your line and watch a six-pound fish jump out of the water with your bait in its mouth" and "You are skiing down a mountain very fast while still in good control of yourself").

1.2.2.3 Temporal Experience of Pleasure Scale

The Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006) consists of a consummatory pleasure scale (TEPS-CON) with 8 statements about the respondents' enjoyment of various stimuli, and an anticipatory subscale (TEPS-ANT) with 10 statements about the respondents' behavior and feelings in the time preceding pleasurable events. Both subscales ask respondents to indicate how true statements about pleasurable experiences are for them on a six-point scale ranging from 'very false for me' to 'very true for me'. The shortness, availability, and the focus on both consummatory and anticipatory pleasure are strengths that make the TEPS attractive to researchers. However, this scale has some important limitations. As with the Chapman and FCPS scales, some of the items are very specific and may not be representative of experiences that most people have access to (e.g. "When I'm on my way to an amusement park, I can hardly wait to ride the roller coasters"). Other items may be culturally biased (e.g. "I love it when people play with my hair"). Furthermore, unlike the other anhedonia-specific scales, the TEPS focuses mostly on physical pleasure and does not tap directly into social pleasures.

1.2.2.4 The Snaith-Hamilton Pleasure Scale

The Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) is another popular tool for assessing anhedonia or hedonic capacity. It consists of 14 statements about a variety of pleasurable experiences, and the respondents are asked to indicate whether they 1) definitely/strongly agree; 2) agree, 3) disagree or 4) strongly disagree with each statement based on their memory of the last few days.

The SHAPS has several advantages over other questionnaires designed to measure anhedonia. It is quick to complete, all 14 items are available in the appendix of the original paper, and the items were generated by asking people from the general population to provide

examples of events they experience as pleasurable. Thus, the SHAPS items may better represent enjoyable situations that most people encounter in their daily lives compared to the items of the Chapman scales, FCPS and TEPS. Accessibility to certain pleasurable events may also have less impact on the SHAPS than the TEPS because i) the events described in the SHAPS are framed in terms of whether the respondents would enjoy such events if they were accessible, and ii) many items are unspecific or broad (e.g. “I would enjoy my favourite meal” or “I would find pleasure in the scent of flowers or the smell of a fresh sea breeze or freshly baked bread”). Finally, in contrast to the TEPS, the SHAPS covers a broad range of pleasures. These include interest/pastimes (e.g. “I would find pleasure in my hobbies and pastimes”), social interaction (e.g. “I would enjoy being with my family or close friends”), sensory experience (e.g. “I would find pleasure in the scent of flowers or the smell of a fresh sea breeze or freshly baked bread”) and food/drink (e.g. “I would enjoy a cup of tea or coffee or my favourite drink”). The SHAPS has high internal consistency (Franken, Rassin, & Muris, 2007; Snaith et al., 1995), suggesting that it measures a single underlying construct despite covering such a wide variety of pleasures. The framing of the scale items (i.e. “I would...”) implies that SHAPS scores likely reflect a participant’s hypothesized consummatory pleasure experience. The responses are as such not a direct measure of either the consummatory pleasure experience or motivation, but likely related to both the anticipated pleasure and the current motivation for said pleasure. Limitations of the SHAPS questionnaire will be discussed in more detail in the discussion.

Since its publication in 1995, the SHAPS has been cited over 700 times and translated into many languages, including Dutch (Franken et al., 2007), German (Franz et al., 1998), French (Loas et al., 1997), Spanish (Fresán & Berlanga, 2013), Italian (Santangelo, Morgante, et al., 2009), Turkish (Kesebir, Yıldız, Göçmen, & Tezcan, 2015), Arabic (Thomas, Al Ali, Al Hashmi, & Rodriguez, 2012), Chinese (Liu, Wang, Zhu, Li, & Chan, 2012), Japanese (Nagayama et al., 2012) and Malay (Ng et al., 2014).

Although each item of the SHAPS has four response options, Snaith et al. (1995) originally used a two-point scoring method by assigning 0 to the “definitely/strongly agree” and “agree” responses, and 1 to the “disagree” and “strongly disagree” responses. SHAPS total scores would therefore range from 0 to 14, with higher scores indicating greater levels of anhedonia or reduced hedonic capacity. Disagreeing or strongly disagreeing with three or more reward statements (A SHAPS score >2) was deemed clinically significant based on the scores of

a general population sample and a sample of mainly depressed patients. Other researchers have later opted for four-point scoring of the SHAPS items, often to be able to measure individual differences in hedonic capacity within non-patient samples (Franken et al., 2007).

Snaith et al.'s (1995) original scoring scheme facilitated discrimination between normal levels of hedonic capacity and clinically significant anhedonia. However, the established cut-off value provides no information about the severity of anhedonia (or variation in hedonic capacity). Currently, there are no available reference values for anhedonia scores across healthy and clinical populations for the available anhedonia questionnaires. Accordingly, it is currently unclear whether the level of anhedonia reported in e.g. major depression differs from anhedonia symptoms reported in schizophrenia or other groups associated with reward processing impairments. To provide a road-map of current knowledge of hedonic capacity across healthy and clinical populations, we conducted a set of meta-analyses of the available literature measuring anhedonia symptoms with the SHAPS. Our meta-analysis is untraditional in the sense that it does not estimate effects found in randomized controlled trials (RCT). Rather, it aggregates baseline SHAPS scores to generate reference values for this commonly used questionnaire.

1.3 Objectives

The primary objective of this meta-analysis was to assess the severity of anhedonia as measured by the same anhedonia instrument across various clinical and non-clinical populations. We aimed to produce reference values for the typical level of – and variation in – SHAPS scores that can guide interpretation of anhedonia symptoms in both clinical settings and future research.

By using a meta-analytic approach, we benefit from a large literature reporting SHAPS scores across populations to generate summary estimates of SHAPS scores (i.e. meta-analytic mean and corresponding 95% confidence interval) for healthy participants and clinical populations associated with anhedonia, such as major depressive disorder, schizophrenia and substance use disorder.

1.3.1 Hypotheses

We hypothesized that

- 1) SHAPS scores from healthy participant samples would fall in the lower range of the anhedonia spectrum, significantly lower than clinical groups previously associated with anhedonia.

Due to anhedonia being considered a core symptom of major depression, we hypothesized that

- 2) Patients with MDD would score significantly higher on the SHAPS than other clinical groups, forming the upper range of the anhedonia spectrum.

Furthermore, we expected anhedonia in BD and SUD to be state-dependent. Specifically, based on theoretical accounts of altered reward processing in bipolar disorders, we expected that

- 3) Patients with BD in a (hypo)manic or euthymic state would have SHAPS scores comparable to healthy samples, while patients in a depressive state would have scores comparable to patients with MDD.

Based on reviews of anhedonia in substance use disorders, we hypothesized that

- 4) Patients with SUD actively using (or very recently abstaining from) addictive substances would display more anhedonia symptoms (higher SHAPS scores) than healthy participants, while patients with SUD characterized by successful prolonged abstinence would show SHAPS scores comparable to the healthy samples.

2 Methods

2.1 Protocol and registration

A preregistration of the project is available in the PROSPERO register at <https://www.crd.york.ac.uk/prosperto/> with the identifier CRD42018109910 (Trøstheim, Eikemo, Hansen, Alnes, & Leknes, 2018) and in the appendix. PROSPERO is an international database of prospectively registered systematic reviews with health related outcomes. The present meta-analysis will follow the guidelines for reporting systematic reviews presented in the PRISMA statement (Moher, Liberati, Tetzlaff, Altman, & the PRISMA Group, 2009). The PRISMA statement consists of a detailed checklist of issues that should be addressed in a systematic review, including the search strategy, study eligibility criteria, data extraction, data synthesis and risk of bias assessment in individual studies and across studies. Preregistration at PROSPERO requires the researchers to report these aspects of their methods for the systematic review ahead of completed data extraction. The report is evaluated by the organizers of PROSPERO before publication.

2.2 Data material

2.2.1 Literature search

To locate studies using the SHAPS, we limited the literature search to all articles citing the original SHAPS report by Snaith et al. (1995). We first located the original SHAPS report (i.e. Snaith et al., 1995) in the electronic databases Web of Science, Scopus and PubMed and in the search engine Google Scholar, and then used the built-in function of these services to list all articles citing this paper. Searches in Web of Science, Scopus and PubMed were conducted on April 5 2018 while the search using Google Scholar was performed on April 11 2018. References for all the search results were downloaded and imported into EndNote either directly or (for Google Scholar results) using the software Publish or Perish (version 6.28.6197.6663; Harzing, 2007). We also included Snaith et al.'s (1995) original report in the data material.

2.2.2 Eligibility criteria

Based on a preliminary qualitative evaluation of a randomly selected subsample of papers using the SHAPS, we chose to include studies that:

- 1) Included original data (e.g. excluding reviews, book chapters, protocols, editorials)
- 2) Used the complete questionnaire (i.e. all 14 items)
- 3) Used four-point or two-point scoring of the SHAPS items
- 4) Assessed SHAPS at baseline or in no-treatment condition
- 5) Did not perform selective recruitment of participants based on SHAPS score, and that
- 6) Reported SHAPS data from analyses performed without adjusting for covariates.

There were no language restrictions.

2.2.2.1 Categorization of samples

For the purpose of this thesis, we refer to a collection of participants as samples while we reserve the term 'group' for a collection of samples. We categorized individual study samples as healthy if the participants were described by the study authors as having no current or recent psychiatric and/or medical conditions. Categorization of clinical samples were based on the diagnostic descriptions of each sample. Clinical samples were included if they had a diagnosis according to established criteria (e.g. DSM, ICD) and if the diagnosis was verified in the report

(e.g. by structured clinical interview, medical tests, by qualified professionals, as a requirement for admission to treatment). Clinical samples were excluded if the verification method was not specified. Samples of patients with MDD were stratified based on the state of the disorder (i.e. current or past/remitted major depression). We stratified samples of patients with SUD based on drug use status (i.e. current use, abstinence, receiving pharmacotherapy). Samples of patients with BD were grouped based on descriptions of their current phase or condition (i.e. depressed, euthymic, manic, and psychotic).

Finally, we included samples of unspecified clinical status (e.g. students, controls, general population). These samples were classified as “general population”. For exploratory purposes, we also included other well-defined groups (e.g. smokers).

2.2.3 Article selection and data extraction

Two student researchers examined all the references downloaded using EndNote and removed any duplicates. Following duplicate removal, each full-text articles study was evaluated for inclusion by two student researchers. Any disagreement at this stage was resolved through discussion between the two researchers. Following recommendations by Fu et al. (2011), a group was included in the statistical analyses if a minimum of four separate samples assessed SHAPS in this group and if these samples were assessed with SHAPS using the same scoring format (e.g. two-point or four-point scoring). Fu et al. (2011) noted that this cut-off is arbitrary. Alternatively, we could have followed the recommendation put forth by The Cochrane Collaboration (2011) of at least ten studies per subgroup. However, this recommendation is also largely arbitrary. Due to the exploratory nature of this meta-analysis, it was deemed appropriate to use a low cut-off in order to obtain a broad selection of groups.

The thesis author extracted data from all the included articles ($k = 189$). The thesis author also contacted article authors via e-mail to obtain missing data ($k = 107$ articles). From each included paper, the following information was extracted:

- 1) The total number of participants
- 2) The number of female participants
- 3) Age (mean and standard deviation)
- 4) SHAPS information including scoring method, mean, standard deviation, and the number of anhedonic participants according to the original cut-off.

- 5) Further, the mean and standard deviation for several established measures of depression was extracted as planned in the preregistration. These included the Beck Depression Inventory (BDI; Beck, Steer, & Brown, 1996; Beck et al., 1961), Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995), Hamilton Rating Scale for Depression (HAM-D; Hamilton, 1960), and Montgomery-Åsberg Depression Rating Scale (MADRS; Montgomery & Åsberg, 1979).

Depression severity was not covered by the above depression scales for several of the included samples. To increase the number of data points in some of the exploratory analyses, the thesis author also extracted the mean and standard deviation of additional depression measures for all the included samples. These measures were not specified in the preregistration and included the Mood and Feelings Questionnaire (MFQ; Costello & Angold, 1988), the depression subscale of the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), the Inventory of Depressive Symptomatology (IDS; Rush et al., 1986), the Quick Inventory of Depressive Symptomatology (QIDS; Rush et al., 2003), the Bech-Rafaelsen Melancholia Scale (BRMS; Bech & Rafaelsen, 1980), the General Distress: Depressive Symptoms and Anhedonic Depression subscales of the Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al., 1995), the Geriatric Depression Scale (GDS; Yesavage et al., 1982), Zung Self-Rating Depression Scale (SDS; Zung, 1965), Self-Rating Questionnaire for Depression (SRQ-D; Rockliff, 1969), the depression item on the Short Parkinson's Evaluation Scale (SPES; Rabey et al., 1997), and the Calgary Depression Scale (CDS; Addington, Addington, & Maticka-tyndale, 1993). To run additional exploratory analyses, the thesis author also extracted the percentage of patients being medicated for their condition for all the included clinical samples.

We also extracted some general information about the articles, including publication year, the article's written language, whether the article was published in a peer-reviewed journal, and the sample location (i.e. what country the sample resided in).

For the purpose of quality assessment, we noted whether there were any modifications made to the SHAPS, whether any missing data had been obtained from article authors, and whether there was any comorbid major depression, psychotic features or disorders, and substance dependence/abuse/disorders for the included clinical samples.

When a study within an article included multiple samples from the same group, we combined the data using formulae for weighted mean and pooled standard deviation with the number of participants in each sample as weights.

To evaluate the quality and reliability of the data extraction, a second student researcher extracted data from a random selection of 25% of the included articles. The average error rate for extracted variables per article was 1% ($SD = 4\%$). All detected errors were corrected. Due to the low error rate, we deemed the 25% quality control sufficient.

2.2.4 Quality assessment

For the assessment of individual study quality, we chose a descriptive approach. The other available quality assessment methods were either too exhaustive and/or were intended for evaluation of specific study design (e.g. the Downs and Black Checklist; Downs & Black, 1998; the Newcastle-Ottawa Scale; Wells et al., 2008) of little relevance to the present meta-analysis. For this meta-analysis, it was important that the SHAPS data quality was good, that we were able to include most of the literature, and that groups could be compared.

To summarize the quality of the data material, we calculated 1) the number of samples assessed with a modified SHAPS, what kind of modifications were made, and how common each type of modification was; 2) how much data we were able to cover before and after receiving missing data, and how much data was still missing for each group; and 3) the number of samples with no (0 participants) or any (≥ 1 participant) comorbidity with major depression, psychotic symptoms/disorders, and substance dependence/abuse/disorders.

2.2.4.1 Risk of bias

In traditional meta-analyses of intervention effects, there are well-established guidelines for risk-of-bias assessment (The Cochrane Collaboration, 2011). These guidelines are optimized for RCTs and focus on randomization, allocation concealment, and blinding of the participants and experimenters. Because we were analyzing baseline SHAPS data that had been obtained before any intervention or experimental manipulation, many of the questions addressed by the assessment tools for risk-of-bias in RCTs were inappropriate or inapplicable for the included studies (Bero et al., 2018). Furthermore, risk of other sources of bias would likely be small as the SHAPS has most commonly been used as a secondary outcome variable and often solely for

descriptive purposes. We therefore had little reason to believe that scores on the SHAPS would affect whether results would be published or not.

2.3 Data pre-processing

For individual studies, we calculated the percentage of female participants and depression severity for each included sample. For all studies that reported the number of participants scoring above the original SHAPS cut-off (Snaith et al., 1995), we also calculated the percentage of anhedonic participants.

Different iterations of two-point (e.g. 0-1, 1-0) and four-point (e.g. 1-4, 4-1, 0-3, 3-0) were reported throughout the SHAPS literature. When necessary, we recalculated SHAPS scores from individual studies to conform to a 0-1 scoring method (1 representing ‘disagree’/‘strongly disagree’) in the case of two-point scoring, and a 1-4 scoring method (4 representing ‘strongly disagree’) in the case of four-point scoring, such that higher values indicated higher anhedonia symptoms for both scoring methods. SHAPS total scores could range from 0 to 14 under the two-point scoring method and from 14 to 56 under the four-point scoring method.

A large variety of measures instruments had been used to measure depression severity in the included samples. To facilitate exploratory analyses with minimum data reduction and number of tests, we created a common depression severity variable. For each measure of depression, we rescaled each sample mean score according to the highest obtainable score on each particular instrument. The resulting scores expressed depression severity in percentage of the maximum score and could therefore range from 0-100, with higher scores indicating greater severity and/or more symptoms of depression (see section 4.2 for discussion of other options for defining the depression severity variable). For samples with more than one depression measure reported, we then averaged this percentage score across all available measures of depression.

2.4 Comparisons of group characteristics

We used z-tests to compare differences in age, percentage of female participants and depression severity between the included groups.

2.5 Meta-analyses

2.5.1 Random-effects model

Two types of meta-analysis are commonly used: The fixed-effect model and the random-effects model. Under a fixed-effect model, we assume that any variation in the measured effect between studies is solely due to sampling error. Under a random-effects model on the other hand, we assume that the various study effects are sampled from similar populations that may vary in some respects. Instead of assuming a *single common underlying true effect* (as in a fixed-effects model), the random-effects model assumes an underlying distribution of true effects. Variation in the effect between studies is therefore assumed to stem from variation in the true effects underlying the different studies (Borenstein, Hedges, Higgins, & Rothstein, 2009). The random-effects model estimates the mean and variance of this underlying distribution of true effects. Each study included in the model contributes with information about the underlying distribution because they sample from different populations. Larger studies with less variance sample from only some of the many different populations. To avoid bias, these studies are given less relative weight than under a fixed-effects model, whereas smaller studies that sample from other populations will have a greater impact on the estimated mean of the underlying distribution of true effects.

Random effects models were deemed suitable for all analyses as the studies we included originated from a range of different research groups and samples across the world, and several translations and other minor modifications of the SHAPS were used. For all meta-analyses, we used random-effects models implemented in the “metafor” package (Viechtbauer, 2010) in R statistical software (R Core Team, 2018). We used the DerSimonian-Laird (DL; DerSimonian & Laird, 1986) method for estimating the between-studies variance component (T^2) in all meta-analyses. This is the most commonly used estimator of the between-studies variance in random-effects meta-analyses (Veroniki et al., 2016). For continuous outcome data, the DL method performs similarly to other recommended methods such as the Paule-Mandel (PM) and the restricted maximum likelihood (REML) methods in terms of bias. These methods show little bias when the number of studies is high, but are more biased when the number of studies is particularly small (Novianti, Roes, & van der Tweel, 2014).

2.5.2 Estimates of heterogeneity

Heterogeneity refers to the variation in the true effects underlying each study in the meta-analysis (Borenstein et al., 2009). Different heterogeneity estimates are reported with meta-analyses to give an overview of the spread of the study effects. *Cochran's Q* is used to test the null-hypothesis that all studies share the same underlying effect. A significant *Cochran's Q* suggests that there is variation in the observed study effects that cannot be explained by sampling error. I^2 complements *Cochran's Q* by indicating “the percentage of total variation across studies that is due to heterogeneity rather than chance” (Higgins, Thompson, Deeks, & Altman, 2003, p. 558). Neither *Cochran's Q* nor I^2 allow us to evaluate the spread of the study effects on the same scale as the outcome measure. For this, we calculated T (i.e. the square root of T^2), which indicates the between-studies standard deviation of the observed study effects (Borenstein et al., 2009). For moderator analyses, we also calculated R^2 , which indicates the percentage of the total heterogeneity that is explained by the moderator(s) (López-López, Marín-Martínez, Sánchez-Meca, Van den Noortgate, & Viechtbauer, 2014).

2.5.3 Confidence intervals

The critical z-value at $\alpha = .05$ was used to calculate 95% confidence intervals (CI) of the summary effect in each random-effects model. These CIs are on the same scale as the summary effect.

2.5.4 Prediction intervals

Confidence intervals indicate the uncertainty in the summary effect and are useful for predicting the observed effects in future studies if there is a common true effect for past studies (as is assumed in a fixed-effect model). In random-effects meta-analyses, the true effect is assumed to be different for each past study. Because confidence intervals do not take this heterogeneity into account, they may not be optimal for predicting the observed effects in future studies Nagashima, Noma, and Furukawa (2018).

To be able to infer which levels of hedonic capacity can be expected for each of the healthy and clinical groups included here based on the available literature of SHAPS scores, we also calculated a 95% prediction interval (PI) for each summary effect in the primary meta-analyses. The prediction interval accounts for heterogeneity and predicts the true effect of a new

study given past studies. The prediction intervals were estimated using a bootstrapping procedure introduced by Nagashima et al. (2018) and implemented in the “pimeta” package in R statistical software. This method for calculating the prediction intervals has good coverage probability even when the number of studies is small. 100 000 bootstrap samples were used to estimate the 95% PI for each summary effect. These PIs are on the same scale as the summary effect.

2.5.5 The meta-analyses presented in this thesis

We conducted two types of meta-analyses: 1) A primary set of meta-analyses producing and comparing point-estimates of the average SHAPS total scores for each included group, and 2) a secondary set of meta-analyses of effect sizes of the difference in SHAPS total scores between healthy and clinical samples.

2.5.5.1 Point-estimate meta-analyses

All point-estimate meta-analyses used SHAPS total scores of individual samples as input and were performed separately for studies using four-point and two-point scoring formats for the SHAPS. The primary outcome of these meta-analyses were meta-analytic estimates of the mean SHAPS total scores and the respective 95% confidence intervals for the various groups for which SHAPS have been reported in the literature. Separate random-effects models were computed for each of the included groups. We used meta-regression to compare groups. For each of these meta-regressions, we first selected pairs of groups to be compared, then dummy-coded the samples according to group type, and then entered the dummy variable as a predictor of SHAPS total score.

2.5.5.2 Effect size meta-analyses

Effect sizes were calculated as *Hedges' g* (Hedges, 1981). For small samples, *Hedges' g* is less positively biased than *Cohen's d*, which is another popular alternative for calculating effect sizes for differences in means (Borenstein et al., 2009). The primary outcome of these analyses were meta-analytic estimates of the mean *Hedges' g* and respective 95% CIs. A benefit of conducting meta-analysis of effect sizes was the ability to include studies using both the four-point and two-point scoring methods. All effect sizes were from studies contrasting SHAPS scores in healthy participants and patients. We used meta-regression to address whether the

effect sizes from studies contrasting SHAPS scores in healthy participants and patients with current major depressive disorder were different from effect sizes from studies contrasting SHAPS scores in healthy participants and each of the other clinical groups.

2.5.6 Sensitivity analyses

To test whether the results from our meta-analyses was dependent on the choice of methods for estimating the between-studies variance, we repeated the above analyses using other recommended τ^2 estimators for continuous outcomes including the Paule-Mandel (PM) and the restricted maximum likelihood (REML) methods (Veroniki et al., 2016).

In addition, because data for some of the samples were from the same articles, we tested the potential clustering effects by repeating analyses with an added random effect at the article-level (Konstantopoulos, 2011).

2.5.7 Additional analyses

For exploratory purposes, we performed additional meta-regression to identify variables that might moderate SHAPS scores between and within groups.

Elevated depression and depressive disorders are common in schizophrenia, substance use disorders and Parkinson's disease (Buckley, Miller, Lehrer, & Castle, 2008; Davis, Uezato, Newell, & Frazier, 2008; Reijnders et al., 2008). To assess whether any differences in SHAPS scores between healthy and clinical groups could be explained by differences in general depression severity between these groups, we conducted a series of meta-regressions moderators. For these analyses, we first reduced the dataset to only include studies with available depression data. To provide a basis for the comparison with model results including depression scores, we first ran meta-regressions across groups without adding depression severity as a predictor. For the point-estimate meta-regressions, this meant only including the dummy-coded group variable as a predictor of SHAPS scores. For the effect size meta-regressions, this meant simply estimating the summary effect (i.e. intercept). Finally, we added depression severity to the models. In the point-estimate meta-regressions, we added the depression severity variable score per sample. For the effect size meta-regressions, we first computed *Hedge's g* for the difference in depression severity between the healthy sample and the clinical sample within each study before adding this effect size variable to the models.

Due to differences in age and the percentage of female participants between the healthy group and the SCZ, SUD and PD groups (see section 3.1.5), we performed additional meta-regressions controlling for these variables. These analyses were similar to the analyses controlling for depression severity, with the exception that they included either age or the percentage of female participants as a predictor instead of depression severity.

We also performed meta-regressions to address whether the number of medicated patients in the current MDD, SCZ and PD samples predicted SHAPS scores. These meta-regressions were conducted separately for each group.

2.5.8 Notes on multiple testing

It is common to perform multiple tests in meta-analyses, but not (yet) common to address issues of multiple testing (Imberger, Vejlbj, Hansen, Møller, & Wetterslev, 2011; Polanin & Pigott, 2015). Currently, there is no consensus on how to account for multiple testing in meta-analyses (Bender et al., 2008; The Cochrane Collaboration, 2011). Due to the exploratory nature of our meta-analysis, results are reported here without adjustments for multiple testing.

3 Results

3.1 Data material

3.1.1 Article selection

The article selection process is visualized in figure 1. The initial literature search returned 1531 results in total, 961 of which were duplicates. Overall, our searches yielded 570 unique results. The final dataset consisted of 189 published and unpublished articles reporting 195 studies assessing SHAPS in 269 samples meeting the predefined inclusion criteria. These samples had been categorized into nine different groups: Healthy, current major depressive disorder, past major depressive disorder, bipolar disorders schizophrenia/schizoaffective disorder, substance use disorders, Parkinson's disease, smokers, and "general population".

Of the 189 included articles, 58 were eligible for inclusion in the effect size meta-analysis.



PRISMA 2009 Flow Diagram

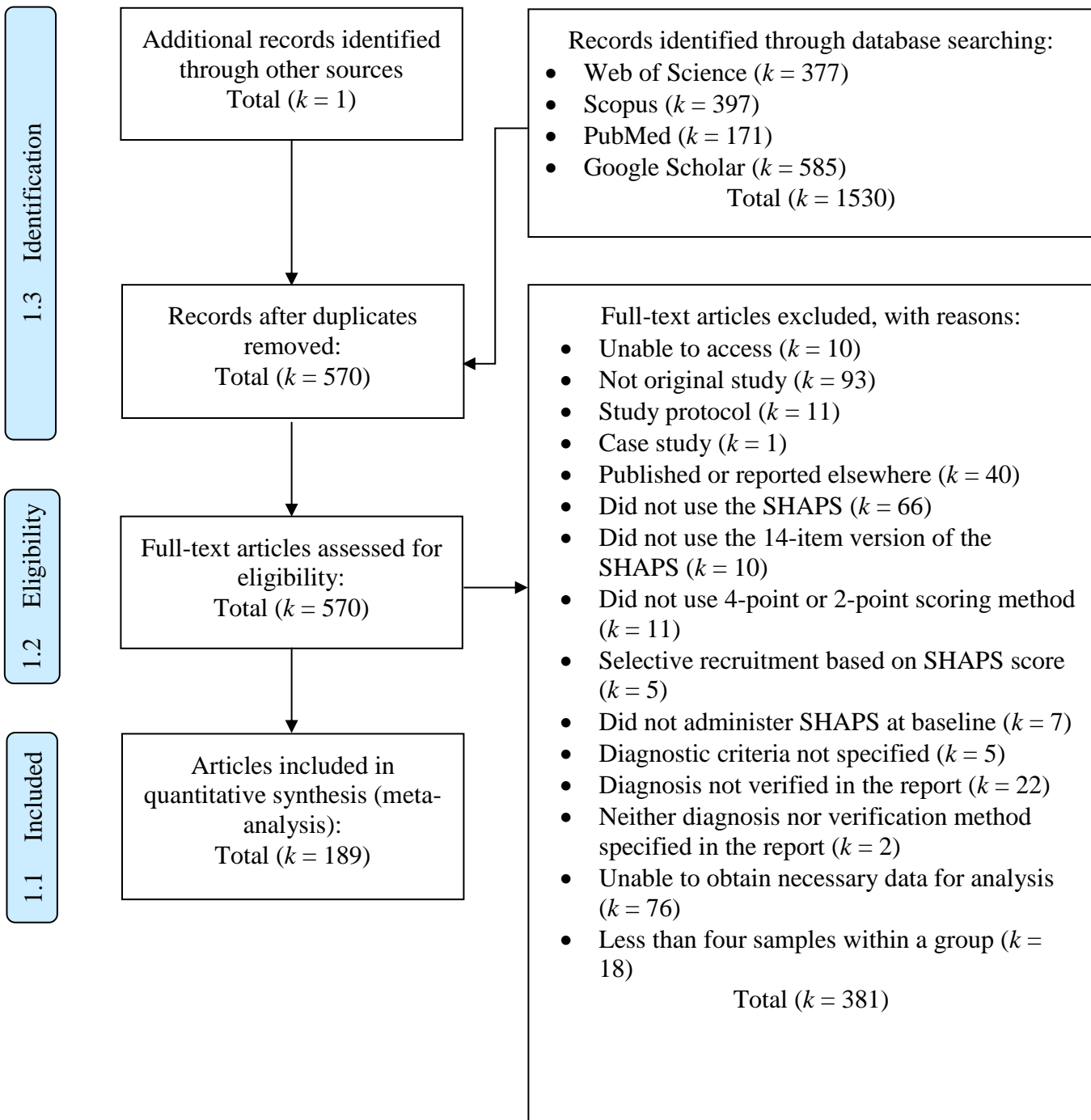


Figure 1. PRISMA flow diagram of the article selection process.

3.1.2 Article and sample characteristics

Article characteristics are presented in table 1. General sample characteristics are available in table 2.

Table 1

Article characteristics (k = 189)

	<i>k articles (%)</i>
Publication year	
1995-2008	28 (15%)
2009-2018	161 (85%)
Article languages	
English	183 (97%)
Non-English	6 (3%)
Peer-reviewed journal	164 (87%)
SHAPS scoring format	
Four-point only	97 (51%)
Two-point only	89 (47%)
Both	3 (2%)
SHAPS scoring method ^a	
0-1	89 (47%)
1-0	3 (2%)
0-3	9 (5%)
3-0	5 (3%)
1-4	63 (33%)
4-1	23 (12%)
Received missing data ^b	
Necessary data	97 (51%)
Moderator data	41 (22%)
Groups covered ^c	
Healthy	98 (52%)
MDD (current and past/remitted)	54 (29%)
BD	3 (2%)
SCZ	16 (8%)
SUD	11 (6%)
PD	22 (12%)
Smokers	9 (5%)
“General population”	47 (25%)

Note. ^a‘Strongly agree’-‘strongly disagree’.

^bNecessary data included the number of participants, SHAPS mean and standard deviation, and SHAPS scoring method. ^cGroups with at least four samples.

Table 2

Sample characteristics (k = 269)

	<i>Range</i>
Mean age	13.04-72.01
Percent female participants	0-100%
Sample location	<i>k samples (%)</i>
US	85 (32%)
UK	48 (18%)
Italy	25 (9%)
Germany	24 (9%)
Canada	19 (7%)
China	11 (4%)
The Netherlands	11 (4%)
Other*	48 (17%)

Note. *Japan, Belgium, France, Australia, South Korea, Switzerland, United Arab Emirates, Uruguay, Austria, Malaysia, Norway, Poland and Sweden.

3.1.2.1 Healthy samples

The majority of the included healthy samples (81%, $k = 79$) were described as having no psychiatric conditions at the time of the study. Four percent ($k = 4$) were described as having no medical conditions, and 15% ($k = 15$) had neither any psychiatric conditions nor any medical conditions. Assessment of health status in healthy samples was usually done with structured clinical interviews (50%, $k = 49$), followed by clinical interviews with no specification of interview format (8%, $k = 8$) and self-report (6%, $k = 6$). For 36% ($k = 35$) of the healthy samples, verification method was not specified.

3.1.2.2 Psychiatric samples

All psychiatric samples (i.e. MDD, BD, SCZ and SUD; $k = 88$) had diagnoses according to DSM-IV, DSM-V or ICD-10 (inclusion criteria). Diagnoses were verified through structural clinical interviews in 85% ($k = 75$) of the psychiatric samples. Other verification methods included clinical interviews with no specification of interview format (12%, $k = 11$), medical records (1%, $k = 1$), and specification that diagnosis was required for admission to treatment program (1%, $k = 1$).

3.1.2.3 Parkinson's disease samples

Eighty-six percent ($k = 19$) of the included Parkinson's disease samples had a diagnosis according to the UK Brain Bank criteria (Hughes, Daniel, Kilford, & Lees, 1992), while the diagnosis in 14% ($k = 3$) of the samples was in accordance with the criteria specified by Gelb, Oliver, and Gilman (1999). Both set of criteria highlight bradykinesia, rigidity and tremor as central behavioral features of Parkinson's disease.

3.1.3 Quality of data material

3.1.3.1 SHAPS modifications

Authors reported using modified versions of the SHAPS in 26% ($k = 50$) of the included articles. Twenty-five percent ($k = 47$) of the included articles reported use of translated version of the SHAPS. These non-English languages included Arabic, Chinese, Dutch, French, German, Italian, Japanese, Korean, Malay, Polish, Spanish and Swedish. Other SHAPS modifications included changes in the wordings or content of the items, and the use of the SHAPS-C which

was designed to be administered by clinicians (Ameli et al., 2014). These types of modifications were reported in only 2% ($k = 4$) of the included articles. Overall, at least 27% ($k = 73$) of the included samples were assessed with a modified version of the SHAPS. In many articles, descriptions of the SHAPS was brief, and it is possible that more samples were assessed with modified versions of the SHAPS.

3.1.3.2 Completeness of data

Before contacting authors, necessary data (i.e. correct N, SHAPS scoring method, SHAPS mean or SHAPS standard deviation) to run the primary analyses was available for 126 out of 353 samples from the included groups. Insufficient scoring information, sometimes in combination with missing SHAPS data, was often what initially prevented us from including samples in the analyses. After contacting authors to obtain missing data, we were able to include an additional 143 samples (see table 3 for the current completeness of the data for each included group). We also received missing moderator data (e.g. N female, mean and SD for age and depression measures) for 54 articles.

Table 3
Completeness of necessary data for each included group.

	<u>Healthy</u>	<u>MDD</u>		<u>BD</u>	<u>SCZ</u>	<u>SUD</u>	<u>PD</u>	<u>Gen</u>	<u>Smokers</u>
		Current	Past						
Total	128	62	7	5	19	18	28	71	17
Included	98 (77%)	49 (79%)	6 (86%)	4 (80%)	16 (84%)	13 (72%)	22 (79%)	51 (72%)	10 (59%)
Available data	43 (34%)	21 (34%)	1 (14%)	2 (40%)	3 (16%)	10 (56%)	17 (61%)	25 (35%)	4 (24%)
Received data	55 (43%)	28 (45%)	5 (71%)	2 (40%)	13 (68%)	3 (17%)	5 (18%)	26 (37%)	6 (35%)
Still missing data	30 (23%)	13 (21%)	1 (14%)	1 (20%)	3 (16%)	5 (28%)	6 (21%)	20 (28%)	7 (41%)

Note. Necessary data included the number of participants, SHAPS mean and standard deviation, and SHAPS scoring method. All numbers indicate k samples and percentage of total samples. ‘Included’ indicates the number of samples included for each group. ‘Available data’ indicates the amount of samples for which necessary data was available in the article. ‘Received data’ indicates the amount of samples for which we received necessary data. ‘Still missing data’ indicates samples for which necessary data is still missing despite repeated emails to study authors.

3.1.3.3 Diagnostic comorbidity

There was generally little diagnostic overlap between the MDD, SCZ and SUD groups (see table 4). This suggested that it was indeed appropriate to generate separate meta-analytic estimates of SHAPS scores for each group and to compare these estimates against each other.

Information about co-occurring psychiatric disorders was often not reported for the PD samples, and when it was, the samples usually consisted of at least some patients with major depression (see table 4).

Table 4
Reporting of comorbidity for clinical samples

	<u>MDD</u>		<u>BD</u>	<u>SCZ</u>	<u>SUD</u>	<u>PD</u>
	Current	Past				
Total samples	49 (100%)	6 (100%)	4 (100%)	16 (100%)	13 (100%)	22 (100%)
Samples reporting comorbidity data						
Major depression						
No comorbidity	---	---	2 (50%)	6 (38%)	9 (69%)	6 (27%)
At least some comorbidity	---	---	2 (50%)	0 (0%)	3 (23%)	5 (23%)
Not reported	---	---	0 (0%)	10 (63%)	1 (8%)	11 (50%)
Psychotic symptoms/disorders						
No comorbidity	39 (80%)	4 (67%)	4 (100%)	---	11 (85%)	13 (59%)
At least some comorbidity	0 (0%)	1 (17%)	0 (0%)	---	0 (0%)	0 (0%)
Not reported	10 (20%)	1 (17%)	0 (0%)	---	2 (15%)	9 (41%)
Substance dependence/abuse/disorders						
No comorbidity	36 (73%)	4 (67%)	4 (100%)	13 (81%)	---	8 (36%)
At least some comorbidity	1 (2%)	1 (17%)	0 (0%)	0 (0%)	---	0 (0%)
Not reported	12 (24%)	1 (17%)	0 (0%)	3 (19%)	---	14 (64%)

Note. All numbers indicate k samples and percentage of total samples. ‘No comorbidity’ was defined as 0 participants with comorbid symptoms/disorders. ‘At least some comorbidity’ was defined as ≥ 1 participant(s) with comorbid symptoms/disorders.

3.1.1 Group characteristics

Group characteristics (e.g. total number of samples and participants, proportion of female participants, age, and depression severity) for the included groups are available in figure 2-7 in the main text and in figure A1-A9 in appendix A.

Compared to the healthy group, the current MDD group was slightly older and contained a greater proportion of female participants (all but one $p < .001$). The SCZ, SUD and PD groups were on average older and contained a larger proportion of male participants compared to both the healthy and current MDD groups (all but one $p < .05$). Depression was more severe in the

SCZ, SUD and PD groups than in the healthy group, but less severe than in the current MDD group (all $ps < .001$).

3.1.1.1 Prevalence of clinically significant anhedonia

Some of the included articles reported the number of participants who scored above the original SHAPS cut-off for clinical anhedonia. The reported prevalence of clinical anhedonia in healthy samples ranged from 5-15% ($M = 15\%$). These estimates were higher in current major depressive disorder (range 35-87%, $M = 62\%$, $z = 12.21$, $p < .001$), substance use disorders (range 19-55%, $M = 32\%$, $z = 7.93$, $p < .001$) and Parkinson's disease (range 5-46%, $M = 26\%$, $z = 7.95$, $p < .001$), but not in schizophrenia ($M = 23\%$, $z = 1.63$, $p = .10$). Please note that these prevalence estimates are based on very few samples.

3.2 Meta-analyses

3.2.1 Meta-analyses of SHAPS scores under 1-4 scoring

Forest plots displaying SHAPS scores for individual healthy, MDD, BD, SCZ, SUD and PD samples under four-point scoring are shown in figure 2-7 (see figure A1 and A2 in appendix A for forest plots for the “general population” and smokers groups, respectively). Separate random-effects models for each included group are presented collectively in figure 8. *Cochran's Q* indicated that within most of the groups, the samples did not share a common effect, and I^2 suggested that the most of the variation between samples was due to heterogeneity rather than chance. Formal statistical comparisons between groups are presented in the following section.

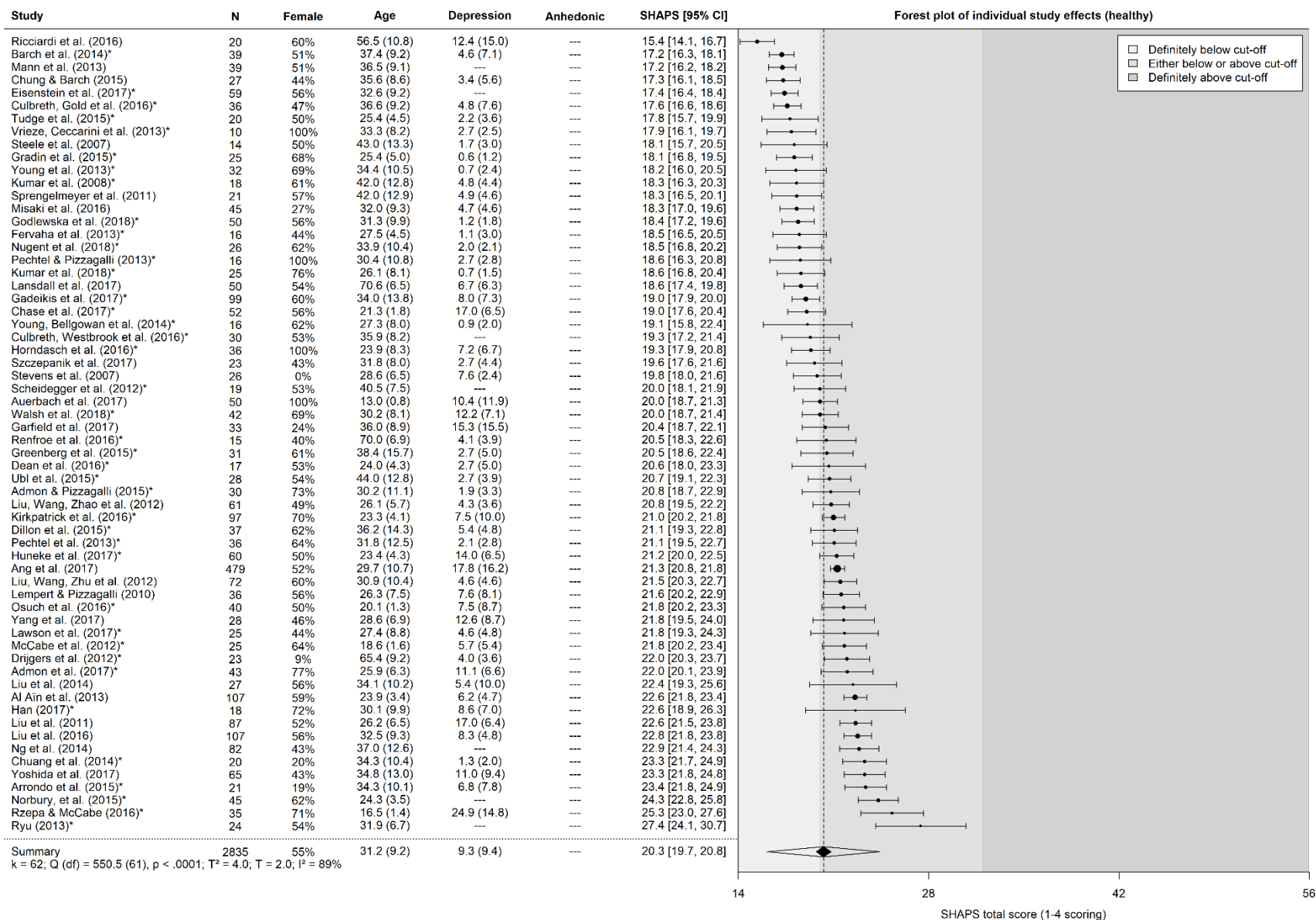


Figure 2. Forest plot of SHAPS scores under 1-4 scoring for healthy samples. See p. 31 for complete figure information.

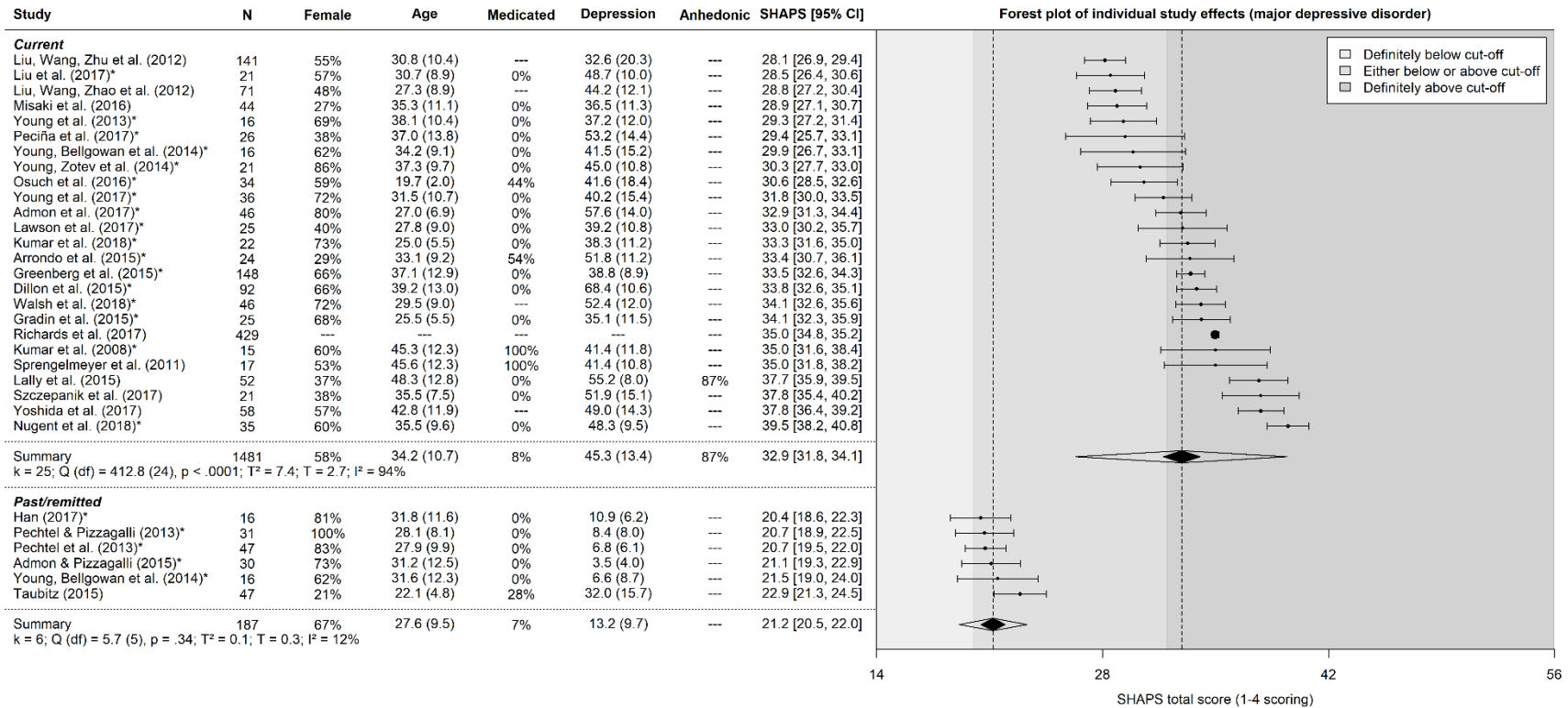


Figure 3. Forest plot of SHAPS scores under 1-4 scoring for samples of patients with current and past/remitted major depressive disorder. See p. 31 for complete figure information.

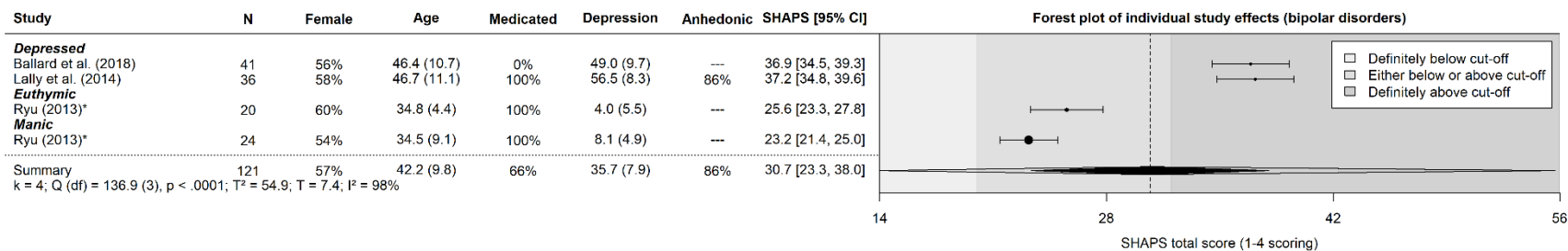


Figure 4. Forest plot of SHAPS scores under 1-4 scoring for samples of patients with bipolar disorder. See p. 31 for complete figure information.

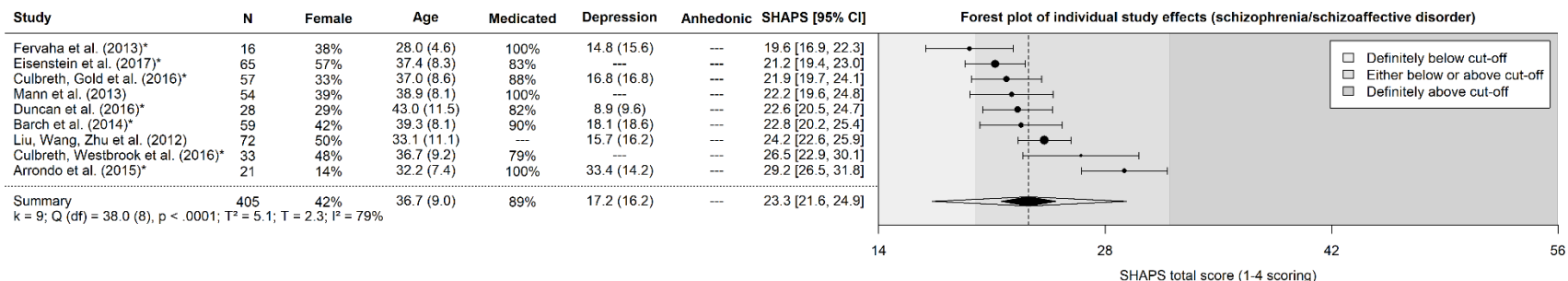


Figure 5. Forest plot of SHAPS scores under 1-4 scoring for samples of patients with schizophrenia or schizoaffective disorder. See p. 31 for complete figure information.

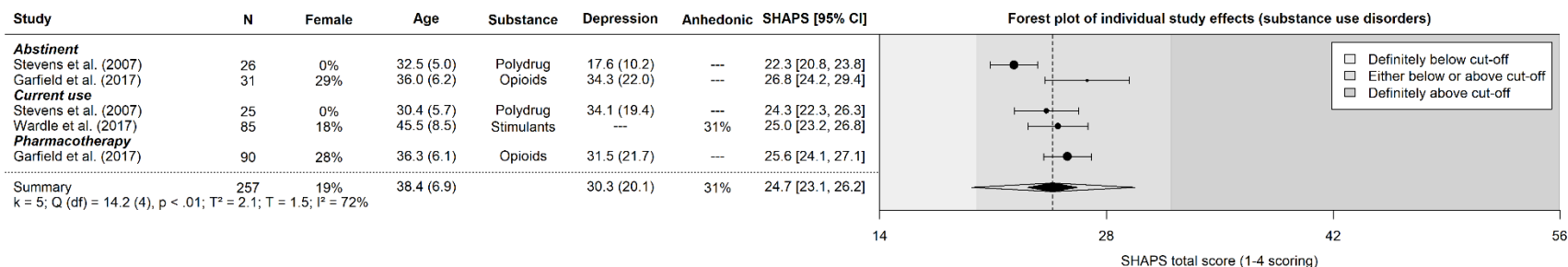


Figure 6. Forest plot of SHAPS scores under 1-4 scoring for samples of patients with substance use disorders. See p. 31 for complete figure information.

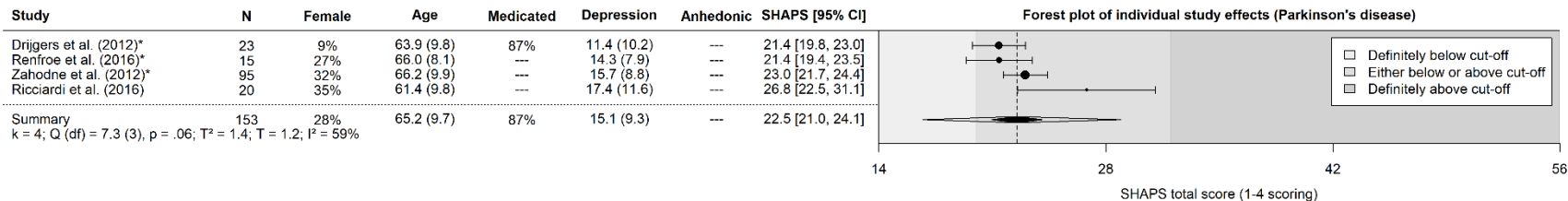


Figure 7. Forest plot of SHAPS scores under 1-4 scoring for samples of patients with Parkinson’s disease. See below for complete figure information.

Figure 2-7. Forest plot of SHAPS total scores under 1-4 scoring. ‘Female’ is the percentage of female participants. ‘Medicated’ is the number of medicated patients. ‘Substance’ is the primary substance of abuse. ‘Depression’ can range from 0-100, with higher scores indicating greater severity or more symptoms of depression. ‘Anhedonic’ is the percentage of participants who disagreed or strongly disagreed with more than two items on the SHAPS. k is the number of studies. Q is Cochran’s Q. T² is the estimated between-studies variance. T is the estimated between-studies standard deviation. I² is the amount of variation between studies that is due to heterogeneity rather than chance. Black dots and horizontal bars represent SHAPS total scores and 95% CIs, respectively, for individual samples. Black polygons represent the summary SHAPS score and 95% CI. Transparent polygons with black border represent 95% PIs. Gray areas indicate SHAPS scores under 1-4 scoring that a) would be the cut-off if the data was recoded to 0-1 scoring (light gray); b) could either be below or above the cut-off if the data was recoded to 0-1 scoring (medium gray); and c) would be above the cut-off if the data was recoded to 0-1 scoring (dark gray). *Received missing data.

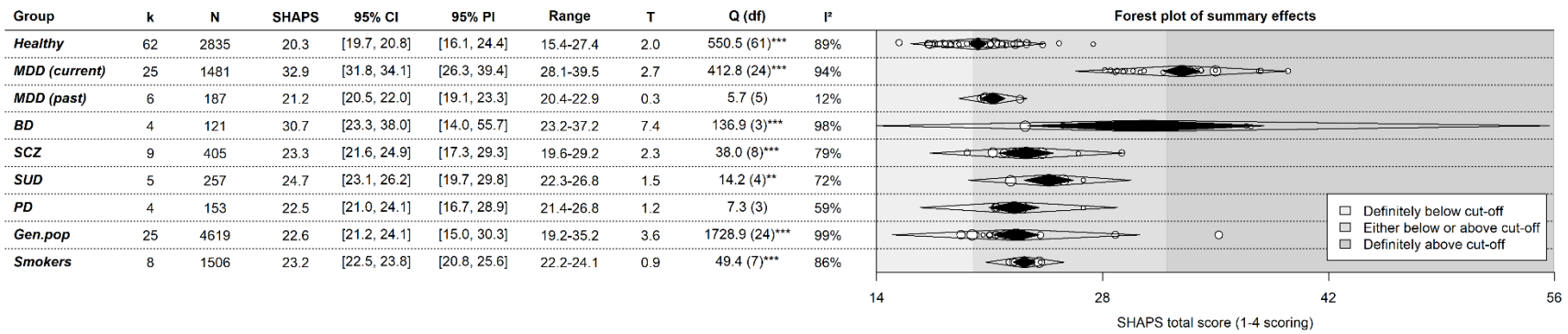


Figure 8. Forest plot of summary SHAPS total scores per included group under 1-4 scoring. k is the number of studies. N is the number of participants. Q is Cochran's Q. T is the estimated between-studies standard deviation. I² is the amount of variation between studies that is due to heterogeneity rather than chance. White dots represent SHAPS total scores for individual samples. Black polygons represent the summary SHAPS score and 95% CI. Transparent polygons with black border represent 95% PIs. Gray areas indicate SHAPS scores under 1-4 scoring that a) would be the cut-off if the data was recoded to 0-1 scoring (light gray); b) could either be below or above the cut-off if the data was recoded to 0-1 scoring (medium gray); and c) would be above the cut-off if the data was recoded to 0-1 scoring (dark gray). ** $p < .01$, *** $p < .001$.

3.2.1.1 Between-group comparisons (1-4 scoring)

Results from pairwise comparisons using meta-regression are available in table 5. As expected, samples of patient with current MDD scored considerably higher on the SHAPS compared to the healthy group. Furthermore, samples of patients with SCZ, SUD and PD had SHAPS scores that were significantly higher than healthy samples, but also significantly lower than samples of patients with current MDD. Although no formal subgroup analyses could be performed for the BD group, visual inspection of the forest plot (figure 4) suggested markedly higher SHAPS scores in depressed samples compared to (hypo)manic samples.

Table 5

Pairwise comparisons using meta-regressions (1-4 scoring)

Comparison	<i>B</i> (<i>SE</i>)	<i>z</i>	<i>p</i>	<i>R</i> ²
Healthy vs MDD (current)	12.66 (0.58)	21.69	< .001	92%
Healthy vs MDD (past)	0.96 (0.93)	1.03	.30	0%
MDD (past) vs MDD (current)	11.70 (1.25)	9.37	< .0001	75%
Healthy vs SCZ	2.98 (0.84)	3.55	< .001	9%
SCZ vs MDD (current)	9.63 (1.14)	8.44	< .001	64%
Healthy vs SUD	4.45 (1.03)	4.33	< .001	17%
SUD vs MDD (current)	8.17 (1.38)	5.92	< .001	57%
Healthy vs PD	2.45 (1.18)	2.07	.04	3%
PD vs MDD (current)	10.07 (1.57)	6.42	< .001	60%

Note. 1-4 scoring of the SHAPS. *B* is the difference in SHAPS score between the groups. *R*² is the explained heterogeneity.

Visual inspection of forest plots of SHAPS scores for individual samples suggested substantial of overlap between the healthy (figure 2), past/remitted MDD (figure 3), SCZ (figure 5), SUD (figure 6) and PD (figure 7) groups, and little or no overlap between these groups and the current MDD group (figure 3). Indeed, 95% PIs (see figure 8) indicated that expected SHAPS scores for SCZ (95% PI [17.3, 29.3]), SUD (95% PI [19.7, 29.8]) and PD (95% PI [16.7, 28.9]) spanned from the healthy range and up to the lowest scores reported for samples of patients with current MDD. There was no overlap in 95% PIs between current (95% PI [26.3, 39.4]) and past/remitted (95% PI [19.1, 23.3]) MDD. Instead, the PI for the past/remitted MDD group was fully contained within the PI for the healthy group (95% PI [16.1, 24.4]).

In summary, the results from this set of meta-analyses indicated that while SCZ, SUD and PD are associated with slightly elevated anhedonia, the severity of anhedonia is markedly higher in patients with current MDD.

3.2.2 Meta-analyses of SHAPS scores under 0-1 scoring

Separate random-effects models for each included group are available collectively in figure 9. On average, only patients with current MDD ($M = 5.8$, 95% CI [5.0, 6.5]) and SCZ ($M = 2.8$, 95% CI [0.5, 5.1]) had SHAPS scores above the original cut-off of 2. While the 95% CI of current MDD group did not cross this cut-off, the 95% CI of the SCZ group did. *Cochran's Q* indicated that within most of the groups, the samples did not share a common effect, and I^2 suggested that most of the variation between samples were due to heterogeneity rather than chance. Due to highly similar results under four-point and two-point scoring, forest plots under two-point scoring can be found in appendix A: healthy samples (figure A3), MDD (figure A4), SCZ (figure A5), SUD (figure A6), PD (figure A7), “general population” (figure A8) and smokers (figure A9).

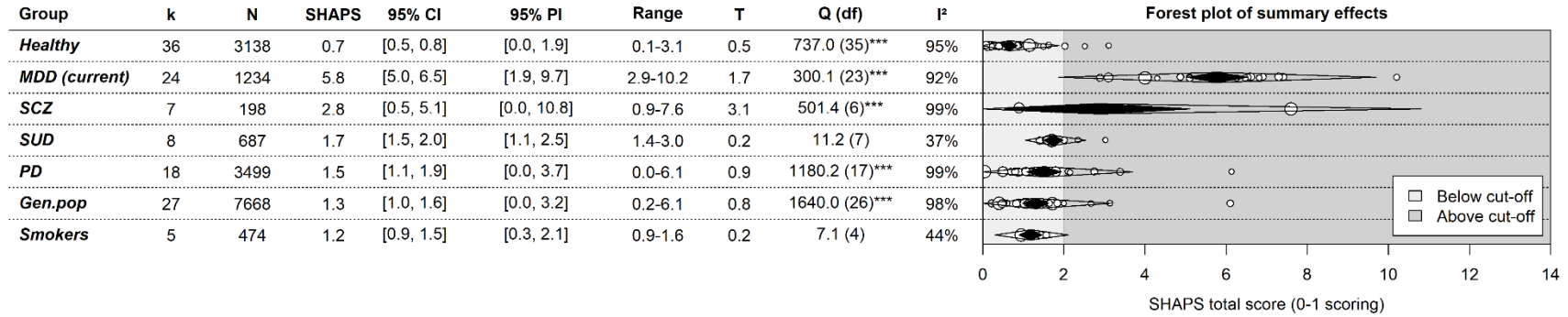


Figure 9. Forest plot of summary SHAPS total scores per included group under 0-1 scoring. k is the number of studies. N is the number of participants. Q is Cochran's Q. T is the estimated between-studies standard deviation. I² is the amount of variation between studies that is due to heterogeneity rather than chance. White dots represent SHAPS total scores for individual samples. Black polygons represent the summary SHAPS score and 95% CI. Transparent polygons with black border represent 95% PIs. Gray areas indicate SHAPS scores that are below the cut-off (light gray) and above the cut-off (dark gray) for clinically significant anhedonia. *** $p < .001$.

3.2.2.1 Between-group comparisons (0-1 scoring)

Table 6 presents results from pairwise comparisons using meta-regression. These results mirrored those obtained under 1-4 scoring. While groups of current MDD, SCZ, SUD and PD all scored higher on the SHAPS than the healthy group, the SCZ, SUD and PD groups scored lower on the SHAPS than the group of current MDD.

Drug use status (dummy-coded: abstinent = 0, current use = 1) did not predict SHAPS scores in samples of patients with SUD ($k = 8$, $B = 0.19$, $SE = 0.27$, $z = 0.70$, $p = .48$).

Table 6

Pairwise comparisons using meta-regression (0-1 scoring)

Comparison	B (SE)	z	p	R^2
Healthy vs MDD (current)	5.02 (0.21)	23.63	< .001	66%
Healthy vs SCZ	2.23 (0.31)	6.99	< .001	30%
SCZ vs MDD (current)	2.95 (1.01)	2.93	< .005	0%
Healthy vs SUD	1.18 (0.24)	4.95	< .001	14%
SUD vs MDD (current)	3.88 (0.52)	7.47	< .001	67%
Healthy vs PD	0.78 (0.21)	3.72	< .001	0%
PD vs MDD (current)	4.23 (0.33)	12.69	< .001	56%

Note. 0-1 scoring of the SHAPS. B is the difference in SHAPS score between the groups. R^2 is the explained heterogeneity.

Visual inspection of forest plots of SHAPS scores for individual samples suggested substantial overlap between the healthy (figure A3), SCZ (figure A5), SUD (figure A6) and PD (figure A7) groups and some overlap between these groups and the current MDD group (figure A4). Indeed, 95% PIs indicated that expected SHAPS scores for SUD (95% PI [1.1, 2.5]) and PD (95% PI [0.0, 3.7]) spanned from the healthy range and up to the lowest scores reported for samples with current MDD. The ninety-five percent PI for SCZ (95 % PI [0.0, 10.8]) spanned from the lowest healthy scores to the highest MDD scores. This was likely in part due to one study of patients with SCZ reporting a considerably higher SHAPS score than the other studies.

Consistent with the previous results, the results from this set of meta-analyses indicated slightly increased anhedonia in SCZ, SUD and PD, and more severe anhedonia in current MDD.

3.2.3 Effect size meta-analyses

Results from the meta-analyses of effect sizes for the difference in SHAPS scores between healthy participants and patients are presented in figure 10. Individual study effect sizes are available in figure A10 in appendix A. The results from these analyses were highly similar to those obtained from the point-estimate analyses and indicated that patients with current MDD, SCZ, SUD or PD tend to score higher on the SHAPS than healthy participants. The summary effect was particularly large for current MDD (*Hedges' g* = 2.1, 95% CI [1.9, 2.4]). Patients with past/remitted MDD did not score higher on the SHAPS than healthy participants (*Hedges' g* = 0.1, 95% CI [-0.2, 0.3]).

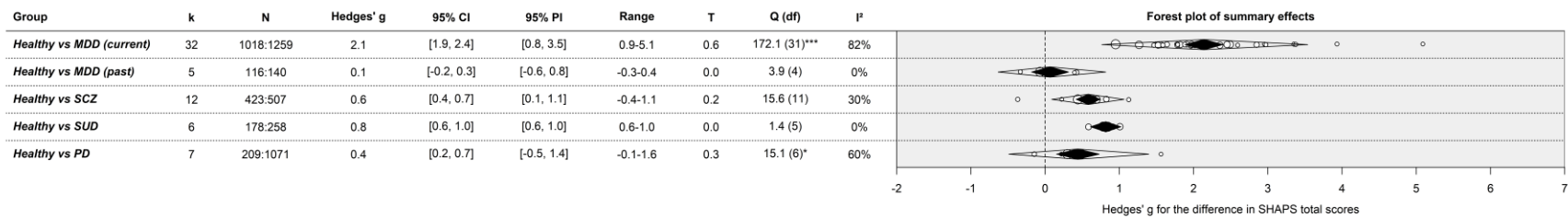


Figure 10. Forest plot of summary effect sizes of differences in SHAPS scores between healthy and various clinical samples. k is the number of studies. N is the number of participants (Healthy:Patients). Q is Cochran's Q. T² is the estimated between-studies variance. T is the estimated between-studies standard deviation. I² is the amount of variation between studies that is due to heterogeneity rather than chance. Black dots and horizontal bars represent Hedges' g and 95% CIs, respectively, from individual studies. Black polygons represent the summary Hedges' g and 95% CI. Transparent polygons with black border represent 95% PIs. *p < .05, ***p < .001.

Effect sizes of differences in SHAPS scores between healthy participants and patients with current MDD were significantly larger than effect sizes from studies comparing healthy participants to patients from any of the other included clinical groups (i.e. past MDD, SCZ, SUD and PD, see table 7).

Table 7
Comparisons of effect sizes using meta-regression

Comparison	<i>B</i> (<i>SE</i>)	<i>z</i>	<i>p</i>
MDD (past) vs MDD (current)	2.04 (0.33)	6.27	< .001
SCZ vs MDD (current)	1.56 (0.20)	7.72	< .001
SUD vs MDD (current)	1.32 (0.29)	4.61	< .001
PD vs MDD (current)	1.67 (0.27)	6.20	< .001

Note. All effect sizes were computed with the healthy sample as baseline. *B* is the difference in Hedges' *g*.

Visual inspection of individual study effects suggested little or some overlap between MDD and other clinical groups (i.e. SCZ, SUD, PD, see figure A10). Ninety-five percent PIs indicated that expected effects from comparisons with healthy participants are greater than zero for SCZ (95% PI [0.1, 1.1]) and SUD (95% PI [0.6, 1.0]), but not for PD (95 % PI [-0.5, 1.4]). Furthermore, the 95% PIs of these groups contained some of the smallest effects found for current MDD. Ninety-five percent PIs for the effects for current (95% PI [0.8, 3.5]) and past/remitted (95% PI [-0.6, 0.8]) MDD showed minimal overlap.

This set of effect size meta-analyses replicated the results from our previous point-estimate meta-analyses of and showed that while SCZ, SUD and PD are associated with a small increase in anhedonia, the severity of anhedonia is much greater in patients with current MDD.

3.2.4 Sensitivity analysis

Sensitivity analyses provided results that were highly consistent with the results obtained in the primary analyses. When substituting the DL method for the PM and REML methods, the results remained largely the same. Adding a random effect at the article-level did not lead to any notable changes in the results.

3.2.5 Additional analyses

3.2.5.1 Differences in SHAPS scores between group while controlling for depression severity

In the point-estimate meta-analyses, adding depression severity to the models explained some but not all of the heterogeneity in SHAPS scores across groups (see table 8).

Table 8

Meta-regressions for pairwise comparisons of SHAPS scores while controlling for depression severity

Comparison	Model	k	Group			Depression severity			R ²
			B (SE)	z	p	B (SE)	z	p	
<u>1-4 scoring</u>									
Healthy vs SCZ	1	61	3.20 (0.95)	3.37	< .001	---	---	---	9%
Healthy vs SCZ	2	61	1.27 (1.05)	1.21	.22	0.17 (0.05)	3.69	< .001	20%
Healthy vs SUD	1	59	4.44 (1.08)	4.12	< .001	---	---	---	16%
Healthy vs SUD	2	59	0.99 (1.48)	0.67	.51	0.15 (0.05)	3.22	< .005	26%
Healthy vs PD	1	59	2.50 (1.12)	2.23	.03	---	---	---	3%
Healthy vs PD	2	59	1.29 (1.14)	1.13	.26	0.15 (0.05)	3.03	< .005	13%
<u>0-1 scoring</u>									
Healthy vs SCZ	1	30	1.09 (0.25)	4.40	< .001	---	---	---	26%
Healthy vs SCZ	2	30	0.85 (0.29)	2.96	< .005	0.02 (0.01)	1.79	.07	20%
Healthy vs SUD	1	31	1.32 (0.21)	6.16	< .001	---	---	---	55%
Healthy vs SUD	2	31	1.10 (0.27)	4.13	< .001	0.02 (0.01)	1.45	.15	51%
Healthy vs PD	1	40	0.80 (0.23)	3.47	< .001	---	---	---	0%
Healthy vs PD	2	40	-0.32 (0.23)	-1.34	.18	0.06 (0.01)	6.69	< .001	50%

Note. Models without (model 1) and with (model 2) depression severity as covariate. *B* and *SE* are on the same scale as the SHAPS. *R*² is the explained heterogeneity.

Table 9 displays the results from the effect size meta-regressions. Controlling for the effect size of differences in depression severity reduced the effect sizes of differences in SHAPS scores between healthy and SCZ samples so that it was no longer significantly larger than zero. This was not the case for the effect size of differences in SHAPS scores between healthy and SUD. An opposite pattern emerged for the effect sizes of differences in SHAPS scores between healthy and PD, in which the effect size increased when adding depression severity to the model.

Table 9*Meta-regression of SHAPS effect sizes while controlling for depression severity effect sizes*

Healthy vs	Model	k	Intercept			Depression severity			R ²
			B (SE)	z	p	B (SE)	z	p	
SCZ	1	7	0.60 (0.09)	6.66	< .001	---	---	---	---
SCZ	2	7	0.44 (0.25)	1.76	.08	0.16 (0.21)	0.72	.47	---
SUD	1	4	0.82 (0.13)	6.39	< .001	---	---	---	---
SUD	2	4	0.80 (0.38)	2.09	.04	0.02 (0.32)	0.05	.96	---
PD	1	5	0.43 (0.24)	1.81	.07	---	---	---	---
PD	2	5	0.88 (0.39)	2.24	.02	-0.34 (0.23)	-1.47	.14	0%

Note. Models without (model 1) and with (model 2) depression severity as predictor. All effect sizes were computed with the healthy sample as baseline. *B* and *SE* are on the same scale as *Hedges' g*. *R*² is the explained heterogeneity.

3.2.5.2 Differences in SHAPS scores between group while controlling for age and gender

Neither age nor gender (i.e. percentage of female participants) could explain the observed differences in SHAPS scores between the healthy group and the SCZ, SUD and PD groups in most of the analyses (all but one $p < .05$ for group in point-estimate meta-analyses; all $ps < .05$ for intercept in effect size meta-analyses).

3.2.5.3 The effect of medication status on SHAPS scores within current MDD, SCZ and PD

The percentage of medicated patients included in each sample did not significantly predict SHAPS scores for samples of patients with current MDD (four-point scoring: $k = 20$, $B = 0.02$, $SE = 0.02$, $z = 0.64$, $p = .52$; two-point scoring: $k = 19$, $B = 0.00$, $SE = 0.01$, $z = 0.42$, $p = .67$), SCZ (four-point scoring: $k = 8$, $B = 0.01$, $SE = 0.13$, $z = 0.10$, $p = .92$) or PD (two-point scoring: $k = 8$, $B = 0.01$, $SE = 0.01$, $z = 1.24$, $p = .21$).

4 Discussion

4.1 Summary and discussion of findings

Anhedonia has been identified as a symptom in many different clinical conditions, including major depression, schizophrenia, substance use disorder and Parkinson's disease. Until now however, it has not been possible to compare the degree of symptom load across conditions

based on the extensive published literature. Even for the most frequently used anhedonia instruments such as the SHAPS, a lack of reference values has made it difficult to evaluate the severity of anhedonia within and between these groups. We used a meta-analytic approach to estimate the level of anhedonia in clinical groups and healthy samples. Across three distinct sets of meta-analyses, we show that anhedonia as measured by the same instrument, is elevated in MDD, SCZ, SUD and PD compared to healthy participants. This finding is consistent with current views on anhedonia symptoms for each of these disorders (APA, 2013; Assogna et al., 2011; Hatzigiakoumis et al., 2011; WHO, 2018). Interestingly however, SCZ, SUD and PD were all associated with relatively low levels of anhedonia, not too different from the highest mean scores reported for certain psychiatrically healthy samples. MDD on the other hand displayed markedly higher anhedonia than healthy samples, and also significantly more severe anhedonia than SCZ, SUD and PD.

We also found that samples of patients with past/remitted MDD had comparable levels of anhedonia to healthy samples. These data support the view of anhedonia as a stable but reversible state in depression. However, since the data was cross-sectional, it is at least theoretically possible that the healthy levels of hedonic capacity evidenced in these samples of past/remitted MDD were also present during their major depressive episode. The severity of anhedonia evidenced in the ongoing MDD samples (*Hedges' g* was estimated to 2.1) and the lack of overlap between the prediction interval of the current and past MDD samples renders this view unlikely.

Akin to the current MDD samples, depressed bipolar disorders samples showed high SHAPS scores. This is consistent with the reward hypersensitivity hypothesis (Alloy et al., 2015). SHAPS scores from the euthymic and manic samples were markedly lower and were similar to some of the highest scores that have been reported for healthy samples. Unfortunately, the currently available data was insufficient for formal subgroup analysis of the bipolar disorders group. More data, especially longitudinal, is needed to explore the possible phase/state-dependency of self-reported anhedonia in bipolar disorders.

SHAPS scores were elevated in schizophrenia and substance use disorder samples compared to healthy participants, with medium to large effects. However, the data did not support the expected (Garfield et al., 2014; Hatzigiakoumis et al., 2011) difference in anhedonia between current use and abstinence in SUD.

The results for the “general population” group (see figure A1 and A8) also warrant some comment. Most of these samples were comprised of students or control participants in the age around 20 for whom health status was not clearly described. With the exception of a few outliers, the SHAPS scores for these samples were within the range of scores reported for healthy participants. While this group may not be representative of the general population, the results suggest that mean sample scores up to about 24 under four-point scoring and about 2 under two-point scoring are quite common. This further supports our conclusion that hedonic capacity is only slightly reduced in SUD, SCZ and PD.

Overall, our results indicate that the severity of anhedonia differs across psychiatric disorders associated with anhedonia. The high SHAPS scores in current MDD suggest that anhedonia in this disorder likely affects multiple domains of pleasure (e.g. food/drink, pastimes/hobbies, social, physical). As illustrated in figure A4 the MDD samples reported that they would not enjoy on average six out of the 14 types of rewards that comprise SHAPS items. In contrast, the mean number of items reported as un-enjoyable by healthy participants was less than one, and below three for the other clinical samples. Thus, anhedonia in SCZ, SUD and PD likely reflects a decrease in projected enjoyment of only a minority of life’s many rewards. An interesting question for future research is whether patients within these groups find the same or different types of stimuli/activities less pleasurable. For example, loss of smell is common in Parkinson’s disease, and impaired taste has also been reported. Many patients also display weight loss, suggesting a potential reduction of appetite in this disorder (Aiello, Eleopra, & Rumiati, 2015). Consequently, lower scores on SHAPS items may be confined to the items concerning food, drink and smell. Raw data with scores for each item rather than meta-analytically extracted means are needed for future studies to address the mechanisms underpinning elevated anhedonia scores across populations.

While our results suggests that SCZ, SUD and PD are associated with reduced self-reported enjoyment for at least some stimuli/activities, we also find that many of the samples in these groups fall well within the range of SHAPS scores reported for healthy participants. SCZ, SUD and PD are all severe conditions that are accompanied by great distress and can deeply interfere with the patients’ functioning in their daily lives. Yet, impaired ability to achieve rewards does not necessarily imply an inability to enjoy life’s rewards when these occur.

The discrepancy in SHAPS scores between current MDD and the other groups associated with anhedonia also suggests the possibility that the term anhedonia has been applied to different types of symptoms across disorders. For example, the finding that SCZ often show intact immediate hedonic responses in laboratory tasks (Kring & Moran, 2008) has led some authors to suggest that anhedonia in this patient group can be explained by motivational impairments (Foussias & Remington, 2008). Indeed, several studies have found evidence for reduced motivation or inappropriate effort allocation in behavioral tasks in patients with SCZ (Barch, Treadway, & Schoen, 2014; Fervaha et al., 2013; Gold et al., 2013; Treadway, Peterman, Zald, & Park, 2015; Wolf et al., 2014). Similarly, Parkinson's disease has been associated with apathy (Leentjens et al., 2008), which is largely characterized by lack of motivation, effort and interest (Marin, 1991). To resolve these issues, future studies should include both behavioral tasks and anhedonia questionnaires and address the relationship between these measures. The benefit of combining measures is improved understanding of the mechanisms underpinning intact and impaired hedonic capacity across populations.

The slightly elevated SHAPS scores in the SCZ, SUD and PD groups could also be related to higher depression severity, as depression is relatively common in these groups (Buckley et al., 2008; Davis et al., 2008; Reijnders et al., 2008). When controlling for depression severity using our normalized depression score based on the numerous depression scales reported in the literature, we found that depression accounted for significant heterogeneity in the comparison between clinical groups and healthy participants. This is perhaps to be expected since most depression inventories include some items on anhedonia. At the individual study-level, SHAPS scores typically show only a modest correlation with depression severity in healthy participants (average $r = .23$; Al Aïn, Carré, Fantini-Hauwel, Baudouin, & Besche-Richard, 2013; Boehm et al., 2018; Cooper, Duke, Pickering, & Smillie, 2014; M. G. Kirkpatrick et al., 2016; Nagayama et al., 2017) and in patients with SUD ($r = .28$; Boger et al., 2014). Correlations from studies of PD are typically moderate (average $r = .34$; Fujiwara et al., 2011; M. R. Lemke et al., 2005; Matsui et al., 2013; Mrochen et al., 2016; Nagayama et al., 2017; Santangelo, Morgante, et al., 2009; Spalletta et al., 2013). Similarly, the correlation in studies of current MDD is on average around .33 (Lally et al., 2015; M. R. Lemke, Puhl, Koethe, & Winkler, 1999; Tremblay, Naranjo, Cardenas, Herrmann, & Busto, 2002; Vrieze, Pizzagalli, et

al., 2013), which is consistent with the notion that depression and anhedonia should not be equated.

Another possible explanation for the low SHAPS scores in SCZ and PD compared to current MDD is that most of the patients with SCZ and PD were medicated for their respective conditions. However, meta-regressions within each of these groups (i.e. current MDD, SCZ and PD) showed no significant effect of the number of medicated participants on the magnitude of SHAPS scores.

4.2 Limitations

Some limitations warrant discussion. One question is whether the patients recruited for the studies meta-analyzed here are representative of the larger patient population, given the tendency in the literature to exclude patients with comorbidities. Because anhedonia is part of the diagnostic criteria for MDD, patients with SCZ, SUD or PD who score high on the SHAPS are more likely to be diagnosed with comorbid MDD and in turn more likely to be excluded from studies. Consequently, the reference values we produced may not reflect the severity of anhedonia in the larger populations of patients with SCZ, SUD or PD where comorbid depression is more common. Larger epidemiological studies may provide more accurate estimates of the full psychiatric groups. Conversely, our reference values may be indicative of the levels of anhedonia specifically associated with each disorder in isolation.

Data is still missing from several articles identified by the literature search. However at the time of writing, we were able to cover more than 70% of the identified literature for most groups. Thus, while the inclusion of missing data might introduce (modest) changes in the reference values for some of the smaller groups (e.g. SCZ, SUD, PD), the results are likely to be highly stable for the larger groups (e.g. healthy, current MDD).

The lack of consistent use of depression scales in the literature hampered our ability to address the role of depression for anhedonia scores in SCZ, SUD and PD. Depression measures differ in how much weight they put on various symptoms. For example, while the BDI includes three items on loss of pleasure and interest (i.e. item 4, 12 and 21) and one item on sleep (i.e. item 16), the HAM-D assesses loss of interest with two items (i.e. item 4 and 14) and sleep with three items (i.e. item 4-6). Because the depression severity variable is based on different combinations of depression measures for each sample, the summary score we created here may

not represent depressive symptoms equally across samples. Furthermore, the same percentage score on two distinct measures may not correspond to the same severity level. For example, while a score of ~46% or more on the BDI indicates severe depression, the percentage cut-off corresponding to severe depression on the MADRS is ~58% (Müller, Szegedi, Wetzel, & Benkert, 2000; Snaith, Harrop, Newby, & Teale, 1986). Consequently, the depression severity variable as we defined it is likely noisy and may suffer from problems with reliability.

We considered other options for defining the depression variable such as using the percentage of participants with comorbid major depression. However, this would have resulted in too little variation in the data (a floor effect for the healthy, SCZ, SUD and PD samples). Performing separate analyses for each measure of depression would have resulted in numerous meta-regressions with very few data points. Another option we considered was to convert depression scores to severity scores according to established cut-off points for each measure of depression (e.g. no, mild, moderate and severe depression). This proved less feasible as there is disagreement on cut-off scores for some of the most common scales such as the HAM-D (Zimmerman, Martinez, Young, Chelminski, & Dalrymple, 2013), and some scales only operate with a single cut-off point (e.g. CES-D; Radloff, 1977). Although the approach we used to define the depression severity variable was not optimal, it offered several advantages over other alternatives in that it 1) allowed for more variation between samples, 2) required the least amount of data reduction for each group, and 3) required the least amount of tests.

There was considerable heterogeneity of SHAPS scores within several groups in this meta-analysis. We could have explored this heterogeneity further by extracting additional variables and conducting meta-regressions. However, The Cochrane Collaboration (2011) recommends no less than 10 data points for meta-regressions, and the estimated predictive power of continuous moderators may still be unreliable for moderators in meta-regressions with up to 40 data points (López-López et al., 2014). Accordingly, we did not statistically address effects of age, gender and culture within groups. The SHAPS was designed to cover events that most people would find enjoyable, and we would therefore expect little influence of these variables on the magnitude of SHAPS scores. However, some authors applying the SHAPS in the Japanese population report substituting ‘freshly baked bread’ with ‘freshly boiled rice’ in the item “I would find pleasure in the scent of flowers or the smell of a fresh sea breeze or freshly baked bread” (Miura et al., 2012). This is consistent with at least some cultural biases in the SHAPS

items. Although the SHAPS has been translated to many different languages and applied in many cultures around the world, the current literature does not allow for detailed analysis of whether SHAPS scores varies systematically between cultures. With the rapidly growing SHAPS literature, such analyses will likely be possible in the future.

Cigarette smoking has been associated with anhedonia in the literature, specifically with withdrawal (Stone, Audrain-McGovern, & Leventhal, 2017) and past smoking initiation (Cook et al., 2015). While some SHAPS data on smokers was available in the literature, very few studies reported such data on non-smokers. Although we did not have an appropriate control group for the smokers, the summary SHAPS scores for this group were rather low and comparable to some of the highest scores reported for healthy samples (see figure A2 and A9).

We did not conduct any formal risk-of-bias assessment for the current meta-analyses. A commonly used method for evaluating risk of bias (reporting bias in particular) in meta-analyses is to produce funnel plots and conduct Egger's test of asymmetry in these plots (Sterne et al., 2011). Asymmetry in funnel plots indicate that there might be reporting bias for the effect of interest, but the shape of these plots is also sensitive to heterogeneity and the number of studies (Sterne et al., 2011). Considering the high amount of heterogeneity and/or low number of data points in many of the included groups in this meta-analysis, results from such tests would be difficult or impossible to interpret. Alternatively, we could have performed meta-regressions to address potential differences in SHAPS scores between published and unpublished studies. This was not feasible as few unpublished studies were included in the dataset. Because the SHAPS is often used as a secondary outcome measure or for descriptive purposes, risk of bias due to selective reporting is likely very low.

4.3 Comments on the SHAPS

In this meta-analysis, we focused exclusively on questionnaire measures of anhedonia and specifically on the Snaith-Hamilton Pleasure Scale. A limitation of the SHAPS, which also applies to other anhedonia questionnaires, is that the data it generates are distanced from the actual pleasurable events in both space and time. While the questionnaire may to some extent tap into respondents' capacity for pleasure, it likely also tap into their ability to remember and predict pleasure due to items being hypothetical (i.e. "I would enjoy..."). A variety of laboratory tasks have been employed to get closer to actual human reward responses and behaviors. These

tasks allow researchers to address how people respond to and act upon reward, but this comes at the cost of limiting the types of rewards and contexts that can be measured. Experience sampling represents a promising avenue for future research on (an)hedonia that allows researchers to sample reward-related behaviors, thoughts and feelings in natural settings. This approach would complement results from controlled laboratory tasks and questionnaires about hypothetical scenarios. For example, in a study by Gard, Kring, Gard, Horan, and Green (2007), controls and patients with SCZ wrote down at several time points throughout the day 1) what they were doing and how much they enjoyed it, and 2) what they were looking forward to and how much enjoyment they anticipated that this would give them. While patients and controls did not differ in how much they enjoyed current activities, the patients tended to anticipate less enjoyment from future activities compared to controls. These results mirrored those obtained with the TEPS consummatory and anticipatory subscales in a second study (Gard et al., 2007).

In surveying the SHAPS literature, we noticed that within healthy participants, MDD, SCZ, SUD and PD, very little data has been published on the associations between this questionnaire and other reward-related measures. This makes it difficult to evaluate the construct validity of the SHAPS within these groups. The SHAPS has good face validity as a measure of anticipated or remembered pleasure considering the hypothetical nature of its items, but more data is needed to properly address what underlying processes this questionnaire taps into and whether these processes are similar or different across groups.

Another concern about the SHAPS is that the content of some of the items may become outdated and no longer reflect pleasurable activities that most people engage in. For example, items such as “I would enjoy my favourite television or radio programme” and “I would enjoy reading a book, magazine or newspaper” contain forms of entertainment that are transitioning into digital formats (e.g. video streaming services, podcasts, e-books, news websites). These items will eventually need to be revised. Meanwhile, the lack of specificity and the broadness of the SHAPS items will likely compensate to some extent for bias introduced by outdated content.

The SHAPS has also been criticized for being too broad (Rizvi et al., 2015). A concern is that the lack of specificity in the items may result in the scale not capturing certain activities or events that produce strong feelings of pleasure. The Dimensional Anhedonia Rating Scale (DARS; Rizvi et al., 2015) represents an alternative approach to measuring anhedonia and hedonic capacity by asking respondents to provide examples of what they enjoy (within the same

four domains as the SHAPS) and then ask them questions about how much they enjoy and desire these activities or events. This allows researchers to address how much the respondents enjoy their favorite activities or events, which may be overlooked by the SHAPS. However, because the DARS does not provide data on what pleasures people do not enjoy, this questionnaire presents a limited picture of the respondents' hedonic capacity. By surveying a wide range of activities and events, the SHAPS may offer greater insight into the extent of anhedonia in peoples' daily lives compared to the DARS. It is also likely that the broad and unspecific SHAPS items prompt participants to imagine or remember some of their favorite activities or events and that the two scales therefore measure largely the same construct. Indeed, the DARS development paper reported moderate ($r = -.58$) to high ($r = -.79$) correlations between the two scales (Rizvi et al., 2015).

Many researchers have turned to four-point scoring for the SHAPS in favor of the traditional binary scoring format, suggesting a growing interest for the variability in hedonic capacity across healthy and clinical groups. This has resulted in researchers adopting a variety of different scoring methods (i.e. 0-3, 3-0, 1-4, 4-1) for the same questionnaire. To avoid confusion in future research that includes the SHAPS, standardization of the scoring method is needed. We recommend reporting SHAPS scores based on the 0-1 or the 1-4 scoring method, such that higher values indicate more anhedonia. In addition, we recommend that authors report the percentage of respondents who disagreed with more than two statements, i.e. meeting Snaith and Hamilton's original cut-off. Presenting SHAPS scores along with the percentage of participants scoring above the cut-off will give readers information about both the severity of anhedonia and the frequency of clinically significant anhedonia in the study sample(s).

5 Conclusions

Anhedonia has been associated with a variety of clinical conditions. The SHAPS is a popular self-report measure of anhedonia that has been used in research on major depressive disorder, schizophrenia, substance use disorders and Parkinson's disease, as well as in healthy participants. Until now, knowledge on the degree of hedonic capacity (or severity of anhedonia) in these clinical and non-clinical groups has been lacking. We used a meta-analytic approach to generate reference values for these groups on the SHAPS. Our results indicate that the severity of anhedonia differs across disorders that have been associated with anhedonia. Whereas anhedonia

in current MDD likely affects multiple domains of pleasure (e.g. food/drink, pastimes/hobbies, social, physical), anhedonia in SCZ, SUD and PD may instead reflect a decrease in projected enjoyment of only a minority of life's many rewards. We believe that the reference values generated in the current meta-analyses (see figure 8 and 9) can guide interpretation of SHAPS data in future research on anhedonia and hedonic capacity.

6 Funding

None.

7 My role in the project

I wrote the first draft of the preregistration, performed all article selection and data extraction, and contacted authors to obtain missing data. I also suggested all methods, scripted and conducted all statistical analyses, and wrote the present thesis in full.

References

- Addington, D., Addington, J., & Maticka-tyndale, E. (1993). Assessing Depression in Schizophrenia: The Calgary Depression Scale. *British Journal of Psychiatry*, *163*(Supplement 22), 39-44. doi:<https://doi.org/10.1192/S0007125000292581>
- Admon, R., Kaiser, R. H., Dillon, D. G., Beltzer, M., Goer, F., Olson, D. P., Vitaliano, G., & Pizzagalli, D. A. (2017). Dopaminergic Enhancement of Striatal Response to Reward in Major Depression. *American Journal of Psychiatry*, *174*(4), 378-386. doi:<https://doi.org/10.1176/appi.ajp.2016.16010111>
- Admon, R., & Pizzagalli, D. A. (2015). Corticostriatal pathways contribute to the natural time course of positive mood. *Nature Communications*, *6*, 10065. doi:<https://doi.org/10.1038/ncomms10065>
- Aharon, I., Etcoff, N., Ariely, D., Chabris, C. F., O'Connor, E., & Breiter, H. C. (2001). Beautiful Faces Have Variable Reward Value: fMRI and Behavioral Evidence. *Neuron*, *32*(3), 537-551. doi:[https://doi.org/10.1016/S0896-6273\(01\)00491-3](https://doi.org/10.1016/S0896-6273(01)00491-3)
- Aiello, M., Eleopra, R., & Rumiati, R. I. (2015). Body weight and food intake in Parkinson's disease. A review of the association to non-motor symptoms. *Appetite*, *84*, 204-211. doi:<https://doi.org/10.1016/j.appet.2014.10.011>

- Al Ain, S., Carré, A., Fantini-Hauwel, C., Baudouin, J.-Y., & Besche-Richard, C. (2013). What is the emotional core of the multidimensional Machiavellian personality trait? *Frontiers in psychology*, 4, 454. doi:<https://doi.org/10.3389/fpsyg.2013.00454>
- Alloy, L. B., Nusslock, R., & Boland, E. M. (2015). The Development and Course of Bipolar Spectrum Disorders: An Integrated Reward and Circadian Rhythm Dysregulation Model. *Annual Review of Clinical Psychology*, 11, 213-250. doi:<https://doi.org/10.1146/annurev-clinpsy-032814-112902>
- Alloy, L. B., Olino, T., Freed, R. D., & Nusslock, R. (2016). Role of Reward Sensitivity and Processing in Major Depressive and Bipolar Spectrum Disorders. *Behavior Therapy*, 47(5), 600-621. doi:<https://doi.org/10.1016/j.beth.2016.02.014>
- Ameli, R., Luckenbaugh, D. A., Gould, N. F., Holmes, M. K., Lally, N., Ballard, E. D., & Zarate, C. A., Jr. (2014). SHAPS-C: the Snaith-Hamilton pleasure scale modified for clinician administration. *PeerJ*, 2, e429. doi:<https://doi.org/10.7717/peerj.429>
- American Psychiatric Association. (1980). *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.). Washington, DC: American Psychiatric Association.
- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.): American Psychiatric Association.
- Andreasen, N. C. (1982). Negative Symptoms in Schizophrenia: Definition and Reliability. *Archives of General Psychiatry*, 39(7), 784-788. doi:<https://doi.org/10.1001/archpsyc.1982.04290070020005>
- Ang, Y.-S., Lockwood, P., Apps, M. A. J., Muhammed, K., & Husain, M. (2017). Distinct Subtypes of Apathy Revealed by the Apathy Motivation Index. *PLOS ONE*, 12(1), e0169938. doi:<https://doi.org/10.1371/journal.pone.0169938>
- Arrondo, G., Segarra, N., Metastasio, A., Ziauddeen, H., Spencer, J., Reinders, N. R., Dudas, R. B., Robbins, T. W., Fletcher, P. C., & Murray, G. K. (2015). Reduction in ventral striatal activity when anticipating a reward in depression and schizophrenia: a replicated cross-diagnostic finding. *Frontiers in psychology*, 6, 1280. doi:<https://doi.org/10.3389/fpsyg.2015.01280>
- Assogna, F., Cravello, L., Caltagirone, C., & Spalletta, G. (2011). Anhedonia in Parkinson's disease: A systematic review of the literature. *Movement Disorders*, 26(10), 1825-1834. doi:<https://doi.org/10.1002/mds.23815>

- Audrain-McGovern, J., Rodriguez, D., Leventhal, A. M., Cuevas, J., Rodgers, K., & Sass, J. (2012). Where Is the Pleasure in That? Low Hedonic Capacity Predicts Smoking Onset and Escalation. *Nicotine & Tobacco Research, 14*(10), 1187-1196.
doi:10.1093/ntr/nts017
- Auerbach, R. P., Pisoni, A., Bondy, E., Kumar, P., Stewart, J. G., Yendiki, A., & Pizzagalli, D. A. (2017). Neuroanatomical Prediction of Anhedonia in Adolescents. *Neuropsychopharmacology, 42*, 2087-2095. doi:10.1038/npp.2017.28
- Bakic, J., Pourtois, G., Jepma, M., Duprat, R., De Raedt, R., & Baeken, C. (2017). Spared internal but impaired external reward prediction error signals in major depressive disorder during reinforcement learning. *Depression and Anxiety, 34*(1), 89-96.
doi:<https://doi.org/10.1002/da.22576>
- Balducci, X. L. (2009). *Probing Mesocorticolimbic Dopamine Function in Alcohol Dependence Using Dextroamphetamine: Behavioural and FMRI Studies*. (Doctoral thesis), University of Toronto, Retrieved from <http://hdl.handle.net/1807/17452>
- Ballard, E. D., Yarrington, J. S., Farmer, C. A., Lener, M. S., Kadriu, B., Lally, N., Williams, D., Machado-Vieira, R., Niciu, M. J., Park, L., & Zarate Jr, C. A. (2018). Parsing the heterogeneity of depression: An exploratory factor analysis across commonly used depression rating scales. *Journal of Affective Disorders, 231*, 51-57.
doi:<https://doi.org/10.1016/j.jad.2018.01.027>
- Barch, D. M., Pagliaccio, D., & Luking, K. (2015). Mechanisms underlying motivational deficits in psychopathology: similarities and differences in depression and schizophrenia. In E. H. Simpson & P. D. Balsam (Eds.), *Behavioral Neuroscience of Motivation* (pp. 411-449). Cham: Springer.
- Barch, D. M., Treadway, M. T., & Schoen, N. (2014). Effort, anhedonia, and function in schizophrenia: Reduced effort allocation predicts amotivation and functional impairment. *Journal of abnormal psychology, 123*(2), 387-397. doi:<https://doi.org/10.1037/a0036299>
- Barra, A., Camardese, G., Tonioni, F., Sgambato, A., Picello, A., Autullo, G., Silvia, D., Bria, P., & Cittadini, A. (2007). Plasma magnesium level and psychomotor retardation in major depressed patients. *Magnesium research, 20*(4), 245-249.
doi:<https://doi.org/10.1684/mrh.2007.0115>

- Bech, P., & Rafaelsen, O. J. (1980). The use of rating scales exemplified by a comparison of the Hamilton and the Bech-Rafaelsen Melancholia Scale. *Acta Psychiatrica Scandinavica*, 62(S285), 128-132. doi:<https://doi.org/10.1111/j.1600-0447.1980.tb07683.x>
- Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, 50(1-3), 7-15. doi:[https://doi.org/10.1016/0010-0277\(94\)90018-3](https://doi.org/10.1016/0010-0277(94)90018-3)
- Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for Beck Depression Inventory-II*. San Antonio, TX: Psychological Corporation.
- Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An Inventory for Measuring Depression. *Archives of General Psychiatry*, 4(6), 561-571. doi:<https://doi.org/10.1001/archpsyc.1961.01710120031004>
- Bender, R., Bunce, C., Clarke, M., Gates, S., Lange, S., Pace, N. L., & Thorlund, K. (2008). Attention should be given to multiplicity issues in systematic reviews. *Journal of Clinical Epidemiology*, 61(9), 857-865. doi:<https://doi.org/10.1016/j.jclinepi.2008.03.004>
- Berkowitz, L., & Donnerstein, E. (1982). External validity is more than skin deep: Some answers to criticisms of laboratory experiments. *American Psychologist*, 37(3), 245-257. doi:<https://doi.org/10.1037/0003-066X.37.3.245>
- Berlin, I., Givry-Steiner, L., Lecrubier, Y., & Puech, A. J. (1998). Measures of anhedonia and hedonic responses to sucrose in depressive and schizophrenic patients in comparison with healthy subjects. *European Psychiatry*, 13(6), 303-309. doi:[https://doi.org/10.1016/S0924-9338\(98\)80048-5](https://doi.org/10.1016/S0924-9338(98)80048-5)
- Bero, L., Chartres, N., Diong, J., Fabbri, A., Ghersi, D., Lam, J., Lau, A., McDonald, S., Mintzes, B., Sutton, P., Turton, J. L., & Woodruff, T. J. (2018). The risk of bias in observational studies of exposures (ROBINS-E) tool: concerns arising from application to observational studies of exposures. *Systematic Reviews*, 7(1), 242. doi:<https://doi.org/10.1186/s13643-018-0915-2>
- Berridge, K. C. (2000). Measuring hedonic impact in animals and infants: microstructure of affective taste reactivity patterns. *Neuroscience & Biobehavioral Reviews*, 24(2), 173-198. doi:[https://doi.org/10.1016/S0149-7634\(99\)00072-X](https://doi.org/10.1016/S0149-7634(99)00072-X)
- Berridge, Kent C., & Kringelbach, Morten L. (2015). Pleasure Systems in the Brain. *Neuron*, 86(3), 646-664. doi:<https://doi.org/10.1016/j.neuron.2015.02.018>

- Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neurosciences*, 26(9), 507-513. doi:[https://doi.org/10.1016/S0166-2236\(03\)00233-9](https://doi.org/10.1016/S0166-2236(03)00233-9)
- Boehm, I., Flohr, L., Steding, J., Holzapfel, L., Seitz, J., Roessner, V., & Ehrlich, S. (2018). The Trajectory of Anhedonic and Depressive Symptoms in Anorexia Nervosa: A Longitudinal and Cross-Sectional Approach. *European Eating Disorders Review*, 26(1), 69-74. doi:<https://doi.org/10.1002/erv.2565>
- Boger, K. D., Auerbach, R. P., Pechtel, P., Busch, A. B., Greenfield, S. F., & Pizzagalli, D. A. (2014). Co-occurring depressive and substance use disorders in adolescents: An examination of reward responsiveness during treatment. *Journal of Psychotherapy Integration*, 24(2), 109-121. doi:<https://doi.org/10.1037/a0036975>
- Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Chichester, UK: John Wiley & Sons.
- Briggs, L., Talbot, C., & Melvin, K. (2007). Demoralisation and migration experience. *International Review of Modern Sociology*, 33(2), 193-209.
- Buckley, P. F., Miller, B. J., Lehrer, D. S., & Castle, D. J. (2008). Psychiatric Comorbidities and Schizophrenia. *Schizophrenia Bulletin*, 35(2), 383-402. doi:<https://doi.org/10.1093/schbul/sbn135>
- Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008). A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review*, 28(4), 676-691. doi:<https://doi.org/10.1016/j.cpr.2007.10.001>
- Cella, M., Dymond, S., & Cooper, A. (2010). Impaired flexible decision-making in major depressive disorder. *Journal of Affective Disorders*, 124(1-2), 207-210. doi:<https://doi.org/10.1016/j.jad.2009.11.013>
- Chapman, L. J., & Chapman, J. P. (1978). Revised physical anhedonia scale.
- Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1976). Scales for physical and social anhedonia. *Journal of abnormal psychology*, 85(4), 374-382. doi:<https://doi.org/10.1037/0021-843X.85.4.374>
- Chase, H. W., Fournier, J. C., Bertocci, M. A., Greenberg, T., Aslam, H., Stiffler, R., Lockovich, J., Graur, S., Bebko, G., Forbes, E. E., & Phillips, M. L. (2017). A pathway linking reward circuitry, impulsive sensation-seeking and risky decision-making in young adults:

- identifying neural markers for new interventions. *Translational Psychiatry*, 7, e1096.
doi:<https://doi.org/10.1038/tp.2017.60>
- Chasson, G. S., Bello, M. S., Luxon, A. M., Graham, T. A. A., & Leventhal, A. M. (2017). Transdiagnostic emotional vulnerabilities linking obsessive-compulsive and depressive symptoms in a community-based sample of adolescents. *Depression and Anxiety*, 34(8), 761-769. doi:<https://doi.org/10.1002/da.22669>
- Chelnokova, O., Laeng, B., Eikemo, M., Riegels, J., Løseth, G., Maurud, H., Willoch, F., & Leknes, S. (2014). Rewards of beauty: the opioid system mediates social motivation in humans. *Molecular Psychiatry*, 19, 746-747. doi:<https://doi.org/10.1038/mp.2014.1>
- Chodkiewicz, J., Miniszewska, J., Strzelczyk, D., & Gąsior, K. (2017). Polish adaptation of the Psychache Scale by Ronald Holden and co-workers. *Psychiatria Polska*, 51(2), 369-381. doi:<https://doi.org/10.12740/PP/OnlineFirst/59448>
- Chuang, J.-Y., Murray, G. K., Metastasio, A., Segarra, N., Tait, R., Spencer, J., Ziauddeen, H., Dudas, R. B., Fletcher, P. C., & Suckling, J. (2014). Brain structural signatures of negative symptoms in depression and schizophrenia. *Frontiers in psychiatry*, 5, 116. doi:<https://doi.org/10.3389/fpsy.2014.00116>
- Chung, S. J., Asgharnejad, M., Bauer, L., Ramirez, F., & Jeon, B. (2016). Evaluation of rotigotine transdermal patch for the treatment of depressive symptoms in patients with Parkinson's disease. *Expert Opinion on Pharmacotherapy*, 17(11), 1453-1461. doi:<https://doi.org/10.1080/14656566.2016.1202917>
- Chung, Y. S., & Barch, D. (2015). Anhedonia is associated with reduced incentive cue related activation in the basal ganglia. *Cognitive, Affective, & Behavioral Neuroscience*, 15(4), 749-767. doi:<https://doi.org/10.3758/s13415-015-0366-3>
- Cohen, A. S., & Minor, K. S. (2010). Emotional experience in patients with schizophrenia revisited: meta-analysis of laboratory studies. *Schizophrenia Bulletin*, 36(1), 143-150. doi:<https://doi.org/10.1093/schbul/sbn061>
- Cohen, A. S., Najolia, G. M., Brown, L. A., & Minor, K. S. (2011). The state-trait disjunction of anhedonia in schizophrenia: Potential affective, cognitive and social-based mechanisms. *Clinical Psychology Review*, 31(3), 440-448. doi:<https://doi.org/10.1016/j.cpr.2010.11.001>

- Cook, J. W., Piper, M. E., Leventhal, A. M., Schlam, T. R., Fiore, M. C., & Baker, T. B. (2015). Anhedonia as a component of the tobacco withdrawal syndrome. *Journal of abnormal psychology, 124*(1), 215-225. doi:<https://doi.org/10.1037/abn0000016>
- Cooper, A. J., Duke, É., Pickering, A. D., & Smillie, L. D. (2014). Individual differences in reward prediction error: contrasting relations between feedback-related negativity and trait measures of reward sensitivity, impulsivity and extraversion. *Frontiers in human neuroscience, 8*, 248. doi:<https://doi.org/10.3389/fnhum.2014.00248>
- Costello, E. J., & Angold, A. (1988). Scales to Assess Child and Adolescent Depression: Checklists, Screens, and Nets. *Journal of the American Academy of Child & Adolescent Psychiatry, 27*(6), 726-737. doi:<https://doi.org/10.1097/00004583-198811000-00011>
- Culbreth, A. J., Gold, J. M., Cools, R., & Barch, D. M. (2016). Impaired Activation in Cognitive Control Regions Predicts Reversal Learning in Schizophrenia. *Schizophrenia Bulletin, 42*(2), 484-493. doi:<https://doi.org/10.1093/schbul/sbv075>
- Culbreth, A. J., Westbrook, A., Daw, N. D., Botvinick, M., & Barch, D. M. (2016). Reduced model-based decision-making in schizophrenia. *Journal of abnormal psychology, 125*(6), 777-787. doi:<https://doi.org/10.1037/abn0000164>
- Cunningham, S. (2017). *Childhood Maltreatment and Mechanisms of Vulnerability Within Anhedonia and Depression*. (Master thesis), Queen's University, Retrieved from <http://hdl.handle.net/1974/22645>
- Currie, J., Buruju, D., Perrin, J. S., Reid, I. C., Steele, J. D., & Feltovich, N. (2017). Schizophrenia illness severity is associated with reduced loss aversion. *Brain Research, 1664*, 9-16. doi:<https://doi.org/10.1016/j.brainres.2017.03.006>
- Davis, L., Uezato, A., Newell, J. M., & Frazier, E. (2008). Major depression and comorbid substance use disorders. *Current opinion in psychiatry, 21*(1), 14-18. doi:<https://doi.org/10.1097/YCO.0b013e3282f32408>
- De Berardis, D., Fornaro, M., Orsolini, L., Iasevoli, F., Tomasetti, C., de Bartolomeis, A., Serroni, N., De Lauretis, I., Girinelli, G., Mazza, M., Valchera, A., Carano, A., Vellante, F., Matarazzo, I., Perna, G., Martinotti, G., & Di Giannantonio, M. (2017). Effect of agomelatine treatment on C-reactive protein levels in patients with major depressive disorder: an exploratory study in “real-world,” everyday clinical practice. *CNS Spectrums, 22*(4), 342-347. doi:<https://doi.org/10.1017/S1092852916000572>

- Dean, Z., Horndasch, S., Giannopoulos, P., & McCabe, C. (2016). Enhanced neural response to anticipation, effort and consummation of reward and aversion during bupropion treatment. *Psychological medicine*, *46*(11), 2263-2274.
doi:<https://doi.org/10.1017/S003329171600088X>
- dela Cruz, A. M., Carmody, T., Greer, T. L., Rethorst, C. D., Warden, D., Walker, R., & Trivedi, M. H. (2016). Baseline medical comorbidities in adults randomized in the STRIDE trial for psychostimulant use disorders. *The American Journal on Addictions*, *25*(3), 215-220.
doi:<https://doi.org/10.1111/ajad.12363>
- DerSimonian, R., & Laird, N. (1986). Meta-analysis in clinical trials. *Controlled Clinical Trials*, *7*(3), 177-188. doi:[https://doi.org/10.1016/0197-2456\(86\)90046-2](https://doi.org/10.1016/0197-2456(86)90046-2)
- Di Giuda, D., Camardese, G., Bentivoglio, A. R., Cocciolillo, F., Guidubaldi, A., Pucci, L., Bruno, I., Janiri, L., Giordano, A., & Fasano, A. (2012). Dopaminergic dysfunction and psychiatric symptoms in movement disorders: a 123 I-FP-CIT SPECT study. *European journal of nuclear medicine and molecular imaging*, *39*(12), 1937-1948.
doi:<https://doi.org/10.1007/s00259-012-2232-7>
- Di Nicola, M., De Risio, L., Battaglia, C., Camardese, G., Tedeschi, D., Mazza, M., Martinotti, G., Pozzi, G., Niolu, C., Di Giannantonio, M., Siracusano, A., & Janiri, L. (2013). Reduced hedonic capacity in euthymic bipolar subjects: A trait-like feature? *Journal of Affective Disorders*, *147*(1-3), 446-450. doi:<https://doi.org/10.1016/j.jad.2012.10.004>
- Dillon, D. G., Dobbins, I. G., & Pizzagalli, D. A. (2014). Weak reward source memory in depression reflects blunted activation of VTA/SN and parahippocampus. *Social Cognitive and Affective Neuroscience*, *9*(10), 1576-1583. doi:<https://doi.org/10.1093/scan/nst155>
- Dillon, D. G., Wiecki, T., Pechtel, P., Webb, C., Goer, F., Murray, L., Trivedi, M., Fava, M., McGrath, P. J., Weissman, M., Parsey, R., Kurian, B., Adams, P., Carmody, T., Weyandt, S., Shores-Wilson, K., Toups, M., McInnis, M., Oquendo, M. A., Cusin, C., Deldin, P., Bruder, G., & Pizzagalli, D. A. (2015). A computational analysis of flanker interference in depression. *Psychological medicine*, *45*(11), 2333-2344.
doi:<https://doi.org/10.1017/S0033291715000276>
- Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care

- interventions. *Journal of Epidemiology and Community Health*, 52(6), 377-384.
doi:<https://doi.org/10.1136/jech.52.6.377>
- Drijgers, R. L., Verhey, F. R. J., Tissingh, G., van Domburg, P. H. M. F., Aalten, P., & Leentjens, A. F. G. (2012). The role of the dopaminergic system in mood, motivation and cognition in Parkinson's disease: A double blind randomized placebo-controlled experimental challenge with pramipexole and methylphenidate. *Journal of the Neurological Sciences*, 320(1-2), 121-126. doi:<https://doi.org/10.1016/j.jns.2012.07.015>
- Duncan, M. J., Faulkner, G., Remington, G., & Arbour-Nicitopoulos, K. (2016). Characterizing the affective responses to an acute bout of moderate-intensity exercise among outpatients with schizophrenia. *Psychiatry Research*, 237, 264-270.
doi:<https://doi.org/10.1016/j.psychres.2016.01.030>
- Eckblad, M. L., Chapman, L. J., Chapman, J. P., & Mishlove, M. (1982). The revised social anhedonia scale.
- Eisenstein, S. A., Bogdan, R., Chen, L., Moerlein, S. M., Black, K. J., Perlmutter, J. S., Hershey, T., & Barch, D. M. (2017). Preliminary evidence that negative symptom severity relates to multilocus genetic profile for dopamine signaling capacity and D2 receptor binding in healthy controls and in schizophrenia. *Journal of Psychiatric Research*, 86, 9-17.
doi:<https://doi.org/10.1016/j.jpsychires.2016.11.007>
- Ersche, K. D., Turton, A. J., Chamberlain, S. R., Müller, U., Bullmore, E. T., & Robbins, T. W. (2012). Cognitive Dysfunction and Anxious-Impulsive Personality Traits Are Endophenotypes for Drug Dependence. *American Journal of Psychiatry*, 169(9), 926-936. doi:<https://doi.org/10.1176/appi.ajp.2012.11091421>
- Farabaugh, A., Fisher, L., Nyer, M., Holt, D., Cohen, M., Baer, L., Shapero, B. G., Huz, I., Cardoos, A., Fava, M., & Alpert, J. E. (2015). Similar changes in cognitions following cognitive-behavioral therapy or escitalopram for major depressive disorder: Implications for mechanisms of change. *Annals of Clinical Psychiatry*, 27(2), 118-126.
- Fawcett, J., Clark, D. C., Scheftner, W. A., & Gibbons, R. D. (1983). Assessing Anhedonia in Psychiatric Patients: The Pleasure Scale. *Archives of General Psychiatry*, 40(1), 79-84.
doi:<https://doi.org/10.1001/archpsyc.1983.01790010081010>

- Feng, S. (2017). *Association between Reward Sensitivity and Smoking Status in Major Depressive Disorder*. (Master thesis), Virginia Polytechnic Institute and State University, Retrieved from <http://hdl.handle.net/10919/79954>
- Fervaha, G., Graff-Guerrero, A., Zakzanis, K. K., Foussias, G., Agid, O., & Remington, G. (2013). Incentive motivation deficits in schizophrenia reflect effort computation impairments during cost-benefit decision-making. *Journal of Psychiatric Research*, 47(11), 1590-1596. doi:<https://doi.org/10.1016/j.jpsychires.2013.08.003>
- Fervaha, G., Zakzanis, K. K., Jeffay, E., Graff-Guerrero, A., Foussias, G., Agid, O., & Remington, G. (2014). Amotivation as central to negative schizotypy and their predictive value for happiness. *Personality and Individual Differences*, 68, 37-42. doi:<https://doi.org/10.1016/j.paid.2014.03.039>
- Fletcher, K., Parker, G., Paterson, A., Fava, M., Iosifescu, D., & Pizzagalli, D. A. (2015). Anhedonia in melancholic and non-melancholic depressive disorders. *Journal of Affective Disorders*, 184, 81-88. doi:<https://doi.org/10.1016/j.jad.2015.05.028>
- Fortunati, R., Ossola, P., Camerlengo, A., Bettini, E., De Panfilis, C., Tonna, M., Maggini, C., & Marchesi, C. (2015). Anhedonia in schizophrenia: The role of subjective experiences. *Comprehensive Psychiatry*, 62, 152-160. doi:<https://doi.org/10.1016/j.comppsy.2015.07.011>
- Foussias, G., & Remington, G. (2008). Negative Symptoms in Schizophrenia: Avolition and Occam's Razor. *Schizophrenia Bulletin*, 36(2), 359-369. doi:<https://doi.org/10.1093/schbul/sbn094>
- Frank, M. J., Seeberger, L. C., & Reilly, R. C. (2004). By Carrot or by Stick: Cognitive Reinforcement Learning in Parkinsonism. *Science*, 306(5703), 1940-1943. doi:<https://doi.org/10.1126/science.1102941>
- Franken, I. H. A., Rassin, E., & Muris, P. (2007). The assessment of anhedonia in clinical and non-clinical populations: Further validation of the Snaith–Hamilton Pleasure Scale (SHAPS). *Journal of Affective Disorders*, 99(1-3), 83-89. doi:<https://doi.org/10.1016/j.jad.2006.08.020>
- Franken, I. H. A., Van Strien, J. W., & Nijs, I. M. T. (2006). Effect of hedonic tone on event-related potential measures of cognitive processing. *Psychiatry Research*, 142(2-3), 233-239. doi:<https://doi.org/10.1016/j.psychres.2005.08.013>

- Franz, M., Lemke, M. R., Meyer, T., Ulferts, J., Puhl, P., & Snaith, R. P. (1998). Deutsche Version der Snaith-Hamilton-Pleasure-Scale (SHAPS-D): Erfassung von Anhedonie bei schizophrenen und depressiven Patienten [German version of the Snaith-Hamilton-Pleasure-Scale (SHAPS-D): Assessing anhedonia in schizophrenic and depressive patients]. [German Version of the Snaith-Hamilton-Pleasure Scale (SHAPS-D)]. *Fortschritte der Neurologie · Psychiatrie*, 66(9), 407-413. doi:<https://doi.org/10.1055/s-2007-995279>
- Fresán, A., & Berlanga, C. (2013). Traducción al español y validación de la Escala de Placer Snaith-Hamilton para Anhedonia (SHAPS) [Translation into Spanish and validation of the Snaith-Hamilton Pleasure Scale (SHAPS) for anhedonia]. *Actas espanolas de psiquiatria*, 41(4), 226-231.
- Frey, A.-L., Malinowska, L., Harley, K., Salhi, L., Iqbal, S., Sharma, S., & McCabe, C. (2015). Investigating subtypes of reward processing deficits as trait markers for depression. *Translational Developmental Psychiatry*, 3(1), 27517. doi:<https://doi.org/10.3402/tdp.v3.27517>
- Fu, R., Gartlehner, G., Grant, M., Shamliyan, T., Sedrakyan, A., Wilt, T. J., Griffith, L., Oremus, M., Raina, P., Ismaila, A., Santaguida, P., Lau, J., & Trikalinos, T. A. (2011). Conducting quantitative synthesis when comparing medical interventions: AHRQ and the Effective Health Care Program. *Journal of Clinical Epidemiology*, 64(11), 1187-1197. doi:<https://doi.org/10.1016/j.jclinepi.2010.08.010>
- Fujiwara, S., Kimura, F., Hosokawa, T., Ishida, S., Sugino, M., & Hanafusa, T. (2011). Anhedonia in Japanese patients with Parkinson's disease. *Geriatrics & Gerontology International*, 11(3), 275-281. doi:<https://doi.org/10.1111/j.1447-0594.2010.00678.x>
- Gadeikis, D., Bos, N., Schweizer, S., Murphy, F., & Dunn, B. (2017). Engaging in an experiential processing mode increases positive emotional response during recall of pleasant autobiographical memories. *Behaviour Research and Therapy*, 92, 68-76. doi:<https://doi.org/10.1016/j.brat.2017.02.005>
- Gard, D. E., Gard, M. G., Kring, A. M., & John, O. P. (2006). Anticipatory and consummatory components of the experience of pleasure: A scale development study. *Journal of Research in Personality*, 40(6), 1086-1102. doi:<https://doi.org/10.1016/j.jrp.2005.11.001>

- Gard, D. E., Kring, A. M., Gard, M. G., Horan, W. P., & Green, M. F. (2007). Anhedonia in schizophrenia: Distinctions between anticipatory and consummatory pleasure. *Schizophrenia Research*, 93(1-3), 253-260.
doi:<https://doi.org/10.1016/j.schres.2007.03.008>
- Garfield, J. B. B., Cotton, S. M., Allen, N. B., Cheetham, A., Kras, M., Yücel, M., & Lubman, D. I. (2017). Evidence that anhedonia is a symptom of opioid dependence associated with recent use. *Drug and Alcohol Dependence*, 177, 29-38.
doi:<https://doi.org/10.1016/j.drugalcdep.2017.03.012>
- Garfield, J. B. B., Lubman, D. I., & Yücel, M. (2014). Anhedonia in substance use disorders: A systematic review of its nature, course and clinical correlates. *Australian & New Zealand Journal of Psychiatry*, 48(1), 36-51. doi:<https://doi.org/10.1177/0004867413508455>
- Gelb, D. J., Oliver, E., & Gilman, S. (1999). Diagnostic Criteria for Parkinson Disease. *Archives of Neurology*, 56(1), 33-39. doi:<https://doi.org/10.1001/archneur.56.1.33>
- Gilbert, P., Allan, S., Brough, S., Melley, S., & Miles, J. N. V. (2002). Relationship of anhedonia and anxiety to social rank, defeat and entrapment. *Journal of Affective Disorders*, 71(1-3), 141-151. doi:[https://doi.org/10.1016/S0165-0327\(01\)00392-5](https://doi.org/10.1016/S0165-0327(01)00392-5)
- Godlewska, B. R., Masaki, C., Sharpley, A. L., Cowen, P. J., & Emir, U. E. (2018). Brain glutamate in medication-free depressed patients: a proton MRS study at 7 Tesla. *Psychological medicine*, 48(10), 1731-1737.
doi:<https://doi.org/10.1017/S0033291717003373>
- Gold, J. M., Strauss, G. P., Waltz, J. A., Robinson, B. M., Brown, J. K., & Frank, M. J. (2013). Negative Symptoms of Schizophrenia Are Associated with Abnormal Effort-Cost Computations. *Biological Psychiatry*, 74(2), 130-136.
doi:<https://doi.org/10.1016/j.biopsych.2012.12.022>
- Goldberg, Y. (2012). *Exploring the cognitive correlates of boredom in traumatic brain injury (TBI)*. (Doctoral thesis), University of Waterloo, Retrieved from <http://hdl.handle.net/10012/7087>
- Gradin, V. B., Pérez, A., MacFarlane, J. A., Cavin, I., Waiter, G., Engelmann, J., Dritschel, B., Pomi, A., Matthews, K., & Steele, J. D. (2015). Abnormal brain responses to social fairness in depression: an fMRI study using the Ultimatum Game. *Psychological medicine*, 45(6), 1241-1251. doi:<https://doi.org/10.1017/S0033291714002347>

- Greenberg, T., Chase, H. W., Almeida, J. R., Stiffler, R., Zevallos, C. R., Aslam, H. A., Deckersbach, T., Weyandt, S., Cooper, C., Toups, M., Carmody, T., Kurian, B., Peltier, S., Adams, P., McInnis, M. G., Oquendo, M. A., McGrath, P. J., Fava, M., Weissman, M., Parsey, R., Trivedi, M. H., & Phillips, M. L. (2015). Moderation of the Relationship Between Reward Expectancy and Prediction Error-Related Ventral Striatal Reactivity by Anhedonia in Unmedicated Major Depressive Disorder: Findings From the EMBARC Study. *American Journal of Psychiatry*, *172*(9), 881-891.
doi:<https://doi.org/10.1176/appi.ajp.2015.14050594>
- Guillot, C. R., Halliday, T. M., Kirkpatrick, M. G., Pang, R. D., & Leventhal, A. M. (2017). Anhedonia and Abstinence as Predictors of the Subjective Pleasantness of Positive, Negative, and Smoking-Related Pictures. *Nicotine & Tobacco Research*, *19*(6), 743-749.
doi:<https://doi.org/10.1093/ntr/ntx036>
- Hamilton, M. (1960). A rating scale for depression. *Journal of neurology, neurosurgery, and psychiatry*, *23*(1), 56-62. doi:<https://doi.org/10.1136/jnnp.23.1.56>
- Han, S. (2017). *Measuring and modifying information bias in depression*. (Master thesis), University of Oxford, Retrieved from <https://ora.ox.ac.uk/objects/uuid:3f2d2aa6-83ee-4e2e-be9f-fc9192f561fb>
- Harzing, A. W. (2007). Publish or Perish. Retrieved from <https://harzing.com/resources/publish-or-perish>
- Hatzigiakoumis, D. S., Martinotti, G., Di Giannantonio, M., & Janiri, L. (2011). Anhedonia and substance dependence: clinical correlates and treatment options. *Frontiers in psychiatry*, *2*, 10. doi:<https://doi.org/10.3389/fpsyt.2011.00010>
- Hedges, L. V. (1981). Distribution Theory for Glass's Estimator of Effect size and Related Estimators. *Journal of Educational Statistics*, *6*(2), 107-128.
doi:<https://doi.org/10.3102/10769986006002107>
- Hershenberg, R., Satterthwaite, T. D., Daldal, A., Katchmar, N., Moore, T. M., Kable, J. W., & Wolf, D. H. (2016). Diminished effort on a progressive ratio task in both unipolar and bipolar depression. *Journal of Affective Disorders*, *196*, 97-100.
doi:<https://doi.org/10.1016/j.jad.2016.02.003>

- Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*, 557-560.
doi:<https://doi.org/10.1136/bmj.327.7414.557>
- Hodos, W. (1961). Progressive Ratio as a Measure of Reward Strength. *Science*, *134*(3483), 943-944. doi:<https://doi.org/10.1126/science.134.3483.943>
- Horan, W. P., Kring, A. M., & Blanchard, J. J. (2006). Anhedonia in Schizophrenia: A Review of Assessment Strategies. *Schizophrenia Bulletin*, *32*(2), 259-273.
doi:<https://doi.org/10.1093/schbul/sbj009>
- Horndasch, S., O'Keefe, S., Lamond, A., Brown, K., & McCabe, C. (2016). Increased anticipatory but decreased consummatory brain responses to food in sisters of anorexia nervosa patients. *BJPsych Open*, *2*(4), 255-261.
doi:<https://doi.org/10.1192/bjpo.bp.115.002550>
- Hughes, A. J., Daniel, S. E., Kilford, L., & Lees, A. J. (1992). Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. *Journal of Neurology, Neurosurgery & Psychiatry*, *55*(3), 181-184.
doi:<https://doi.org/10.1136/jnnp.55.3.181>
- Huhn, A. S., Meyer, R. E., Harris, J. D., Ayaz, H., Deneke, E., Stankoski, D. M., & Bunce, S. C. (2016). Evidence of anhedonia and differential reward processing in prefrontal cortex among post-withdrawal patients with prescription opiate dependence. *Brain Research Bulletin*, *123*, 102-109. doi:<https://doi.org/10.1016/j.brainresbull.2015.12.004>
- Huneke, N. T. M., Walsh, A. E. L., Brown, R., Browning, M., & Harmer, C. J. (2017). No evidence for an acute placebo effect on emotional processing in healthy volunteers. *Journal of Psychopharmacology*, *31*(12), 1578-1587.
doi:<https://doi.org/10.1177/0269881117739552>
- Imberger, G., Vejlbj, A. D., Hansen, S. B., Møller, A. M., & Wetterslev, J. (2011). Statistical Multiplicity in Systematic Reviews of Anaesthesia Interventions: A Quantification and Comparison between Cochrane and Non-Cochrane Reviews. *PLOS ONE*, *6*(12), e28422.
doi:10.1371/journal.pone.0028422
- Janiri, L., Martinotti, G., Dario, T., Reina, D., Paparello, F., Pozzi, G., Addolorato, G., Di Giannantonio, M., & De Risio, S. (2005). Anhedonia and Substance-Related Symptoms

- in Detoxified Substance-Dependent Subjects: A Correlation Study. *Neuropsychobiology*, 52(1), 37-44. doi:<https://doi.org/10.1159/000086176>
- Johnson, S. L., Edge, M. D., Holmes, M. K., & Carver, C. S. (2012). The Behavioral Activation System and Mania. *Annual Review of Clinical Psychology*, 8, 243-267. doi:<https://doi.org/10.1146/annurev-clinpsy-032511-143148>
- Jordan, L. L., Zahodne, L. B., Okun, M. S., & Bowers, D. (2013). Hedonic and behavioral deficits associated with apathy in Parkinson's disease: Potential treatment implications. *Movement Disorders*, 28(9), 1301-1304. doi:<https://doi.org/10.1002/mds.25496>
- Kaufmann, L.-K. (2017). *"Reshaping" the brain – longitudinal investigation of structural and functional brain alterations during weight gain in anorexia nervosa*. (Doctoral thesis), University of Fribourg,
- Kesebir, S., Yıldız, H., Göçmen, D., & Tezcan, E. (2015). Snaith-Hamilton Hoşnutluk Değerlendirme Ölçeği: Geçerlik, Güvenilirlik, Toplumumuzda Psikometrik Özellikleri [Snaith-Hamilton Pleasure Scale: Validity, reliability, psychometric characteristics in our society]. *Cukurova Medical Journal*, 40(2), 252-257. doi:<https://doi.org/10.17826/cutf.40986>
- Kirkpatrick, B., Fenton, W. S., Carpenter, W. T., Jr., & Marder, S. R. (2006). The NIMH-MATRICES Consensus Statement on Negative Symptoms. *Schizophrenia Bulletin*, 32(2), 214-219. doi:<https://doi.org/10.1093/schbul/sbj053>
- Kirkpatrick, M. G., Goldenson, N. I., Kapadia, N., Kahler, C. W., de Wit, H., Swift, R. M., McGeary, J. E., Sussman, S., & Leventhal, A. M. (2016). Emotional traits predict individual differences in amphetamine-induced positive mood in healthy volunteers. *Psychopharmacology*, 233(1), 89-97. doi:<https://doi.org/10.1007/s00213-015-4091-y>
- Konstantopoulos, S. (2011). Fixed effects and variance components estimation in three-level meta-analysis. *Research Synthesis Methods*, 2(1), 61-76. doi:<https://doi.org/10.1002/jrsm.35>
- Koob, G. F., & Le Moal, M. (2001). Drug Addiction, Dysregulation of Reward, and Allostasis. *Neuropsychopharmacology*, 24, 97-129. doi:[https://doi.org/10.1016/S0893-133X\(00\)00195-0](https://doi.org/10.1016/S0893-133X(00)00195-0)

- Kos, C., Klaasen, N. G., Marsman, J.-B. C., Opmeer, E. M., Knegtering, H., Aleman, A., & van Tol, M.-J. (2017). Neural basis of self-initiative in relation to apathy in a student sample. *Scientific Reports*, 7, 3264. doi:<https://doi.org/10.1038/s41598-017-03564-5>
- Kraepelin, E. (1919). *Dementia praecox and paraphrenia* (R. M. Barclay, Trans. G. M. Robertson Ed.). Chicago: Chicago Medical Book Co.
- Kring, A. M., & Moran, E. K. (2008). Emotional Response Deficits in Schizophrenia: Insights From Affective Science. *Schizophrenia Bulletin*, 34(5), 819-834. doi:<https://doi.org/10.1093/schbul/sbn071>
- Kumar, P., Goer, F., Murray, L., Dillon, D. G., Beltzer, M. L., Cohen, A. L., Brooks, N. H., & Pizzagalli, D. A. (2018). Impaired reward prediction error encoding and striatal-midbrain connectivity in depression. *Neuropsychopharmacology*, 43(7), 1581-1588. doi:<https://doi.org/10.1038/s41386-018-0032-x>
- Kumar, P., Slavich, G. M., Berghorst, L. H., Treadway, M. T., Brooks, N. H., Dutra, S. J., Greve, D. N., O'Donovan, A., Bleil, M. E., Maninger, N., & Pizzagalli, D. A. (2015). Perceived life stress exposure modulates reward-related medial prefrontal cortex responses to acute stress in depression. *Journal of Affective Disorders*, 180, 104-111. doi:<https://doi.org/10.1016/j.jad.2015.03.035>
- Kumar, P., Waiter, G., Ahearn, T., Milders, M., Reid, I., & Steele, J. D. (2008). Abnormal temporal difference reward-learning signals in major depression. *Brain*, 131(8), 2084-2093. doi:<https://doi.org/10.1093/brain/awn136>
- Lally, N., Nugent, A. C., Luckenbaugh, D. A., Ameli, R., Roiser, J. P., & Zarate, C. A. (2014). Anti-anhedonic effect of ketamine and its neural correlates in treatment-resistant bipolar depression. *Translational Psychiatry*, 4, e469. doi:<https://doi.org/10.1038/tp.2014.105>
- Lally, N., Nugent, A. C., Luckenbaugh, D. A., Niciu, M. J., Roiser, J. P., & Zarate Jr, C. A. (2015). Neural correlates of change in major depressive disorder anhedonia following open-label ketamine. *Journal of Psychopharmacology*, 29(5), 596-607. doi:<https://doi.org/10.1177/0269881114568041>
- Lampe, I. K., Kahn, R. S., & Heeren, T. J. (2001). Apathy, Anhedonia, and Psychomotor Retardation in Elderly Psychiatric Patients and Healthy Elderly Individuals. *Journal of Geriatric Psychiatry and Neurology*, 14(1), 11-16. doi:<https://doi.org/10.1177/089198870101400104>

- Lampe, I. K., Sitskoorn, M. M., & Heeren, T. J. (2004). Effects of recurrent major depressive disorder on behavior and cognitive function in female depressed patients. *Psychiatry Research, 125*(2), 73-79. doi:<https://doi.org/10.1016/j.psychres.2003.12.004>
- Langvik, E., & Austad, S. B. (2018). Psychometric Properties of the Snaith–Hamilton Pleasure Scale and a Facet-Level Analysis of the Relationship Between Anhedonia and Extraversion in a Nonclinical Sample. *Psychological Reports, 0*(0), 1-16. doi:<https://doi.org/10.1177/0033294118756336>
- Lansdall, C. J., Coyle-Gilchrist, I. T. S., Jones, P. S., Vázquez Rodríguez, P., Wilcox, A., Wehmann, E., Dick, K. M., Robbins, T. W., & Rowe, J. B. (2017). Apathy and impulsivity in frontotemporal lobar degeneration syndromes. *Brain, 140*(6), 1792-1807. doi:<https://doi.org/10.1093/brain/awx101>
- Lawn, W., Freeman, T. P., Hindocha, C., Mokrysz, C., Das, R. K., Morgan, C. J. A., & Curran, H. V. (2015). The effects of nicotine dependence and acute abstinence on the processing of drug and non-drug rewards. *Psychopharmacology, 232*(14), 2503-2517. doi:<https://doi.org/10.1007/s00213-015-3883-4>
- Lawn, W. M. (2016). *Drug and non-drug reward processing in cigarette and cannabis users*. (Doctoral thesis), University College London, Retrieved from <http://discovery.ucl.ac.uk/id/eprint/1498584>
- Lawson, R. P., Nord, C. L., Seymour, B., Thomas, D. L., Dayan, P., Pilling, S., & Roiser, J. P. (2017). Disrupted habenula function in major depression. *Molecular Psychiatry, 22*, 202-208. doi:<https://doi.org/10.1038/mp.2016.81>
- Leentjens, A. F. G., Dujardin, K., Marsh, L., Martinez-Martin, P., Richard, I. H., Starkstein, S. E., Weintraub, D., Sampaio, C., Poewe, W., Rascol, O., Stebbins, G. T., & Goetz, C. G. (2008). Apathy and anhedonia rating scales in Parkinson's disease: Critique and recommendations. *Movement Disorders, 23*(14), 2004-2014. doi:<https://doi.org/10.1002/mds.22229>
- Lemke, M. R. (2002). Effect of reboxetine on depression in Parkinson's disease patients. *The Journal of clinical psychiatry, 63*(4), 300-304.
- Lemke, M. R., Brecht, H. M., Koester, J., Kraus, P. H., & Reichmann, H. (2005). Anhedonia, Depression, and Motor Functioning in Parkinson's Disease During Treatment With

- Pramipexole. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 17(2), 214-220. doi:<https://doi.org/10.1176/jnp.17.2.214>
- Lemke, M. R., Koethe, N., & Schleidt, M. (2000). Segmentation of Behavior and Time Structure of Movements in Depressed Patients. *Psychopathology*, 33(3), 131-136. doi:<https://doi.org/10.1159/000029134>
- Lemke, M. R., Koethe, N. H., & Schleidt, M. (1999). Timing of movements in depressed patients and healthy controls. *Journal of Affective Disorders*, 56(2-3), 209-214. doi:[https://doi.org/10.1016/S0165-0327\(99\)00034-8](https://doi.org/10.1016/S0165-0327(99)00034-8)
- Lemke, M. R., Puhl, P., Koethe, N., & Winkler, T. (1999). Psychomotor retardation and anhedonia in depression. *Acta Psychiatrica Scandinavica*, 99(4), 252-256. doi:<https://doi.org/10.1111/j.1600-0447.1999.tb07221.x>
- Lemke, M. R., & Schleidt, M. (1999). Temporal segmentation of human short-term behavior in everyday activities and interview sessions. *Naturwissenschaften*, 86(6), 289-292. doi:<https://doi.org/10.1007/s001140050617>
- Lemke, M. R., Wendorff, T., Mieth, B., Buhl, K., & Linnemann, M. (2000). Spatiotemporal gait patterns during over ground locomotion in major depression compared with healthy controls. *Journal of Psychiatric Research*, 34(4-5), 277-283. doi:[https://doi.org/10.1016/S0022-3956\(00\)00017-0](https://doi.org/10.1016/S0022-3956(00)00017-0)
- Lempert, K. M., & Pizzagalli, D. A. (2010). Delay discounting and future-directed thinking in anhedonic individuals. *Journal of Behavior Therapy and Experimental Psychiatry*, 41(3), 258-264. doi:<https://doi.org/10.1016/j.jbtep.2010.02.003>
- Leventhal, A. M. (2012). Relations between anhedonia and physical activity. *American journal of health behavior*, 36(6), 860-872. doi:<https://doi.org/10.5993/AJHB.36.6.12>
- Leventhal, A. M., Munafò, M., Tidey, J. W., Sussman, S., Monterosso, J. R., Sun, P., & Kahler, C. W. (2012). Anhedonia predicts altered processing of happy faces in abstinent cigarette smokers. *Psychopharmacology*, 222(2), 343-351. doi:<https://doi.org/10.1007/s00213-012-2649-5>
- Leventhal, A. M., Waters, A. J., Kahler, C. W., Ray, L. A., & Sussman, S. (2009). Relations between anhedonia and smoking motivation. *Nicotine & Tobacco Research*, 11(9), 1047-1054. doi:<https://doi.org/10.1093/ntr/ntp098>

- Lewandowski, K. E., Whitton, A. E., Pizzagalli, D. A., Norris, L. A., Ongur, D., & Hall, M.-H. (2016). Reward learning, neurocognition, social cognition, and symptomatology in psychosis. *Frontiers in psychiatry*, 7, 100. doi:<https://doi.org/10.3389/fpsyt.2016.00100>
- Lichenstein, S. D., Musselman, S., Shaw, D. S., Sitnick, S., & Forbes, E. E. (2017). Nucleus accumbens functional connectivity at age 20 is associated with trajectory of adolescent cannabis use and predicts psychosocial functioning in young adulthood. *Addiction*, 112(11), 1961-1970. doi:<https://doi.org/10.1111/add.13882>
- Liu, W.-h., Chan, R. C. K., Wang, L.-z., Huang, J., Cheung, E. F. C., Gong, Q.-y., & Gollan, J. K. (2011). Deficits in sustaining reward responses in subsyndromal and syndromal major depression. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 35(4), 1045-1052. doi:<https://doi.org/10.1016/j.pnpbp.2011.02.018>
- Liu, W.-h., Roiser, J. P., Wang, L.-z., Zhu, Y.-h., Huang, J., Neumann, D. L., Shum, D. H. K., Cheung, E. F. C., & Chan, R. C. K. (2016). Anhedonia is associated with blunted reward sensitivity in first-degree relatives of patients with major depression. *Journal of Affective Disorders*, 190, 640-648. doi:<https://doi.org/10.1016/j.jad.2015.10.050>
- Liu, W.-H., Valton, V., Wang, L.-Z., Zhu, Y.-H., & Roiser, J. P. (2017). Association between habenula dysfunction and motivational symptoms in unmedicated major depressive disorder. *Social Cognitive and Affective Neuroscience*, 12(9), 1520-1533. doi:<https://doi.org/10.1093/scan/nsx074>
- Liu, W.-h., Wang, L.-z., Shang, H.-r., Shen, Y., Li, Z., Cheung, E. F. C., & Chan, R. C. K. (2014). The influence of anhedonia on feedback negativity in major depressive disorder. *Neuropsychologia*, 53, 213-220. doi:<https://doi.org/10.1016/j.neuropsychologia.2013.11.023>
- Liu, W.-h., Wang, L.-z., Zhao, S.-h., Ning, Y.-p., & Chan, R. C. K. (2012). Anhedonia and emotional word memory in patients with depression. *Psychiatry Research*, 200(2-3), 361-367. doi:<https://doi.org/10.1016/j.psychres.2012.07.025>
- Liu, W.-h., Wang, L.-z., Zhu, Y.-h., Li, M.-h., & Chan, R. C. K. (2012). Clinical utility of the Snaith-Hamilton-Pleasure scale in the Chinese settings. *BMC Psychiatry*, 12(1), 184. doi:<https://doi.org/10.1186/1471-244X-12-184>
- Loas, G., Dubal, S., Perot, P., Tirel, F., Nowaczkowski, P., & Pierson, A. (1997). Etude de validation de la version française de l'échelle de plaisir de Snaith et Hamilton (Snaith-

- Hamilton Pleasure Scale, SHAPS, Snaith et al. 1995): Détermination des paramètres métrologiques chez 208 sujets sains et chez 103 malades hospitalisés présentant une dépression ou une schizophrénie [Study of the validity and reliability of the French version of the Snaith-Hamilton pleasure scale (SHAPS) in 208 healthy subjects and 103 schizophrenics and depressives]. *L'Encéphale*, 23(6), 454-458.
- Loas, G., Duru, C., Godefroy, O., & Krystkowiak, P. (2014). Hedonic deficits in Parkinson's disease: is consummatory anhedonia specific? *Frontiers in neurology*, 5, 24.
doi:<https://doi.org/10.3389/fneur.2014.00024>
- Loas, G., Krystkowiak, P., & Godefroy, O. (2012). Anhedonia in Parkinson's Disease: An Overview. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 24(4), 444-451.
doi:<https://doi.org/10.1176/appi.neuropsych.11110332>
- Loas, G., Monestes, J. L., Ameller, A., Bubrovsky, M., Yon, V., Wallier, J., Berthoz, S., Corcos, M., Thomas, P., & Gard, D. E. (2009). Traduction et étude de validation de la version française de l'échelle d'expérience temporelle du plaisir (EETP, Temporal Experience of Pleasure Scale [TEPS], Gard et al., 2006) : étude chez 125 étudiants et chez 162 sujets présentant un trouble psychiatrique [Psychometric properties of the French version of the Temporal Experience of Pleasure Scale (TEPS): Study on 125 university students and on 162 psychiatric subjects]. *Annales Médico-psychologiques, revue psychiatrique*, 167(9), 641-648. doi:<https://doi.org/10.1016/j.amp.2009.09.002>
- Lönn, K., & Månhav, M. (2014). *Förmåga till njutning - validering av en svensk version av Snaith-Hamilton Pleasure Scale*. University of Gothenburg, Retrieved from <http://hdl.handle.net/2077/37875>
- López-López, J. A., Marín-Martínez, F., Sánchez-Meca, J., Van den Noortgate, W., & Viechtbauer, W. (2014). Estimation of the predictive power of the model in mixed-effects meta-regression: A simulation study. *British Journal of Mathematical and Statistical Psychology*, 67(1), 30-48. doi:<https://doi.org/10.1111/bmsp.12002>
- Lorenzini, N. (2015). *The relevance and usefulness of the Implicit Associations Test (IAT) in adolescent development, attachment and depression*. (Doctoral thesis), University College London, Retrieved from <http://discovery.ucl.ac.uk/id/eprint/1492717>
- Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales* (2nd ed.). Sydney: Psychology Foundation.

- Lussier, A., & Loas, G. (2015). Relationship between Type D Personality and Anhedonia: A Dimensional Study of University Students. *Psychological Reports, 116*(3), 855-860. doi:<https://doi.org/10.2466/09.02.PR0.116k27w2>
- Mann, C. L., Footer, O., Chung, Y. S., Driscoll, L. L., & Barch, D. M. (2013). Spared and impaired aspects of motivated cognitive control in schizophrenia. *Journal of abnormal psychology, 122*(3), 745-755. doi:<https://doi.org/10.1037/a003306>
- Marin, R. S. (1991). Apathy: A neuropsychiatric syndrome. *The Journal of Neuropsychiatry and Clinical Neurosciences, 3*(3), 243-254. doi:<https://doi.org/10.1176/jnp.3.3.243>
- Marroquín, B., & Nolen-Hoeksema, S. (2015). Event Prediction and Affective Forecasting in Depressive Cognition: Using Emotion as Information About the Future. *Journal of Social and Clinical Psychology, 34*(2), 117-134. doi:<https://doi.org/10.1521/jscp.2015.34.2.117>
- Martino, I., Santangelo, G., Moschella, D., Marino, L., Servidio, R., Augimeri, A., Costabile, A., Capoderose, G., & Cerasa, A. (2018). Assessment of Snaith-Hamilton Pleasure Scale (SHAPS): the dimension of anhedonia in Italian healthy sample. *Neurological Sciences, 39*(4), 657-661. doi:<https://doi.org/10.1007/s10072-018-3260-2>
- Martinotti, G., Cloninger, C. R., & Janiri, L. (2008). Temperament and Character Inventory Dimensions and Anhedonia in Detoxified Substance-Dependent Subjects. *The American Journal of Drug and Alcohol Abuse, 34*(2), 177-183. doi:<https://doi.org/10.1080/00952990701877078>
- Martinotti, G., Di Nicola, M., Reina, D., Andreoli, S., Focà, F., Cunniff, A., Tonioni, F., Bria, P., & Janiri, L. (2008). Alcohol Protracted Withdrawal Syndrome: The Role of Anhedonia. *Substance Use & Misuse, 43*(3-4), 271-284. doi:<https://doi.org/10.1080/10826080701202429>
- Mathew, A. R., Cook, J. W., Japuntich, S. J., & Leventhal, A. M. (2015). Post-traumatic stress disorder symptoms, underlying affective vulnerabilities, and smoking for affect regulation. *The American Journal on Addictions, 24*(1), 39-46. doi:<https://doi.org/10.1111/ajad.12170>
- Matsui, K., Tachibana, H., Yamanishi, T., Oguru, M., Toda, K., Okuda, B., & Oka, N. (2013). Clinical correlates of anhedonia in patients with Parkinson's disease. *Clinical Neurology and Neurosurgery, 115*(12), 2524-2527. doi:<https://doi.org/10.1016/j.clineuro.2013.10.013>

- Mattox, S. T., Valle-Inclán, F., & Hackley, S. A. (2006). Psychophysiological evidence for impaired reward anticipation in Parkinson's disease. *Clinical Neurophysiology*, *117*(10), 2144-2153. doi:<https://doi.org/10.1016/j.clinph.2006.05.026>
- Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion*, *23*(2), 209-237. doi:<https://doi.org/10.1080/02699930802204677>
- Mazza, M., Catalucci, A., Pino, M. C., Giusti, L., Nigri, A., Pollice, R., Roncone, R., Casacchia, M., & Gallucci, M. (2013). Dysfunctional neural networks associated with impaired social interactions in early psychosis: an ICA analysis. *Brain imaging and behavior*, *7*(3), 248-259. doi:<https://doi.org/10.1007/s11682-013-9223-6>
- McCabe, C., Woffindale, C., Harmer, C. J., & Cowen, P. J. (2012). Neural Processing of Reward and Punishment in Young People at Increased Familial Risk of Depression. *Biological Psychiatry*, *72*(7), 588-594. doi:<https://doi.org/10.1016/j.biopsych.2012.04.034>
- Meehl, P. E. (1962). Schizotaxia, schizotypy, schizophrenia. *American Psychologist*, *17*(12), 827-838.
- Meshesha, L. Z., Pickover, A. M., Teeters, J. B., & Murphy, J. G. (2017). A longitudinal behavioral economic analysis of non-medical prescription opioid use among college students. *The Psychological Record*, *67*(2), 241-251. doi:<https://doi.org/10.1007/s40732-017-0235-2>
- Mies, G., Van den Berg, I., Franken, I. H., Smits, M., Van Der Molen, M., & Van Der Veen, F. (2013). Neurophysiological correlates of anhedonia in feedback processing. *Frontiers in human neuroscience*, *7*, 96. doi:<https://doi.org/10.3389/fnhum.2013.00096>
- Milders, M., Bell, S., Boyd, E., Thomson, L., Mutha, R., Hay, S., & Gopala, A. (2016). Reduced detection of positive expressions in major depression. *Psychiatry Research*, *240*, 284-287. doi:<https://doi.org/10.1016/j.psychres.2016.04.075>
- Misaki, M., Suzuki, H., Savitz, J., Drevets, W. C., & Bodurka, J. (2016). Individual Variations in Nucleus Accumbens Responses Associated with Major Depressive Disorder Symptoms. *Scientific Reports*, *6*, 21227. doi:<https://doi.org/10.1038/srep21227>
- Miura, S., Kida, H., Nakajima, J., Noda, K., Nagasato, K., Ayabe, M., Aizawa, H., Hauser, M., & Taniwaki, T. (2012). Anhedonia in Japanese patients with Parkinson's disease: Analysis using the Snaith–Hamilton Pleasure Scale. *Clinical Neurology and Neurosurgery*, *114*(4), 352-355. doi:<https://doi.org/10.1016/j.clineuro.2011.11.008>

- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & and the PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Annals of Internal Medicine*, 151(4), 264-269. doi:<https://doi.org/10.7326/0003-4819-151-4-200908180-00135>
- Montgomery, S. A., & Åsberg, M. (1979). A New Depression Scale Designed to be Sensitive to Change. *British Journal of Psychiatry*, 134(4), 382-389. doi:<https://doi.org/10.1192/bjp.134.4.382>
- Morris, S. E., & Cuthbert, B. N. (2012). Research Domain Criteria: cognitive systems, neural circuits, and dimensions of behavior. *Dialogues in clinical neuroscience*, 14(1), 29-37.
- Mrochen, A., Marxreiter, F., Kohl, Z., Schlachetzki, J., Renner, B., Schenk, T., Winkler, J., & Klucken, J. (2016). From sweet to sweat: Hedonic olfactory range is impaired in Parkinson's disease. *Parkinsonism & Related Disorders*, 22, 9-14. doi:<https://doi.org/10.1016/j.parkreldis.2015.09.035>
- Müller, M. J., Szegedi, A., Wetzell, H., & Benkert, O. (2000). Moderate and severe depression: Gradations for the Montgomery–Åsberg Depression Rating Scale. *Journal of Affective Disorders*, 60(2), 137-140. doi:[https://doi.org/10.1016/S0165-0327\(99\)00162-7](https://doi.org/10.1016/S0165-0327(99)00162-7)
- Nagashima, K., Noma, H., & Furukawa, T. A. (2018). Prediction intervals for random-effects meta-analysis: A confidence distribution approach. *Statistical Methods in Medical Research*. doi:<https://doi.org/10.1177/0962280218773520>
- Nagayama, H., Kubo, S.-i., Hatano, T., Hamada, S., Maeda, T., Hasegawa, T., Kadowaki, T., Terashi, H., Yoshioka, M., Nomoto, N., Kano, O., Inoue, M., Shimura, H., Takahashi, T., Uchiyama, T., Watanabe, H., Kaneko, S., Takahashi, T., Baba, Y., & YJ-EXPANDS), Y. J. E. G. f. P. s. D. a. M. D. (2012). Validity and Reliability Assessment of a Japanese Version of the Snaith-Hamilton Pleasure Scale. *Internal Medicine*, 51(8), 865-869. doi:<https://doi.org/10.2169/internalmedicine.51.6718>
- Nagayama, H., Maeda, T., Uchiyama, T., Hashimoto, M., Nomoto, N., Kano, O., Takahashi, T., Terashi, H., Hamada, S., Hasegawa, T., Hatano, T., Takahashi, T., Baba, Y., Sengoku, R., Watanabe, H., Inoue, M., Kadowaki, T., Kaneko, S., Shimura, H., & Kubo, S.-i. (2017). Anhedonia and its correlation with clinical aspects in Parkinson's disease. *Journal of the Neurological Sciences*, 372, 403-407. doi:<https://doi.org/10.1016/j.jns.2016.10.051>

- Nakonezny, P. A., Carmody, T. J., Morris, D. W., Kurian, B. T., & Trivedi, M. H. (2010). Psychometric evaluation of the Snaith–Hamilton Pleasure Scale (SHAPS) in adult outpatients with major depressive disorder. *International clinical psychopharmacology*, 25(6), 328-333. doi:<https://doi.org/10.1097/YIC.0b013e32833eb5ee>
- Nakonezny, P. A., Morris, D. W., Greer, T. L., Byerly, M. J., Carmody, T. J., Grannemann, B. D., Bernstein, I. H., & Trivedi, M. H. (2015). Evaluation of anhedonia with the Snaith–Hamilton Pleasure Scale (SHAPS) in adult outpatients with major depressive disorder. *Journal of Psychiatric Research*, 65, 124-130. doi:<https://doi.org/10.1016/j.jpsychires.2015.03.010>
- Ng, C. G., Chin, S. C., Yee, A. H. A., Loh, H. S., Sulaiman, A. H., Sherianne Sook Kuan, W., & Habil, M. H. (2014). Validation of Malay Version of Snaith-Hamilton Pleasure Scale: Comparison between Depressed Patients and Healthy Subjects at an Out-Patient Clinic in Malaysia. *The Malaysian journal of medical sciences : MJMS*, 21(3), 62-70.
- Norbury, A., Kurth-Nelson, Z., Winston, J. S., Roiser, J. P., & Husain, M. (2015). Dopamine Regulates Approach-Avoidance in Human Sensation-Seeking. *International Journal of Neuropsychopharmacology*, 18(10), pyv041. doi:10.1093/ijnp/pyv041
- Novianti, P. W., Roes, K. C. B., & van der Tweel, I. (2014). Estimation of between-trial variance in sequential meta-analyses: A simulation study. *Contemporary Clinical Trials*, 37(1), 129-138. doi:<https://doi.org/10.1016/j.cct.2013.11.012>
- Nugent, A. C., Ballard, E. D., Gould, T. D., Park, L. T., Moaddel, R., Brutsche, N. E., & Zarate, C. A. (2018). Ketamine has distinct electrophysiological and behavioral effects in depressed and healthy subjects. *Molecular Psychiatry*. doi:<https://doi.org/10.1038/s41380-018-0028-2>
- Nyquist, A. C. (2014). *An investigation of the construct validity of selected adaptively administered MMPI-2 substantive scales*. (Master thesis), Ball State University, Retrieved from <http://cardinalscholar.bsu.edu/handle/123456789/198494>
- Olino, T. M., Horton, L. E., & Versella, M. V. (2016). A comparison of psychometric and convergent validity for social anhedonia and social closeness. *Psychological Assessment*, 28(11), 1465-1474. doi:<https://doi.org/10.1037/pas0000291>
- Olino, T. M., McMakin, D. L., & Forbes, E. E. (2016). Toward an Empirical Multidimensional Structure of Anhedonia, Reward Sensitivity, and Positive Emotionality: An Exploratory

- Factor Analytic Study. *Assessment*, 25(6), 679-690.
doi:<https://doi.org/10.1177/1073191116680291>
- Osuch, E. A., Manning, K., Hegele, R. A., Théberge, J., Neufeld, R., Mitchell, D., Williamson, P., & Gardner, R. C. (2016). Depression, marijuana use and early-onset marijuana use conferred unique effects on neural connectivity and cognition. *Acta Psychiatrica Scandinavica*, 134(5), 399-409. doi:<https://doi.org/10.1111/acps.12629>
- Pause, B. M., Miranda, A., Göder, R., Aldenhoff, J. B., & Ferstl, R. (2001). Reduced olfactory performance in patients with major depression. *Journal of Psychiatric Research*, 35(5), 271-277. doi:[https://doi.org/10.1016/S0022-3956\(01\)00029-2](https://doi.org/10.1016/S0022-3956(01)00029-2)
- Pechtel, P., Dutra, S. J., Goetz, E. L., & Pizzagalli, D. A. (2013). Blunted reward responsiveness in remitted depression. *Journal of Psychiatric Research*, 47(12), 1864-1869.
doi:<https://doi.org/10.1016/j.jpsychires.2013.08.011>
- Pechtel, P., & Pizzagalli, D. A. (2013). Disrupted reinforcement learning and maladaptive behavior in women with a history of childhood sexual abuse: A high-density event-related potential study. *JAMA Psychiatry*, 70(5), 499-507.
doi:<https://doi.org/10.1001/jamapsychiatry.2013.728>
- Peciña, M., Sikora, M., Avery, E. T., Heffernan, J., Peciña, S., Mickey, B. J., & Zubieta, J.-K. (2017). Striatal dopamine D2/3 receptor-mediated neurotransmission in major depression: Implications for anhedonia, anxiety and treatment response. *European Neuropsychopharmacology*, 27(10), 977-986.
doi:<https://doi.org/10.1016/j.euroneuro.2017.08.427>
- Pettorruso, M., Martinotti, G., Fasano, A., Loria, G., Di Nicola, M., De Risio, L., Ricciardi, L., Conte, G., Janiri, L., & Bentivoglio, A. R. (2014). Anhedonia in Parkinson's disease patients with and without pathological gambling: A case-control study. *Psychiatry Research*, 215(2), 448-452. doi:<https://doi.org/10.1016/j.psychres.2013.12.013>
- Pictet, A., Jermann, F., & Ceschi, G. (2016). When less could be more: Investigating the effects of a brief internet-based imagery cognitive bias modification intervention in depression. *Behaviour Research and Therapy*, 84, 45-51.
doi:<https://doi.org/10.1016/j.brat.2016.07.008>

- Pizzagalli, D. A. (2014). Depression, Stress, and Anhedonia: Toward a Synthesis and Integrated Model. *Annual Review of Clinical Psychology, 10*, 393-423.
doi:<https://doi.org/10.1146/annurev-clinpsy-050212-185606>
- Pizzagalli, D. A., Iosifescu, D., Hallett, L. A., Ratner, K. G., & Fava, M. (2008). Reduced hedonic capacity in major depressive disorder: Evidence from a probabilistic reward task. *Journal of Psychiatric Research, 43*(1), 76-87.
doi:<https://doi.org/10.1016/j.jpsychires.2008.03.001>
- Pizzagalli, D. A., Jahn, A. L., & O'Shea, J. P. (2005). Toward an objective characterization of an anhedonic phenotype: A signal-detection approach. *Biological Psychiatry, 57*(4), 319-327. doi:<https://doi.org/10.1016/j.biopsych.2004.11.026>
- Polanin, J. R., & Pigott, T. D. (2015). The use of meta-analytic statistical significance testing. *Research Synthesis Methods, 6*(1), 63-73. doi:<https://doi.org/10.1002/jrsm.1124>
- Polimeni, J. O., Campbell, D. W., Gill, D., Sawatzky, B. L., & Reiss, J. P. (2010). Diminished humour perception in schizophrenia: Relationship to social and cognitive functioning. *Journal of Psychiatric Research, 44*(7), 434-440.
doi:<https://doi.org/10.1016/j.jpsychires.2009.10.003>
- Pomponi, M., Loria, G., Salvati, S., Di Biase, A., Conte, G., Vilella, C., Righino, E., Ciciarelli, C., Bria, P., La Torre, G., Pomponi, M. F. L., Janiri, L., & Bentivoglio, A. R. (2014). DHA effects in Parkinson disease depression. *Basal Ganglia, 4*(2), 61-66.
doi:<https://doi.org/10.1016/j.baga.2014.03.004>
- Pontieri, F. E., Assogna, F., Pellicano, C., Cacciari, C., Pannunzi, S., Morrone, A., Danese, E., Caltagirone, C., & Spalletta, G. (2015). Sociodemographic, neuropsychiatric and cognitive characteristics of pathological gambling and impulse control disorders NOS in Parkinson's disease. *European Neuropsychopharmacology, 25*(1), 69-76.
doi:<https://doi.org/10.1016/j.euroneuro.2014.11.006>
- Pool, E., Sennwald, V., Delplanque, S., Brosch, T., & Sander, D. (2016). Measuring wanting and liking from animals to humans: A systematic review. *Neuroscience & Biobehavioral Reviews, 63*, 124-142. doi:<https://doi.org/10.1016/j.neubiorev.2016.01.006>
- Porter, R. J., Phipps, A. J., Gallagher, P., Scott, A., Stevenson, P. S., & O'Brien, J. T. (2005). Effects of Acute Tryptophan Depletion on Mood and Cognitive Functioning in Older

- Recovered Depressed Subjects. *The American Journal of Geriatric Psychiatry*, 13(7), 607-615. doi:<https://doi.org/10.1097/00019442-200507000-00009>
- Powers, J. M., Carroll, A. J., Veluz-Wilkins, A. K., Blazekovic, S., Gariti, P., Leone, F. T., Schnoll, R. A., & Hitsman, B. (2017). Is the Effect of Anhedonia on Smoking Cessation Greater for Women Versus Men? *Nicotine & Tobacco Research*, 19(1), 119-123. doi:<https://doi.org/10.1093/ntr/ntw148>
- Preti, A., Corrias, I., Gabbrielli, M., Lai, V., Muratore, T., Pintus, E., Pintus, M., Sanna, S., Scanu, R., Tronci, D., Vellante, M., Siddi, S., Petretto, D. R., & Carta, M. G. (2015). The independence of schizotypy from affective temperaments – A combined confirmatory factor analysis of SPQ and the short TEMPS-A. *Psychiatry Research*, 225(1-2), 145-156. doi:<https://doi.org/10.1016/j.psychres.2014.10.027>
- R Core Team. (2018). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from <https://www.R-project.org/>
- Rabey, J. M., Bass, H., Bonuccelli, U., Brooks, D., Klotz, P., Korczyn, A. D., Kraus, P., Martinez-Martin, P., Morrish, P., Van Sauten, W., & Van Hilten, B. (1997). Evaluation of the Short Parkinson's Evaluation Scale: a new friendly scale for the evaluation of Parkinson's disease in clinical drug trials. *Clinical neuropharmacology*, 20(4), 322-337.
- Radloff, L. S. (1977). The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Applied Psychological Measurement*, 1(3), 385-401. doi:<https://doi.org/10.1177/014662167700100306>
- Rado, S. (1953). Dynamics and classification of disordered behavior. *The American Journal of Psychiatry*, 110, 406-426. doi:<https://doi.org/10.1176/ajp.110.6.406>
- Redlich, R., Dohm, K., Grotegerd, D., Opel, N., Zwitserlood, P., Heindel, W., Arolt, V., Kugel, H., & Dannlowski, U. (2015). Reward Processing in Unipolar and Bipolar Depression: A Functional MRI Study. *Neuropsychopharmacology*, 40, 2623-2631. doi:<https://doi.org/10.1038/npp.2015.110>
- Reijnders, J. S. A. M., Ehrt, U., Weber, W. E. J., Aarsland, D., & Leentjens, A. F. G. (2008). A systematic review of prevalence studies of depression in Parkinson's disease. *Movement Disorders*, 23(2), 183-189. doi:<https://doi.org/10.1002/mds.21803>

- Renfroe, J. B., Bradley, M. M., Okun, M. S., & Bowers, D. (2016). Motivational engagement in Parkinson's disease: Preparation for motivated action. *International Journal of Psychophysiology*, *99*, 24-32. doi:<https://doi.org/10.1016/j.ijpsycho.2015.11.014>
- Ribot, T. A. (1896). *La psychologie des sentiments*. Paris: Félix Alcan.
- Ricciardi, L., Ferrazzano, G., Demartini, B., Morgante, F., Erro, R., Ganos, C., Bhatia, K. P., Berardelli, A., & Edwards, M. (2016). Know thyself: Exploring interoceptive sensitivity in Parkinson's disease. *Journal of the Neurological Sciences*, *364*, 110-115. doi:<https://doi.org/10.1016/j.jns.2016.03.019>
- Richards, D. A., Rhodes, S., Ekers, D., McMillan, D., Taylor, R. S., Byford, S., Barrett, B., Finning, K., Ganguli, P., Warren, F., Farrand, P., Gilbody, S., Kuyken, W., O'Mahen, H., Watkins, E., Wright, K., Reed, N., Fletcher, E., Hollon, S. D., Moore, L., Backhouse, A., Farrow, C., Garry, J., Kemp, D., Plummer, F., Warner, F., & Woodhouse, R. (2017). Cost and Outcome of Behavioural Activation (COBRA): a randomised controlled trial of behavioural activation versus cognitive-behavioural therapy for depression. *Health Technology Assessment*, *21*(46), 1-366. doi:<https://doi.org/10.3310/hta21460>
- Rizvi, S. J. (2015). *Anhedonia in Major Depressive Disorder: Exploration of a Predictive Clinical Phenotype*. (Doctoral thesis), University of Toronto, Retrieved from <http://hdl.handle.net/1807/69447>
- Rizvi, S. J., Quilty, L. C., Sproule, B. A., Cyriac, A., Michael Bagby, R., & Kennedy, S. H. (2015). Development and validation of the Dimensional Anhedonia Rating Scale (DARS) in a community sample and individuals with major depression. *Psychiatry Research*, *229*(1-2), 109-119. doi:<https://doi.org/10.1016/j.psychres.2015.07.062>
- Robinson, T. E., & Berridge, K. C. (1993). The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research Reviews*, *18*(3), 247-291. doi:[https://doi.org/10.1016/0165-0173\(93\)90013-P](https://doi.org/10.1016/0165-0173(93)90013-P)
- Rockliff, B. W. (1969). A Brief Self-Rating Questionnaire for Depression (SRQ-D). *Psychosomatics*, *10*(4), 236-243. doi:[https://doi.org/10.1016/S0033-3182\(69\)71734-0](https://doi.org/10.1016/S0033-3182(69)71734-0)
- Rodriguez, D., Goulazian, T., Strasser, A. A., O'Loughlin, J., Dugas, E. N., Kuoiloi, C., Hitsman, B. L., & Schnoll, R. (2018). The Role of the Subjective Importance of Smoking (SIMS) in Cessation and Abstinence. *Journal of Smoking Cessation*, 1-11. doi:<https://doi.org/10.1017/jsc.2018.7>

- Rolls, E. T., Hornak, J., Wade, D., & McGrath, J. (1994). Emotion-related learning in patients with social and emotional changes associated with frontal lobe damage. *Journal of Neurology, Neurosurgery & Psychiatry*, *57*(12), 1518-1524.
doi:<https://doi.org/10.1136/jnnp.57.12.1518>
- Rømer Thomsen, K. (2015). Measuring anhedonia: impaired ability to pursue, experience, and learn about reward. *Frontiers in psychology*, *6*, 1409.
doi:<https://doi.org/10.3389/fpsyg.2015.01409>
- Rothkirch, M., Tonn, J., Köhler, S., & Sterzer, P. (2017). Neural mechanisms of reinforcement learning in unmedicated patients with major depressive disorder. *Brain*, *140*(4), 1147-1157. doi:<https://doi.org/10.1093/brain/awx025>
- Rush, A. J., Giles, D. E., Schlessler, M. A., Fulton, C. L., Weissenburger, J., & Burns, C. (1986). The inventory for depressive symptomatology (IDS): Preliminary findings. *Psychiatry Research*, *18*(1), 65-87. doi:[https://doi.org/10.1016/0165-1781\(86\)90060-0](https://doi.org/10.1016/0165-1781(86)90060-0)
- Rush, A. J., Trivedi, M. H., Ibrahim, H. M., Carmody, T. J., Arnow, B., Klein, D. N., Markowitz, J. C., Ninan, P. T., Kornstein, S., Manber, R., Thase, M. E., Kocsis, J. H., & Keller, M. B. (2003). The 16-Item quick inventory of depressive symptomatology (QIDS), clinician rating (QIDS-C), and self-report (QIDS-SR): a psychometric evaluation in patients with chronic major depression. *Biological Psychiatry*, *54*(5), 573-583.
doi:[https://doi.org/10.1016/S0006-3223\(02\)01866-8](https://doi.org/10.1016/S0006-3223(02)01866-8)
- Ryu, V. (2013). *Dysfunctional reward learning in bipolar disorder: An event-related potential study*. (Doctoral thesis), Yonsei University,
- Rzepa, E., & McCabe, C. (2016). Decreased anticipated pleasure correlates with increased salience network resting state functional connectivity in adolescents with depressive symptomatology. *Journal of Psychiatric Research*, *82*, 40-47.
doi:<https://doi.org/10.1016/j.jpsychires.2016.07.013>
- Santangelo, G., Morgante, L., Savica, R., Marconi, R., Grasso, L., Antonini, A., De Gaspari, D., Ottaviani, D., Tiple, D., Simoni, L., Barone, P., & on behalf of the PRIAMO study group. (2009). Anhedonia and cognitive impairment in Parkinson's disease: Italian validation of the Snaith–Hamilton Pleasure Scale and its application in the clinical routine practice during the PRIAMO study. *Parkinsonism & Related Disorders*, *15*(8), 576-581.
doi:<https://doi.org/10.1016/j.parkreldis.2009.02.004>

- Santangelo, G., Vitale, C., Trojano, L., Longo, K., Cozzolino, A., Grossi, D., & Barone, P. (2009). Relationship between depression and cognitive dysfunctions in Parkinson's disease without dementia. *Journal of Neurology*, 256(4), 632-638. doi:<https://doi.org/10.1007/s00415-009-0146-5>
- Saxena, A., Luking, K. R., Barch, D. M., & Pagliaccio, D. (2017). Individual differences in hedonic capacity, depressed mood, and affective states predict emotional reactivity. *Motivation and Emotion*, 41(3), 419-429. doi:<https://doi.org/10.1007/s11031-017-9610-1>
- Scheidegger, M., Walter, M., Lehmann, M., Metzger, C., Grimm, S., Boeker, H., Boesiger, P., Henning, A., & Seifritz, E. (2012). Ketamine Decreases Resting State Functional Network Connectivity in Healthy Subjects: Implications for Antidepressant Drug Action. *PLOS ONE*, 7(9), e44799. doi:<https://doi.org/10.1371/journal.pone.0044799>
- Schmidt, L., d'Arc, B. F., Lafargue, G., Galanaud, D., Czernecki, V., Grabli, D., Schüpbach, M., Hartmann, A., Lévy, R., Dubois, B., & Pessiglione, M. (2008). Disconnecting force from money: effects of basal ganglia damage on incentive motivation. *Brain*, 131(5), 1303-1310. doi:<https://doi.org/10.1093/brain/awn045>
- Shankman, S. A., Katz, A. C., DeLizza, A. A., Sarapas, C., Gorka, S. M., & Campbell, M. L. (2014). The different facets of anhedonia and their associations with different psychopathologies. In M. S. Ritsner (Ed.), *Anhedonia: A Comprehensive Handbook Volume I* (pp. 3-22). Dordrecht: Springer.
- Snaith, R. P., Hamilton, M., Morley, S., Humayan, A., Hargreaves, D., & Trigwell, P. (1995). A Scale for the Assessment of Hedonic Tone the Snaith–Hamilton Pleasure Scale. *British Journal of Psychiatry*, 167(1), 99-103. doi:<https://doi.org/10.1192/bjp.167.1.99>
- Snaith, R. P., Harrop, F. M., Newby, D. A., & Teale, C. (1986). Grade Scores of the Montgomery—Åsberg Depression and the Clinical Anxiety Scales. *British Journal of Psychiatry*, 148(5), 599-601. doi:<https://doi.org/10.1192/bjp.148.5.599>
- Sobesky, E. N. (2017). *Activación neural asociada a interacciones sociales en la depresión mayor: Potenciales relacionados a eventos durante el ultimatum game*. University of the Republic,
- Soutschek, A., Kang, P., Ruff, C. C., Hare, T. A., & Tobler, P. N. (2018). Brain Stimulation Over the Frontopolar Cortex Enhances Motivation to Exert Effort for Reward. *Biological Psychiatry*, 84(1), 38-45. doi:<https://doi.org/10.1016/j.biopsych.2017.11.007>

- Spalletta, G., Fagioli, S., Meco, G., Pierantozzi, M., Stefani, A., Pisani, V., Caltagirone, C., Pontieri, F. E., & Assogna, F. (2013). Hedonic tone and its mood and cognitive correlates in Parkinson's disease. *Depression and Anxiety*, *30*(1), 85-91.
doi:<https://doi.org/10.1002/da.22036>
- Spalletta, G., Robinson, R. G., Cravello, L., Pontieri, F. E., Pierantozzi, M., Stefani, A., Long, J. D., Caltagirone, C., & Assogna, F. (2014). The early course of affective and cognitive symptoms in de novo patients with Parkinson's disease. *Journal of Neurology*, *261*(6), 1126-1132. doi:<https://doi.org/10.1007/s00415-014-7327-6>
- Sprenghelmeyer, R., Steele, J. D., Mwangi, B., Kumar, P., Christmas, D., Milders, M., & Matthews, K. (2011). The insular cortex and the neuroanatomy of major depression. *Journal of Affective Disorders*, *133*(1-2), 120-127.
doi:<https://doi.org/10.1016/j.jad.2011.04.004>
- Steele, J. D., Kumar, P., & Ebmeier, K. P. (2007). Blunted response to feedback information in depressive illness. *Brain*, *130*(9), 2367-2374. doi:<https://doi.org/10.1093/brain/awm150>
- Sterne, J. A. C., Sutton, A. J., Ioannidis, J. P. A., Terrin, N., Jones, D. R., Lau, J., Carpenter, J., Rücker, G., Harbord, R. M., Schmid, C. H., Tetzlaff, J., Deeks, J. J., Peters, J., Macaskill, P., Schwarzer, G., Duval, S., Altman, D. G., Moher, D., & Higgins, J. P. T. (2011). Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. *BMJ*, *343*, d4002.
doi:<https://doi.org/10.1136/bmj.d4002>
- Stevens, A., Peschk, I., & Schwarz, J. (2007). Implicit learning, executive function and hedonic activity in chronic polydrug abusers, currently abstinent polydrug abusers and controls. *Addiction*, *102*(6), 937-946. doi:<https://doi.org/10.1111/j.1360-0443.2007.01823.x>
- Stone, M. D., Audrain-McGovern, J., & Leventhal, A. M. (2017). Association of Anhedonia With Adolescent Smoking Susceptibility and Initiation. *Nicotine & Tobacco Research*, *19*(6), 738-742. doi:<https://doi.org/10.1093/ntr/ntw177>
- Strauss, G. P., & Gold, J. M. (2012). A New Perspective on Anhedonia in Schizophrenia. *American Journal of Psychiatry*, *169*(4), 364-373.
doi:<https://doi.org/10.1176/appi.ajp.2011.11030447>

- Strauss, G. P., Waltz, J. A., & Gold, J. M. (2014). A Review of Reward Processing and Motivational Impairment in Schizophrenia. *Schizophrenia Bulletin*, 40(Supplement 2), S107-S116. doi:<https://doi.org/10.1093/schbul/sbt197>
- Stroud, J. B., Freeman, T. P., Leech, R., Hindocha, C., Lawn, W., Nutt, D. J., Curran, H. V., & Carhart-Harris, R. L. (2018). Psilocybin with psychological support improves emotional face recognition in treatment-resistant depression. *Psychopharmacology*, 235(2), 459-466. doi:<https://doi.org/10.1007/s00213-017-4754-y>
- Swiecicki, L., Zatorski, P., Bzinkowska, D., Sienkiewicz-Jarosz, H., Szyndler, J., & Scinska, A. (2009). Gustatory and olfactory function in patients with unipolar and bipolar depression. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 33(5), 827-834. doi:<https://doi.org/10.1016/j.pnpbp.2009.03.030>
- Szczepanik, J. E., Furey, M. L., Nugent, A. C., Henter, I. D., Zarate, C. A., & Lejuez, C. W. (2017). Altered interaction with environmental reinforcers in major depressive disorder: Relationship to anhedonia. *Behaviour Research and Therapy*, 97, 170-177. doi:<https://doi.org/10.1016/j.brat.2017.08.003>
- Szczypiński, J., & Gola, M. (2017). Anhedonia. Co o niej wiemy i jak ją badać? [What do we know about anhedonia? State of the art and research methods]. *Psychiatria*, 14(2), 65-74.
- Taalman, H. C. (2017). *The Effects of Transcranial Magnetic Stimulation on Depression and the Associated Olfactory Dysfunction*. (Master thesis), Queen's University, Retrieved from <http://hdl.handle.net/1974/22702>
- Taubitz, L. E. (2015). *Facilitating Visual Selective Attention via Monetary Reward: the Influence of Feedback, Hedonic Capacity, and Lifetime Major Depressive Disorder*. (Doctoral thesis), University of Wisconsin-Milwaukee,
- The Cochrane Collaboration. (2011). *Cochrane Handbook for Systematic Reviews of Interventions*. In J. P. T. Higgins & S. Green (Eds.). Retrieved from <https://training.cochrane.org/handbook>
- Thomas, J., Al-Mesaabi, W., Bahusain, E., & Mutawa, M. (2014). The relationship between taste sensitivity to phenylthiocarbamide and anhedonia. *Psychiatry Research*, 215(2), 444-447. doi:<https://doi.org/10.1016/j.psychres.2013.11.026>
- Thomas, J., Al Ali, M., Al Hashmi, A., & Rodriguez, A. (2012). Convergent validity and internal consistency of an Arabic Snaith Hamilton Pleasure Scale. *International Perspectives in*

- Psychology: Research, Practice, Consultation*, 1(1), 46-51.
doi:<http://doi.org/10.1037/a0026919>
- Tonioni, F., Mazza, M., Autullo, G., Cappelluti, R., Catalano, V., Marano, G., Fiumana, V., Moschetti, C., Alimonti, F., Luciani, M., & Lai, C. (2014). Is Internet addiction a psychopathological condition distinct from pathological gambling? *Addictive Behaviors*, 39(6), 1052-1056. doi:<https://doi.org/10.1016/j.addbeh.2014.02.016>
- Treadway, M. T., Bossaller, N. A., Shelton, R. C., & Zald, D. H. (2012). Effort-based decision-making in major depressive disorder: a translational model of motivational anhedonia. *Journal of abnormal psychology*, 121(3), 553-558. doi:<https://doi.org/10.1037/a0028813>
- Treadway, M. T., Buckholtz, J. W., Schwartzman, A. N., Lambert, W. E., & Zald, D. H. (2009). Worth the 'EEfRT'? The Effort Expenditure for Rewards Task as an Objective Measure of Motivation and Anhedonia. *PLOS ONE*, 4(8), e6598.
doi:<https://doi.org/10.1371/journal.pone.0006598>
- Treadway, M. T., Peterman, J. S., Zald, D. H., & Park, S. (2015). Impaired effort allocation in patients with schizophrenia. *Schizophrenia Research*, 161(2-3), 382-385.
doi:<https://doi.org/10.1016/j.schres.2014.11.024>
- Treadway, M. T., & Zald, D. H. (2011). Reconsidering anhedonia in depression: Lessons from translational neuroscience. *Neuroscience & Biobehavioral Reviews*, 35(3), 537-555.
doi:<https://doi.org/10.1016/j.neubiorev.2010.06.006>
- Tremblay, L. K., Naranjo, C. A., Cardenas, L., Herrmann, N., & Busto, U. E. (2002). Probing brain reward system function in major depressive disorder: Altered response to dextroamphetamine. *Archives of General Psychiatry*, 59(5), 409-416.
doi:<https://doi.org/10.1001/archpsyc.59.5.409>
- Tremblay, L. K., Naranjo, C. A., Graham, S. J., Herrmann, N., Mayberg, H. S., Hevenor, S., & Busto, U. E. (2005). Functional neuroanatomical substrates of altered reward processing in major depressive disorder revealed by a dopaminergic probe. *Archives of General Psychiatry*, 62(11), 1228-1236. doi:<https://doi.org/10.1001/archpsyc.62.11.1228>
- Tripp, G., & Alsop, B. (1999). Sensitivity to Reward Frequency in Boys With Attention Deficit Hyperactivity Disorder. *Journal of Clinical Child Psychology*, 28(3), 366-375.
doi:<https://doi.org/10.1207/S15374424jccp280309>

- Trøstheim, M., Eikemo, M., Hansen, I., Alnes, S., & Leknes, S. (2018). Anhedonia in clinical and non-clinical populations: an exploratory meta-analysis of studies using the Snaith-Hamilton Pleasure Scale (SHAPS). *PROSPERO*, CRD42018109910.
- Tudge, L., Williams, C., Cowen, P. J., & McCabe, C. (2015). Neural Effects of Cannabinoid CB1 Neutral Antagonist Tetrahydrocannabivarin on Food Reward and Aversion in Healthy Volunteers. *International Journal of Neuropsychopharmacology*, *18*(6), pyu094. doi:<https://doi.org/10.1093/ijnp/pyu094>
- Ubl, B., Kuehner, C., Kirsch, P., Ruttorf, M., Diener, C., & Flor, H. (2015). Altered neural reward and loss processing and prediction error signalling in depression. *Social Cognitive and Affective Neuroscience*, *10*(8), 1102-1112. doi:<https://doi.org/10.1093/scan/nsu158>
- Umemoto, A., & Holroyd, C. B. (2016). Chapter 8 - Exploring individual differences in task switching: Persistence and other personality traits related to anterior cingulate cortex function. In B. Studer & S. Knecht (Eds.), *Progress in Brain Research* (Vol. 229, pp. 189-212): Elsevier.
- Urošević, S., Abramson, L. Y., Harmon-Jones, E., & Alloy, L. B. (2008). Dysregulation of the behavioral approach system (BAS) in bipolar spectrum disorders: Review of theory and evidence. *Clinical Psychology Review*, *28*(7), 1188-1205. doi:<https://doi.org/10.1016/j.cpr.2008.04.004>
- van der Linden, D., Frese, M., & Meijman, T. F. (2003). Mental fatigue and the control of cognitive processes: effects on perseveration and planning. *Acta Psychologica*, *113*(1), 45-65. doi:[https://doi.org/10.1016/S0001-6918\(02\)00150-6](https://doi.org/10.1016/S0001-6918(02)00150-6)
- Veroniki, A. A., Jackson, D., Viechtbauer, W., Bender, R., Bowden, J., Knapp, G., Kuss, O., Higgins, J. P., Langan, D., & Salanti, G. (2016). Methods to estimate the between-study variance and its uncertainty in meta-analysis. *Research Synthesis Methods*, *7*(1), 55-79. doi:<https://doi.org/10.1002/jrsm.1164>
- Vidotto, G., Catalucci, A., Roncone, R., Pino, M. C., & Mazza, M. (2014). Neural correlates of observation of disgusting images in subjects with first episode psychosis and post-traumatic stress disorder. *Journal of Biological Regulators and Homeostatic Agents*, *28*(4), 705-716.
- Viechtbauer, W. (2010). Conducting Meta-Analyses in R with the metafor Package. *Journal of Statistical Software*, *36*(3), 1-48. doi:<https://doi.org/10.18637/jss.v036.i03>

- Viviani, R., Dommes, L., Bosch, J. E., Stingl, J. C., & Beschoner, P. (2018). A Computerized Version of the Scrambled Sentences Test. *Frontiers in psychology*, 8, 2310.
doi:<https://doi.org/10.3389/fpsyg.2017.02310>
- Vrieze, E., Ceccarini, J., Pizzagalli, D. A., Bormans, G., Vandenbulcke, M., Demyttenaere, K., Van Laere, K., & Claes, S. (2013). Measuring extrastriatal dopamine release during a reward learning task. *Human Brain Mapping*, 34(3), 575-586.
doi:<https://doi.org/10.1002/hbm.21456>
- Vrieze, E., Pizzagalli, D. A., Demyttenaere, K., Hompes, T., Sienaert, P., de Boer, P., Schmidt, M., & Claes, S. (2013). Reduced Reward Learning Predicts Outcome in Major Depressive Disorder. *Biological Psychiatry*, 73(7), 639-645.
doi:<https://doi.org/10.1016/j.biopsych.2012.10.014>
- Walker, R. S. W. (2017). *The Function of Conditioned Fear in Reward Propensity: Evidence for Interrelated Approach-Avoid Systems*. (Master thesis), University of Washington, Retrieved from <http://hdl.handle.net/1773/40964>
- Walsh, A. E., Browning, M., Drevets, W. C., Furey, M., & Harmer, C. J. (2018). Dissociable temporal effects of bupropion on behavioural measures of emotional and reward processing in depression. *Philosophical Transactions of the Royal Society B*, 373(1742), 20170030. doi:<https://doi.org/10.1098/rstb.2017.0030>
- Waltz, J. A., & Gold, J. M. (2016). Motivational Deficits in Schizophrenia and the Representation of Expected Value. In E. H. Simpson & P. D. Balsam (Eds.), *Behavioral Neuroscience of Motivation* (pp. 375-410). Cham: Springer International Publishing.
- Wardle, M. C., Vincent, J. N., Suchting, R., Green, C. E., Lane, S. D., & Schmitz, J. M. (2017). Anhedonia Is Associated with Poorer Outcomes in Contingency Management for Cocaine Use Disorder. *Journal of Substance Abuse Treatment*, 72, 32-39.
doi:<https://doi.org/10.1016/j.jsat.2016.08.020>
- Watson, D., Weber, K., Assenheimer, J. S., Clark, L. A., Strauss, M. E., & McCormick, R. A. (1995). Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *Journal of abnormal psychology*, 104(1), 3-14. doi:<https://doi.org/10.1037/0021-843X.104.1.3>
- Wells, G. A., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2008). The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in

- meta-analyses. Retrieved from
http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp
- Werkman, H. (2016). *Anhedonia in Depression: The Role of Positive Emotion Regulation Strategies*. (Bachelor thesis), University of Groningen,
- Whitton, A. E., Treadway, M. T., & Pizzagalli, D. A. (2015). Reward processing dysfunction in major depression, bipolar disorder and schizophrenia. *Current opinion in psychiatry*, 28(1), 7-12. doi:<https://doi.org/10.1097/YCO.0000000000000122>
- Winer, E. S., Veilleux, J. C., & Ginger, E. J. (2014). Development and validation of the Specific Loss of Interest and Pleasure Scale (SLIPS). *Journal of Affective Disorders*, 152-154, 193-201. doi:<https://doi.org/10.1016/j.jad.2013.09.010>
- Wise, R. A. (2004). Dopamine, learning and motivation. *Nature Reviews Neuroscience*, 5, 483-492. doi:<https://doi.org/10.1038/nrn1406>
- Witt, K., Daniels, C., Reiff, J., Krack, P., Volkmann, J., Pinski, M. O., Krause, M., Tronnier, V., Kloss, M., Schnitzler, A., Wojtecki, L., Bötzel, K., Danek, A., Hilker, R., Sturm, V., Kupsch, A., Karner, E., & Deuschl, G. (2008). Neuropsychological and psychiatric changes after deep brain stimulation for Parkinson's disease: a randomised, multicentre study. *The Lancet Neurology*, 7(7), 605-614. doi:[https://doi.org/10.1016/S1474-4422\(08\)70114-5](https://doi.org/10.1016/S1474-4422(08)70114-5)
- Wolf, D. H., Satterthwaite, T. D., Kantrowitz, J. J., Katchmar, N., Vandekar, L., Elliott, M. A., & Ruparel, K. (2014). Amotivation in Schizophrenia: Integrated Assessment With Behavioral, Clinical, and Imaging Measures. *Schizophrenia Bulletin*, 40(6), 1328-1337. doi:<https://doi.org/10.1093/schbul/sbu026>
- World Health Organization. (2003). *International Classification of Diseases* (10th ed.): World Health Organization.
- World Health Organization. (2018). *International Classification of Diseases* (11th ed.): World Health Organization.
- Yang, X.-h., Wang, Y., Wang, D.-f., Tian, K., Cheung, E. F. C., Xie, G.-r., & Chan, R. C. K. (2017). White matter microstructural abnormalities and their association with anticipatory anhedonia in depression. *Psychiatry Research: Neuroimaging*, 264, 29-34. doi:<https://doi.org/10.1016/j.psychresns.2017.04.005>

- Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research*, *17*(1), 37-49.
doi:[https://doi.org/10.1016/0022-3956\(82\)90033-4](https://doi.org/10.1016/0022-3956(82)90033-4)
- Yoshida, K., Shimizu, Y., Yoshimoto, J., Takamura, M., Okada, G., Okamoto, Y., Yamawaki, S., & Doya, K. (2017). Prediction of clinical depression scores and detection of changes in whole-brain using resting-state functional MRI data with partial least squares regression. *PLOS ONE*, *12*(7), e0179638.
doi:<https://doi.org/10.1371/journal.pone.0179638>
- Young, K. D., Bellgowan, P. S. F., Bodurka, J., & Drevets, W. C. (2013). Behavioral and neurophysiological correlates of autobiographical memory deficits in patients with depression and individuals at high risk for depression. *JAMA Psychiatry*, *70*(7), 698-708.
doi:<https://doi.org/10.1001/jamapsychiatry.2013.1189>
- Young, K. D., Bellgowan, P. S. F., Bodurka, J., & Drevets, W. C. (2014). Neurophysiological correlates of autobiographical memory deficits in currently and formerly depressed subjects. *Psychological medicine*, *44*(14), 2951-2963.
doi:<https://doi.org/10.1017/S0033291714000464>
- Young, K. D., Siegle, G. J., Zotev, V., Phillips, R., Misaki, M., Yuan, H., Drevets, W. C., & Bodurka, J. (2017). Randomized Clinical Trial of Real-Time fMRI Amygdala Neurofeedback for Major Depressive Disorder: Effects on Symptoms and Autobiographical Memory Recall. *American Journal of Psychiatry*, *174*(8), 748-755.
doi:<https://doi.org/10.1176/appi.ajp.2017.16060637>
- Young, K. D., Zotev, V., Phillips, R., Misaki, M., Yuan, H., Drevets, W. C., & Bodurka, J. (2014). Real-Time fMRI Neurofeedback Training of Amygdala Activity in Patients with Major Depressive Disorder. *PLOS ONE*, *9*(2), e88785.
doi:<https://doi.org/10.1371/journal.pone.0088785>
- Zahodne, L. B., Marsiske, M., Okun, M. S., & Bowers, D. (2012). Components of Depression in Parkinson Disease. *Journal of Geriatric Psychiatry and Neurology*, *25*(3), 131-137.
doi:<https://doi.org/10.1177/0891988712455236>

- Zald, D. H., & Treadway, M. T. (2017). Reward Processing, Neuroeconomics, and Psychopathology. *Annual Review of Clinical Psychology, 13*(1), 471-495. doi:<https://doi.org/10.1146/annurev-clinpsy-032816-044957>
- Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica, 67*(6), 361-370. doi:<https://doi.org/10.1111/j.1600-0447.1983.tb09716.x>
- Zimmerman, M., Martinez, J. H., Young, D., Chelminski, I., & Dalrymple, K. (2013). Severity classification on the Hamilton depression rating scale. *Journal of Affective Disorders, 150*(2), 384-388. doi:<https://doi.org/10.1016/j.jad.2013.04.028>
- Zung, W. W. K. (1965). A Self-Rating Depression Scale. *Archives of General Psychiatry, 12*(1), 63-70. doi:<https://doi.org/10.1001/archpsyc.1965.01720310065008>

Appendix A

Forest Plots

Figure A1-A2. Forest plot of SHAPS total scores under 1-4 scoring. ‘Female’ is the percentage of female participants. ‘Depression’ can range from 0-100, with higher scores indicating greater severity or more symptoms of depression. ‘Anhedonic’ is the percentage of participants who disagreed or strongly disagreed with more than two items on the SHAPS. k is the number of studies. Q is *Cochran’s Q*. T^2 is the estimated between-studies variance. T is the estimated between-studies standard deviation. I^2 is the amount of variation between studies that is due to heterogeneity rather than chance. Black dots and horizontal bars represent SHAPS total scores and 95% CIs, respectively, for individual samples. Black polygons represent the summary SHAPS score and 95% CI. Transparent polygons with black border represent 95% PIs. Gray areas indicate SHAPS scores under 1-4 scoring that a) would be the cut-off if the data was recoded to 0-1 scoring (light gray); b) could either be below or above the cut-off if the data was recoded to 0-1 scoring (medium gray); and c) would be above the cut-off if the data was recoded to 0-1 scoring (dark gray). *Received missing data.

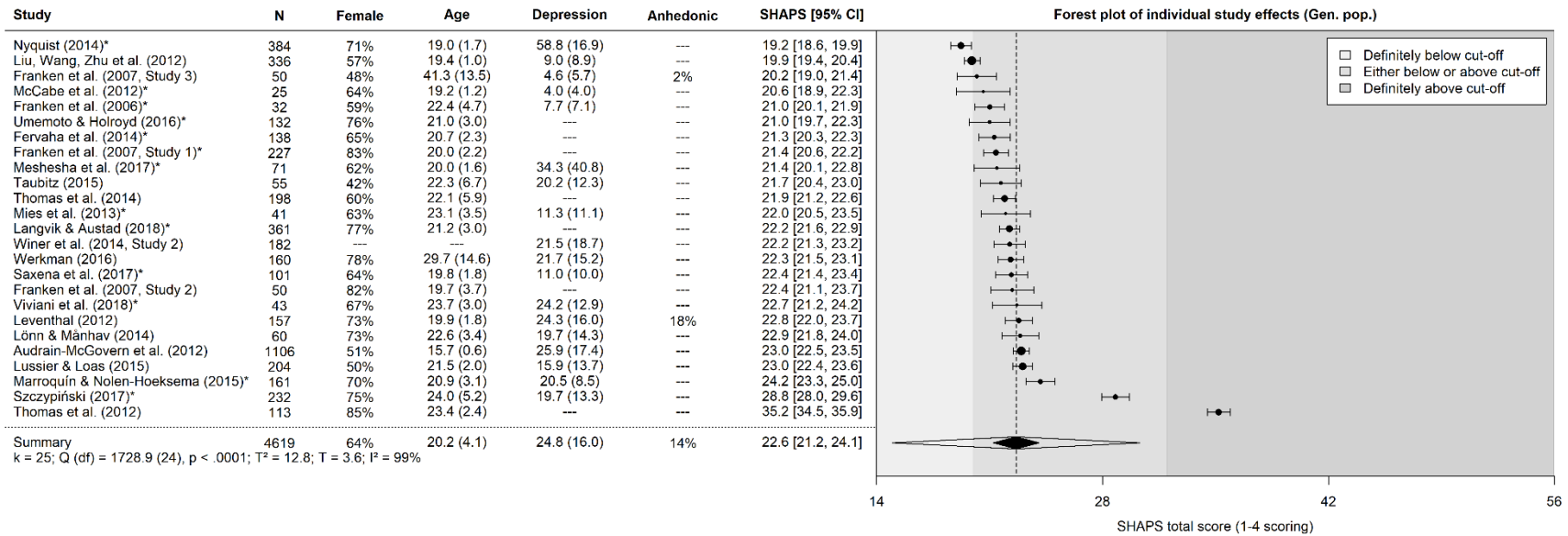


Figure A1. Forest plot of SHAPS scores under 1-4 scoring for samples in the “general population” group. See p. 88 for complete figure information.

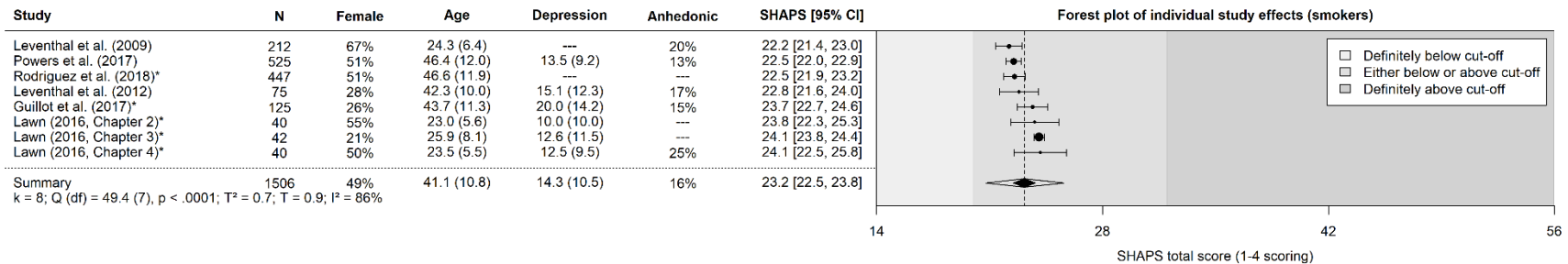


Figure A2. Forest plot of SHAPS scores under 1-4 scoring for samples of smokers. See p. 88 for complete figure information.

Figure A3-A9. Forest plot of SHAPS total scores under 0-1 scoring. 'Female' is the percentage of female participants. 'Medicated' is the number of medicated patients. 'Substance' is the primary substance of abuse. 'Depression' can range from 0-100, with higher scores indicating greater severity or more symptoms of depression. 'Anhedonic' is the percentage of participants who disagreed or strongly disagreed with more than two items on the SHAPS. k is the number of studies. Q is Cochran's Q . T^2 is the estimated between-studies variance. T is the estimated between-studies standard deviation. I^2 is the amount of variation between studies that is due to heterogeneity rather than chance. Black dots and horizontal bars represent SHAPS total scores and 95% CIs, respectively, for individual samples. Black polygons represent the summary SHAPS score and 95% CI. Transparent polygons with black border represent 95% PIs. Gray areas indicate SHAPS scores that are below the cut-off (light gray) and above the cut-off (dark gray) for clinically significant anhedonia.

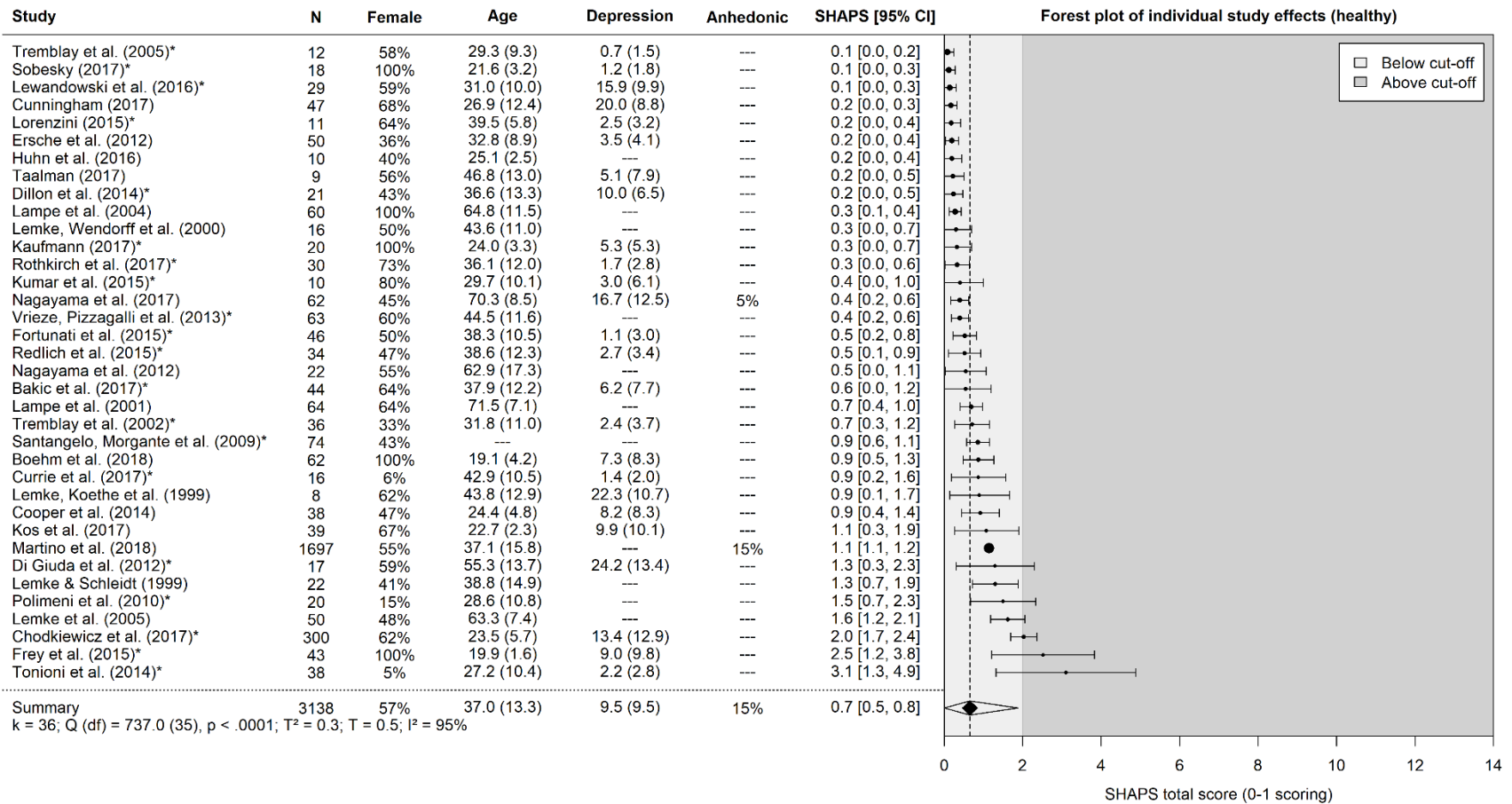


Figure A3. Forest plot of SHAPS scores under 0-1 scoring for healthy samples. See p. 90 for complete figure information.

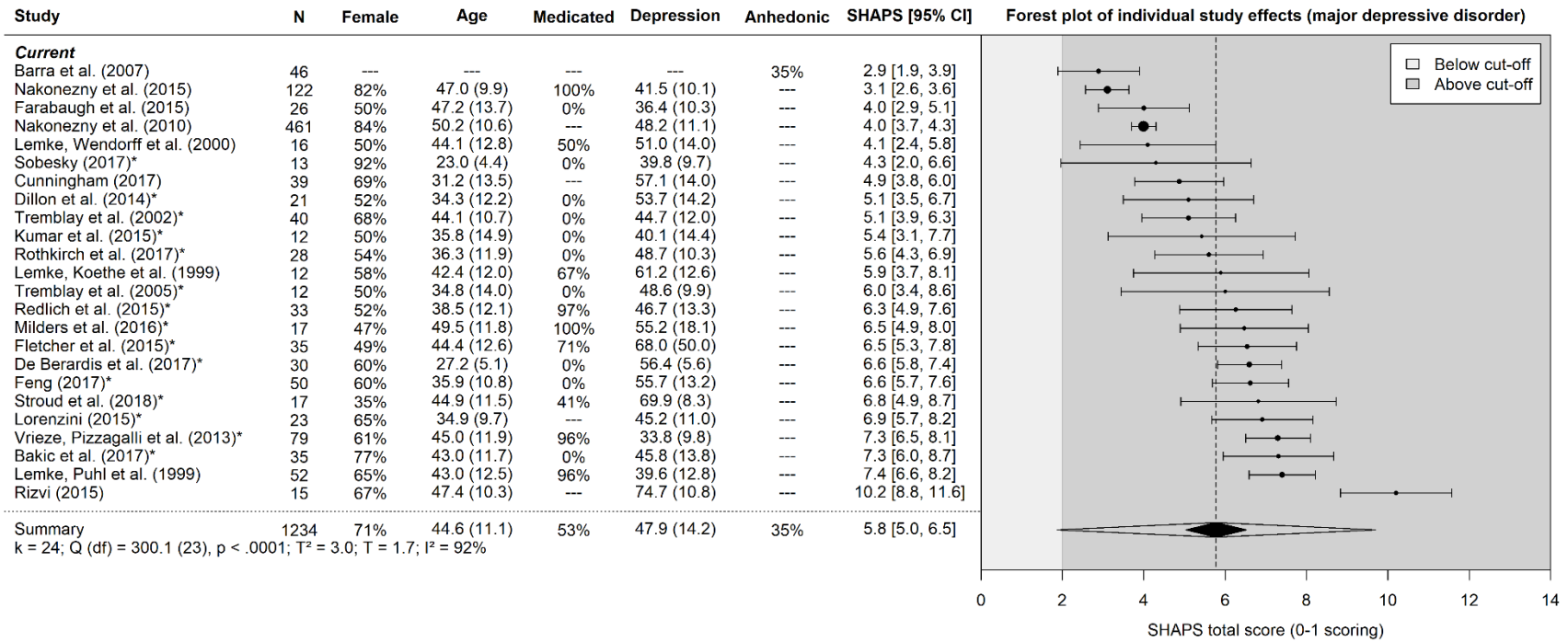


Figure A4. Forest plot of SHAPS scores under 0-1 scoring for samples of patients with current major depressive disorder. See p. 90 for complete figure information.

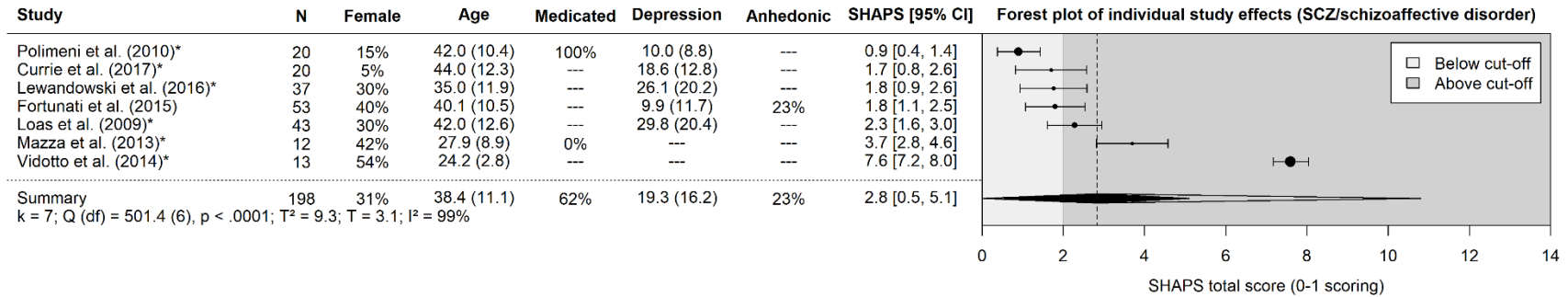


Figure A5. Forest plot of SHAPS scores under 0-1 scoring for samples of patients with schizophrenia or schizoaffective disorder. See p. 90 for complete figure information.

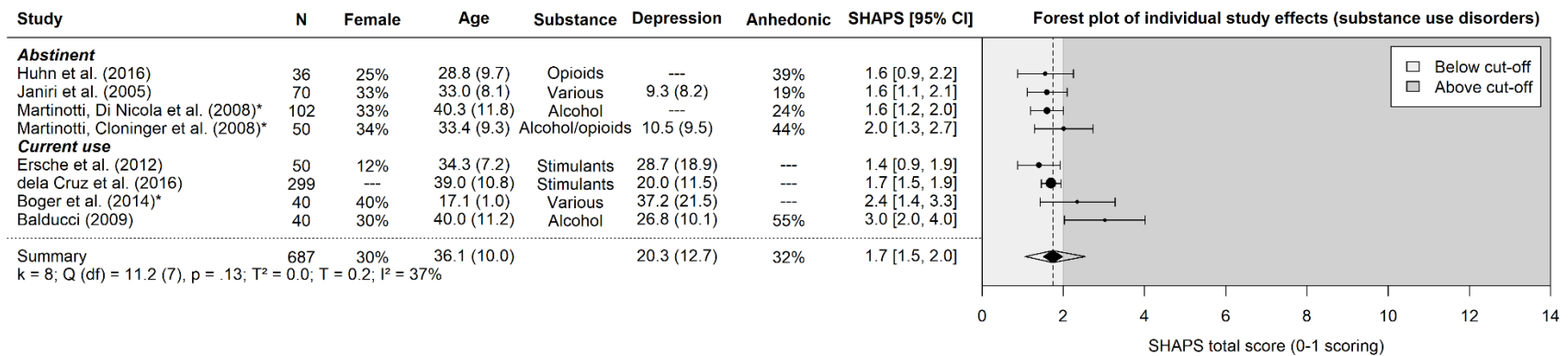


Figure A6. Forest plot of SHAPS scores under 0-1 scoring for samples of patients with substance use disorders. See p. 90 for complete figure information.

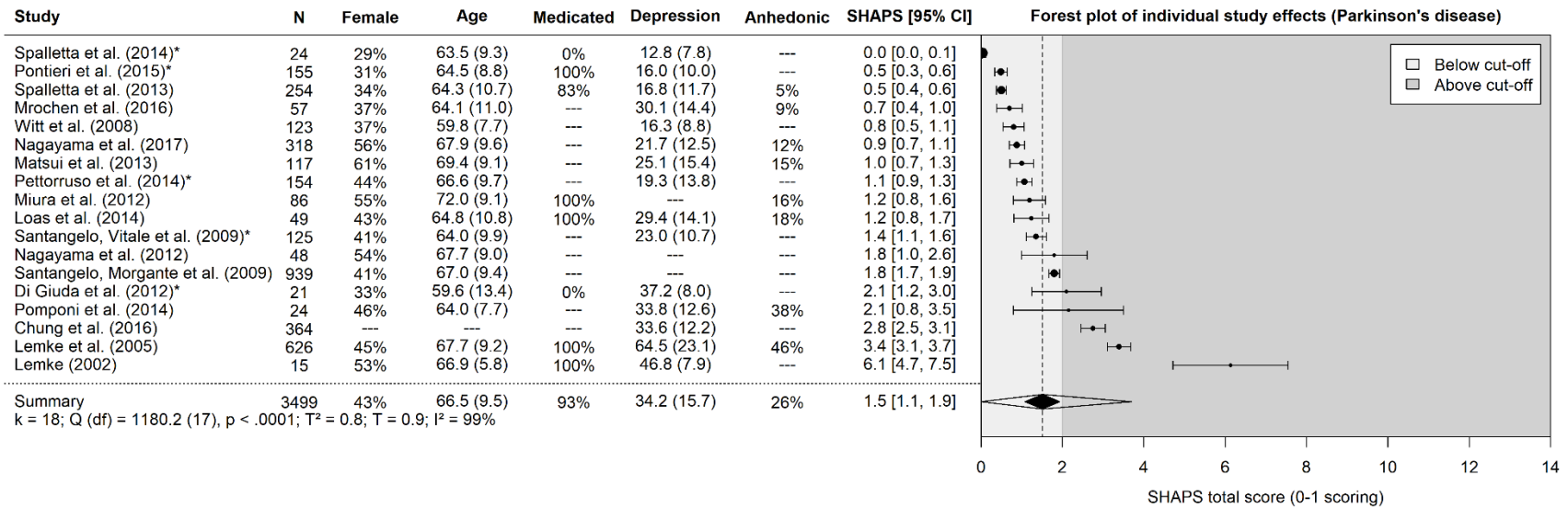


Figure A7. Forest plot of SHAPS scores under 0-1 scoring for samples of patients with Parkinson's disease. See p. 90 for complete figure information.

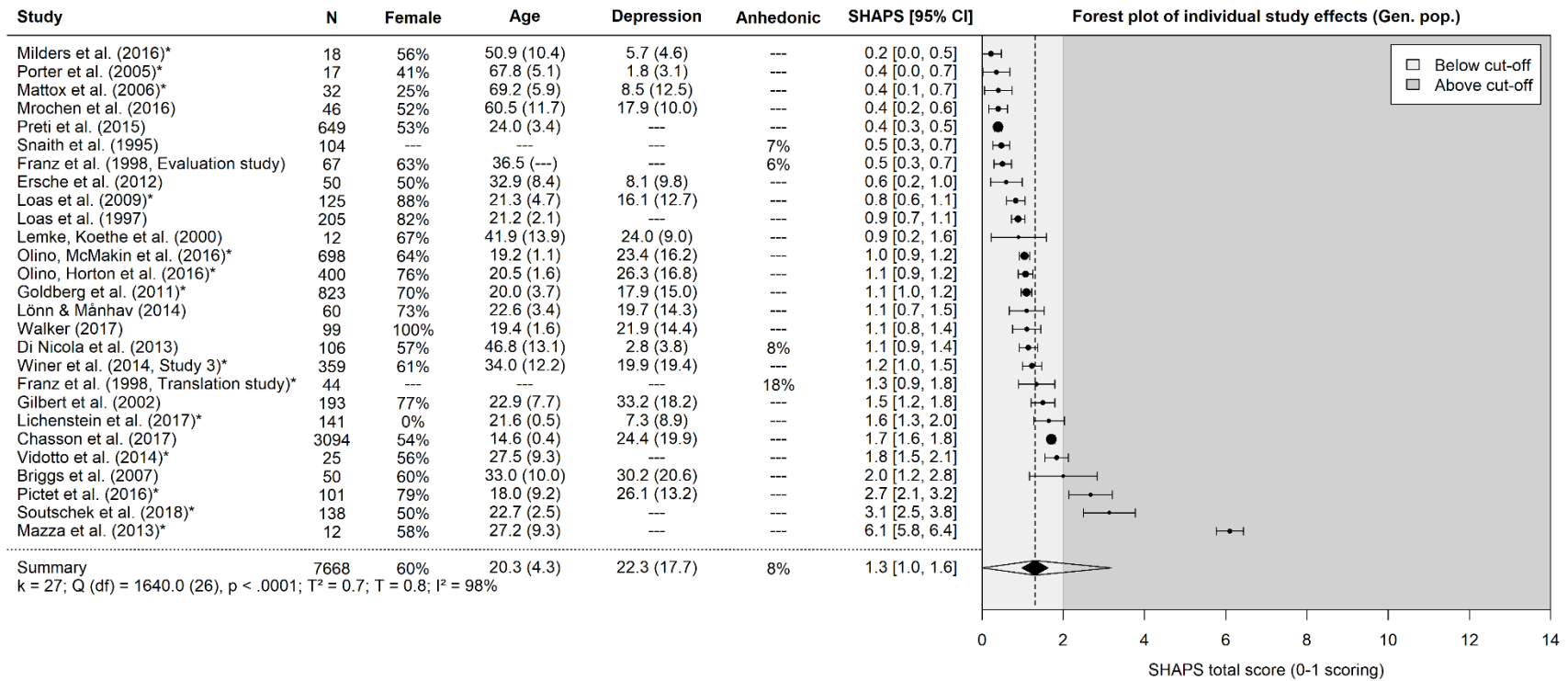


Figure A8. Forest plot of SHAPS scores under 0-1 scoring for samples in the “general population” group. See p. 90 for complete figure information.

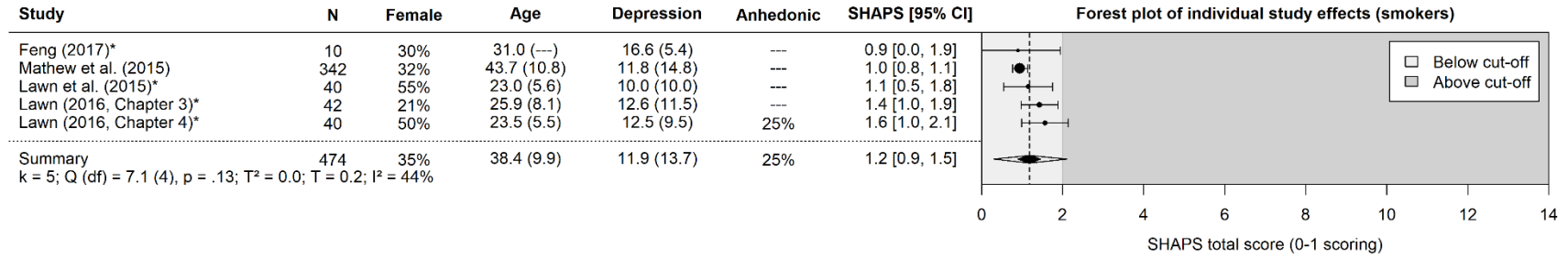


Figure A9. Forest plot of SHAPS scores under 0-1 scoring for samples of smokers. See p. 90 for complete figure information.

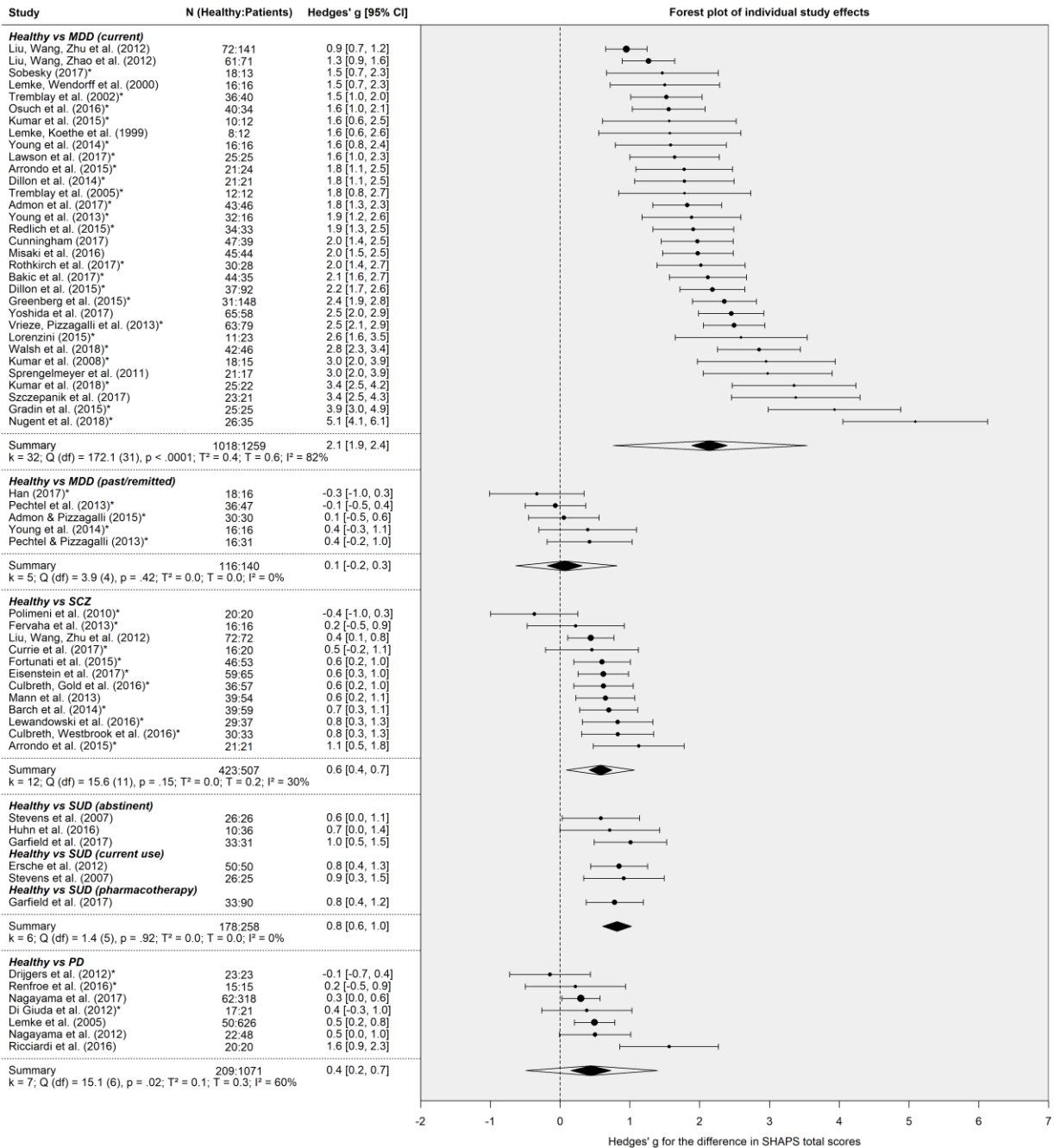


Figure A10. Forest plot of effect sizes of differences in SHAPS scores between healthy and various clinical samples. k is the number of studies. Q is Cochran's Q. T² is the estimated between-studies variance. T is the estimated between-studies standard deviation. I² is the amount of variation between studies that is due to heterogeneity rather than chance. Black dots and horizontal bars represent Hedges' g and 95% CIs, respectively, from individual studies. Black polygons represent the summary Hedges' g and 95% CI. Transparent polygons with black border represent 95% PIs. *Received missing data.

Appendix B
PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Front page
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	III
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1-10
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	10
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	11
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	12-13
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	12
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	12
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	13-15
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	13-15
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	13-15
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	15-16
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	19-20

Section/topic	#	Checklist item	Reported on page #
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	17-21
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA (see pp. 15-16)
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	20-21
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	21-22
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	28-31, 88-97
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA (see pp. 15-16)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	28-31, 88-97
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	27-39
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	24-26
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	39-41
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	41-45
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	45-49
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	49-50
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	50