REVIEW ARTICLE

The Impact of Acupuncture on Self-Perceived Stress and ADHD Core Symptomatology in an Adult, Atomoxetine-taking ADHD Participant. Insights from an In-depth Single Case Study

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Abstract

Background: Attention Deficit Hyperactivity Disorder (ADHD) includes inattention, hyperactivity, and impulsivity as core symptoms and is associated with increased self-perceived stress.

Primary Study Objective: This article evaluates the impact of acupuncture (provided in addition to regular pharmacological treatment with Atomoxetine) on self-perceived stress and ADHD core symptomatology, compared to atomoxetine (ATX) alone.

Methods/Design: In-depth single case study, involving a mixed methods approach with questionnaires and interviews was used. The participant completed two rating scales. Additionally, semi-structured interviews were held. Qualitative data were subjected to content analysis and both sets of data were triangulated.

Setting: Data collection/intervention (treatments) took place at an Acupuncture clinic in Hamburg, Germany, EU.

Participant(s): One adult, atomoxetine-taking ADHD participant.

Intervention: Acupuncture according to Chinese medicine-diagnosis twice/week, over the course of eight weeks, following a pre-defined but flexible point protocol.

Primary Outcome Measures: 1) The Current Symptom Scale (CSS) and the Perceived Stress Scale (PSS). 2) Semi-structured interviews.

Results: Acupuncture treatments in addition to regular ATX intake positively affected the participant's ADHD symptoms (PSS - 31%, total score of the CSS - 47%). There was a considerable decrease in subgroup scores (attention deficit - 39%; functionality impairment - 55%; hyperactivity/impulsivity - 53%; impulsivity - 30%). Post-interventional interviews showed perceived increased self-control, (self-) awareness and centeredness. Combined treatment was perceived as more beneficial than pharmaceutical treatment alone.

Conclusion: Acupuncture treatment appears to have a positive impact on both self-perception of stress and ADHD core symptomatology. Findings were partially congruent with the reviewed research literature but due to limitations/risks of bias (ROBs) associated with the design, no concrete conclusions regarding a potential method-related specificity can be drawn. Further research with larger samples and a more robust design is recommended.

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Introduction

ADHD

Attention Deficit Hyperactivity Disorder (ADHD) is defined by inattention, hyperactivity, and impulsivity.[1] 8-12% of children worldwide are affected,[2,3] and about 65% of those show symptoms into adulthood,[4] where the prevalence is 2.5-4.9%.[4] Three subtypes with different specifications of core symptoms are described: the inattentive, the hyperactive/impulsive, and the combined subtype.[5] The disorder severely impacts the patient's cognitive and behavioural state as well as their social and professional lives.[6,7] Common occurrences are sleep deficit,[8,9] decreased impulse inhibition,[10] higher rates of delinquent behaviour and substance addiction[11] as well as higher levels of self-perceived stress[12] and an increased risk of chronic stress.[13]

Several studies show potentially specific neurobiological peculiarities in people assumed to have ADHD personalities, e.g. an increased density of dopamine-transporters in the striatum, or morphological anomalies in terms of a decreased volume of the frontal lobe, the corpus callosum, or the cerebellum.[14,15] Hence, its aetiology is still not completely understood.[16]

The influence of genetic impact has been explored and remains controversial.[17] Diverse psychological,

e.g. psychoanalytical, approaches to understanding this multifaceted syndrome have been developed.[18]

ADHD individuals are still commonly perceived as 'mentally disordered',[19] which has been questioned.[20] Increasingly, ADHD-associated characteristics may be considered in the context of neurogenetic diversity[20] that is not pathological or disadvantageous *per se*.[21] ADHD is commonly treated with pharmacological stimulants such as methylphenidate (MPH), dexamphetamine sulphates, or atomoxetine hydrochloride (ATX). Atomoxetine as a noradrenaline re-uptake inhibitor (NARI), is a widely used pharmaceutical; its effectiveness is well-documented.[22] Besides the pharmacotherapeutic approach, diverse psychotherapeutic and psychosocial methods also are widely established.[23,24] Certain risks and adverse effects of pharmacological treatments have been documented,[25] and there is little research on potential long-term risks.[26]

Patients therefore often seek additional or alternative therapeutic treatment within the wide spectrum of complementary and alternative medicine (CAM), including acupuncture as a Chinese medicine-based treatment method. Evaluating the prevalence of use, the referral patterns, and the perceived benefit of alternative therapies in children, Australian researchers found that up to 64% of child and adolescent ADHD patients received at least adjuvant or temporary CAM treatments.[27] Across subpopulations, an international evaluation revealed that the worldwide use of CAM ranges between 7.5 and 67%.[28] This raises the question of whether ADHD patients may benefit from Chinese medicine-based acupuncture.

Acupuncture

Acupuncture involves the insertion of single-use sterile needles into specific points on the body. In Chinese medicine, acupuncture is applied according to a particular Chinese medicine-specific diagnosis to address a particular disease or health imbalance.

Biomedical research has revealed some mechanisms of action, such as the activation of the endorphinergic system[29,30] and activation of descending inhibition due to needle-related stimulus, which was found to induce an inhibitive effect on afferent pain signals.[31]

An anti-inflammatory effect due to the activation of vaso-active neuropeptides has also been detected.[32] Stimulation of motor end plates appears to release muscular trigger points.[33] Moreover, systematic effects on the endocrine system and immune-modulative effects,[34] as well as stimulation of neuropeptide-related gene expression, have been postulated.[35]

The initiation of purinergic signalling,[36] a system that utilises adenosine triphosphate (ATP) and adenosine within the regulation or signalling of all organ systems and all systems in the human body also appears to be relevant.[37]

The unique diagnostic approach of Chinese medicine categorises both assumed causalities and symptomatic complaints associated with ADHD into individually diagnosed patterns requiring a pattern-associated, individualised treatment. Recent findings[38,39] may be described as promising.

Stress

Stress is an important warning to the body when facing potential dangers or challenges.[40] Generally, it can be regarded as a cognitive-emotional condition resulting from an individual's perceived difficulties in adjusting to life events.[41] When exposed to stressors, individuals experience behavioural, cognitive, and physiological reactions that induce coping activities. Constructs of stress are subjective[41]; its appraisal may be positively or negatively associated and vary widely in its physiological manifestation.[41] Elevated levels of chronic stress have been associated with an increased risk of cardiovascular diseases,[40] increased infection-susceptibility,[42] accelerated aging,[43] overeating and obesity,[44] and a decreased efficiency of overall immune functionality.[45] Since ADHD-diagnosed people were found to experience higher levels of stress, this particular aspect of the syndrome appears highly relevant.[46] The evaluation of self-perceived stress may reveal information not detectable by investigator-based observation.[47] An established questionnaire for the evaluation of self-perceived stress is the Self-perceived Stress Scale (PSS), a ten-item rating scale[48] used as a key measurement in the research project.

Methods

Ethical Statement

Ethical approval was granted by the Northern College of Acupuncture Research Ethics Committee in August 2018. Written informed consent was obtained from participant(s) prior to the beginning of the study.

PICO Scheme

Below, relevant aspects of the methodology are briefly outlined according to the PICO scheme[49]:

Population: One adult ADHD-diagnosed participant, taking atomoxetine (ATX) regularly. Comorbidities that commonly may occur in ADHD persons since they are over-represented within ADHD populations[6,7] were accepted to occur as long as it did not exceed a certain level, in order to avoid potential bias that may have affected the investigated variables. Referring to ICD-10 terminology,[50] this would include, e.g., depressive disorders whose severity did not exceed a level of 'mild'/F32.0 (resp. F33.0/F41.2).

Intervention: Acupuncture according to Chinese medicine diagnosis, provided in addition to the participant`s regular intake of Atomoxetine. Twice per week for a duration of eight weeks (16 treatments in total). A set of 6-8 regular acupuncture points was defined. A selection of these points was applied at each treatment; point combinations could slightly

vary between treatments since Chinese medicine requires adjusting treatment protocols to the patient's current condition.[51] Body acupuncture was applied according to Chinese medicine pattern diagnoses.[52] *Deqi*, a specific sensation emerging shortly after needle insertion, has been sought. Needles were 0.25 × 25mm sterile single-use (Cloud & Dragon Medical Device Co., Ltd, China), with a retention time of approximately 30 minutes per session. Acupuncture was provided by the author-researcher-practitioner who at the time of the study had more than ten years of clinical experience as an acupuncturist and Chinese medicine practitioner.

Comparison: Acupuncture along with ATX and only ATX.

Outcome: Two questionnaires, applied once during the participant's usual ATX-intake (prior to the beginning of the intervention phase), two times during/at the end of the intervention phase (after weeks 3, 6, and 8), and two times after completion (after 4 and 8 weeks, described as 'follow-ups') using:

- The Perceived Stress Scale (PSS)[48]
- The Current Symptom Scale Self-Report (CSS)[53]

In addition, semi-structured interviews were held twice (once during the usual ATX intake phase prior to, and once at the end of the intervention phase).

Case Characteristics

The recruited participant was male, in his late forties, ADHD-diagnosed in his childhood, and his particular manifestation of ADHD was the 'combined subtype'. Comorbidities were mild depression and a mild anxiety disorder which frequently occur in the investigated population.[6,7]

Recruitment

One participant was recruited from a shared clinic in which the author worked (see Setting). The participant was required not to have received any previous acupuncture treatment for ADHD. The participant was contacted by letter, along with a participant information sheet and an informed consent form.

Data Analysis

Qualitative Data Analysis. Both interviews were transcribed, translated into English, and underwent content analysis using elements of the combined deductive/inductive approach according to Schultz.[54] Since no underlying theory or theory-based hypothesis was postulated in this research project, the term 'inductive' may be considered according to the 'bottom to top' approach (Observations – Patterns – Broader Generalisation/ Tentative Hypothesis – Theory).[54] Regarding the post-intervention interview, both inductive and deductive/'top down' approach (Theory/Specific Framework – Hypothesis – Observation – Confirmation or Rejection) elements[54] were applied to assign data segments to the categorised main themes of the pre-intervention interview.

Quantitative Data Analysis. All data from questionnaires were analysed with the programme 'Analyze Everything' (AE). All non-numeric data were handled as classes and, if possible, clustered into groups. Since the CSS is divided into three distinct sections that address four areas, items were grouped accordingly.

Class comparisons were graphically illustrated through bar charts. Due to the low number of data points, no analysis of the data collected in the context of the present project can reach significance.[55] When discussing the findings derived from the quantitative arm of data collection, the small amount of available data due to the single case study design must be considered. In particular, there was only one pre-intervention data collection point: any comparison with data collected during the intervention or post-intervention refers to this single measurement value only.

Triangulation. A triangulation protocol was applied to combine both methods' findings according to Farmer et al.[56] It included *convergence coding* and an overview regarding the convergence of the diverse themes. The data were analysed for levels of agreement, partial agreement, or silence regarding its theme meaning and prominence, and data collection method-related coverage/examples. The results of the outlined process were assessed for the extent of convergence. Finally, a completeness comparison was carried out.

Setting

Both data collection and intervention (treatments) took place at an acupuncture clinic (Praxis im Gaengeviertel) in Hamburg, Germany.

Results

Qualitative Results

The content analysis of the interviews revealed 10 main themes - 7 before, and 3 during/after the intervention phase. Main themes 1-7 first were inductively identified by analysing the pre-intervention interview. They were then deductively double-checked for their occurrence in the post-intervention interview.

Main theme 1: Current Complaints/Symptoms (including non-specific)
Main Theme 2: Paramount ADHD-core symptomatology – changes over the course of life?
Main theme 3: Resilience & beneficial factors/awareness-process
Main theme 4: Stress-Perception: Triggers & Causal/ Symptomatic Factors (including Frequency)
Main theme 5: Burden
Main theme 6: ATX-Intake: Impact then & now; currently beneficial?
Main theme 7: Additional bodily phenomena/symptoms

Main themes 8-10 only emerged in the post-intervention interview since they addressed themes regarding the received therapeutic intervention that were not addressed within the first/pre-intervention interview but arose over the course of intervention:

Main theme 8: Increased • Self- Control; • (Self-) Awareness; (Self-) Efficacy; • Centeredness; • Ability to focus
Main theme 9: Treatment-associated Changes (including non-specific) & treatment-experiences positively associated
Main theme 10: (Acupuncture)-Treatment-associated:
- Decreased inner tension
- Positively impacted hyperactivity (in terms of perceiving reduced hyperactivity)

Main themes 8-10 are outlined in more detail below:

Post-intervention, the participant still showed hyperactivity-associated restlessness but at the same time, increased (self-) awareness and strengthened self-control (main theme 8) were repeatedly associated with the acupuncture treatments. Increased centeredness, as well as an enhanced ability to focus, were reported to have positively affected his hyperactivity/restlessness, inner tension, and attention-deficit.

The participant's coping- and self-management-abilities were stated to have increased:

> (…) Despite everything (…), for me that goes along with my ability to focus. Because when I'm hyperactive, I can just barely focus (…). Positively. It had a positive impact [on that]. So, as mentioned before, CENTEREDNESS, a bit, IN CERTAIN MOMENTS MORE more FOCUSSED in certain moments, AS WELL, which is not always easy for me, but (…). Exactly, positive. #00:20:25 – 50#

Treatment-associated changes as well as treatment experiences (main theme 9), including perceptions *during* the treatments, were overall positively assessed. The perception that "something just changed" occurred at the beginning of the intervention phase.

During the original treatment sessions, intense psycho-emotional perceptions were reported.

Compared to the established ATX-only therapy, the additional acupuncture was stated to "make a positive difference", and to "have positively affected" his life:

> (…) Since I had this, this positive perception regarding the treatment, I had that (…) quite quickly. That happened (…) after the first treatment already. If it was directly after, unfortunately I just don't know, anymore, if it was immediately after the treatment, or (…) if it then occurred during the course of the day, the course of the evening, or the next day. But it's a fact that I (…) noticed it quite quickly. Thus (…), there's a positive effect. #00:15:08 – 38#

Acupuncture treatments were also perceived to have reduced hyperactivity. They were further perceived to have led to a decreased frequency and duration of states of inner tension (main theme 10). Moreover, they were associated with improved coping abilities, as well as increased self-control and ability to focus.

Replying to the question to what degree the treatment affected their inner tension, the participant responded:

> Positively. (…) So I did notice during the treatment that something's happening. Be it physical, be it, regarding my tension. (…) It yet gave me, I would say it just, just, definitely gave me more tranquillity, in any case (…). #00:09:12 – 20#

Quantitative Results

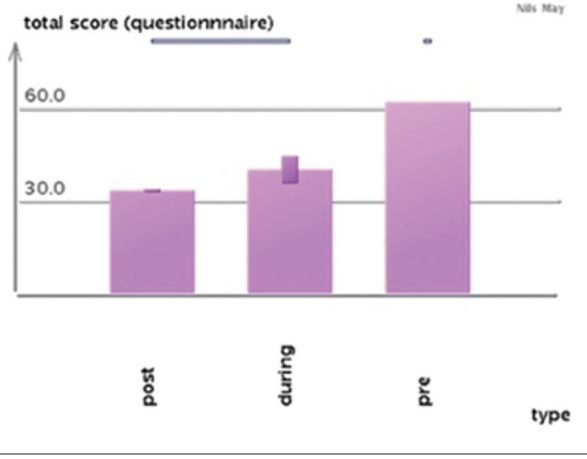
Findings Of The Analysis Of The CSS.

Total Score of the CSS. A 35% reduction of the CSS total score was detected between the values taken pre-intervention and those taken during the intervention phases. A further reduction of 17% was found between measurements taken during the intervention and post-intervention. A total reduction of 47% was detected between measurements taken pre-intervention and post-intervention (see Figure 1).

From the class comparison in the bar 'during (the intervention)', a recognisable standard deviation can be seen.

Total Score of the Subgroup 'Attention Deficit-Related Behaviour'. A 30% reduction was detected between measurements taken pre-intervention and during the intervention; a further reduction of 12% was detected between the values recorded during the intervention and those taken post-intervention. Values obtained during the intervention phase were found to present a recognisable standard deviation, while post-intervention measurement values showed no such deviation. A total reduction of 39% was detected between pre-intervention to post-intervention measurements.

Figure 1. Total Score Current Symptom Rating Scale Self-Report (CSS).



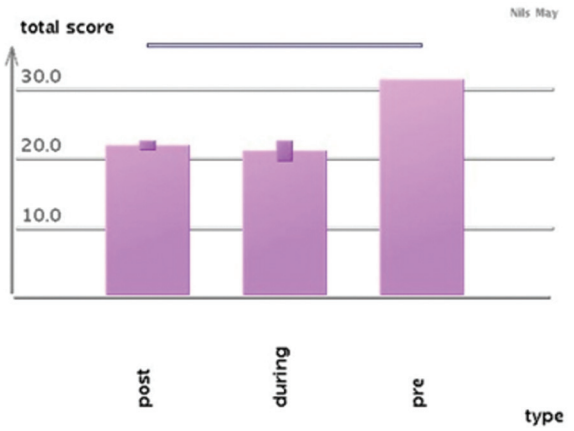
Total Score of the Subgroup 'Function' **.**Values taken during the intervention showed a reduction of 40%, compared to those taken pre-intervention. A recognisable standard deviation was presented as well. Post-intervention values were even smaller. A total reduction of 55% from pre-interventional to post-intervention measurement was detected.

Total Score of the Subgroup 'Hyperactive/Impulsive Behaviour'. A reduction of 33% was obtained in values taken during the intervention, compared to those taken pre-intervention. They also showed a significant standard deviation. Post-intervention values were even smaller. A total reduction of 53% was detected between values obtained from pre-intervention to post-intervention measurement values.

Total Score of the Subgroup 'Impulsivity'. A total reduction of 30% from pre-intervention to post-intervention measurement values was detected. Values taken during the intervention showed a certain standard deviation. However, this deviation was so small that both the values taken during the intervention and those taken post-intervention measurement can be considered almost constant.

Findings of the Analysis of the PSS. A total reduction of 31% was detected between values obtained from pre-interventional to post-interventional measurement (see Figure 2). Only a marginal standard deviation is obtained for the values taken during the intervention and those taken post-intervention, and hence this data can be considered constant.

Figure 2. Self-Perceived Stress Self-Report Rating Scale (PSS) Total Score: Class Comparison.



Discussion

ADHD Core-Symptomatology

According to the (both qualitative and quantitative) sources of data, the severity of the participant`s symptomatology considerably decreased over the course of the intervention phase.

Assessing these results in the context of previous research appears challenging: Envisioning the results of at least one of two reviewed systematic reviews, the meta-analysis of two RCTs showed a significant effect of acupuncture combined with conventional pharmaco-therapy. Lee et al.[57] concluded there was limited evidence for the effectiveness of acupuncture as a symptomatic treatment for ADHD, although a high risk of bias in the underlying primary data was reported, which prevents firm conclusions.

The other systematic review by Li et al.[58] applied inclusion and exclusion criteria according to the Cochrane standard, however, could not find even tentative evidence for the effectiveness of acupuncture in the treatment of ADHD, while the third reviewed paper (a consensus paper) by Ni et al.[59] mentioned that the majority of studies on acupuncture in the treatment of ADHD were still case reports. Some bigger clinical studies were reported to have demonstrated the effectiveness of acupuncture or combined therapy, but at the same time, methodological shortcomings and limitations of those papers were admitted.

Findings of the present study regarding the impact of acupuncture on ADHD core symptomatology thus partially appear congruent with the reviewed previous research findings but need to be considered within this project's methodological limitations (see section 'Limitations and Risks of Bias' below).

Self-Perceived Stress

Analysis of the quantifiable answers to the stress-related items asked by the PSS, as well as the participant's stress perception-related observations in the qualitative interviews demonstrated a decrease in perceived stress.

Unfortunately, no literature that addressed the potential impact of an acupuncture intervention on the variable 'self-perceived stress' was available. The absence of published literature in this area means that the current study cannot compare its findings with those of the extant literature.

Although the PSS total score between pre-intervention and post-intervention decreased by 31%, there was no standard deviation that allowed for concrete conclusions. It could be argued that without a statistically relevant effect, no remarkable impact on 'self-perceived stress' occurred. The participant's statements in the pre-intervention interview related a burdensome intensity and frequency of stress. The participant did not describe a post-intervention decline in stressful situations, nor a significantly decreased intensity of stress.

However, treatments were reportedly associated with a "positive effect". Although stress had not disappeared, the participant managed to overcome stressful situations faster post-intervention. He stated that either "his perception was altered", or that he "could get out of difficult situations faster". Inner tension was reported to have occurred less and for shorter periods of time.

The intervention was associated with an increased self-control (self-) awareness and centeredness, and an

enhanced ability to focus. Post-intervention, his stress perception was reported as less burdensome since his 'perception of powerlessness' had decreased while his self-efficacy had simultaneously increased.

This improvement may have been associated with other unknown variables unrelated to the intervention. In the course of the post-intervention interview, the participant reported that he already noticed a positive change in his condition after the second or third treatment, but then he further specified he retrospectively identified the onset of these changes already after the first treatment. When asked about the duration of such changes, the participant declined to speak on "particulars", but said that he "just could say" that "it all had a positive impact" on him, and that "something was changing in a positive sense".

Although these considerations were inherently subjective, it can be argued that the perception of early onset of changes may indirectly be responsible for the absence of statistical proof of a possible interdependence between the investigated variable 'self-perceived stress', and the *course* of the intervention.

The Chinese Medicine Perspective

Data analysis revealed that the participant positively assessed the acupuncture treatments and that he gained considerable relief from the stress-associated, as well as inattention- and hyperactivity-related complaints, which he clearly associated with the received intervention. While the frequency of stress did not decrease, the participant`s ability to control it, as well as his centeredness, his self-awareness, his ability to focus, and his self-efficacy were reported to have increased.

From a Chinese medicine perspective, this appears consequential since, according to Chinese medicine theory, some of the applied acupuncture points (e.g. Sanyinjiao/Spleen 6) are said to strengthen the organ system related to the Chinese concept of the 'spleen' that is associated with the '*zhongqi*'/'the qi of the centre', which in turn is associated with an individual's 'centeredness' and ability to focus. Another point of the applied protocol (Taichong/Liver 3) is thought to have a regulating effect on the aforementioned organ system related to the Chinese medicine concept of the 'liver', which is associated with an individual's ability to handle stressful experiences.[52] If 'blocked' or 'depressed', the 'liver' tends to suppress the aforementioned organ system referred to as 'spleen'.[52] The pattern arising from this then is termed 'Liver attacks Spleen', which corresponds with the symptomatology of the *combined type* ADHD manifestation.

While these aspects cannot be explored within the scope of the present project, such explanatory models regarding the possible stress-related effect of acupuncture could present starting points for future biomedical investigation.

Placebo

In addition to the below-mentioned biases (see Limitation and Bias), an additional placebo effect may have played a certain role. Placebo effects have been demonstrated in many therapeutic interventions, including a wide range of pharmaceutical applications.[60] Since placebo responses are based on learning, anxiety reduction, or activation of the reward system, they are associated with neuro-biological activity and are sometimes found to be as powerful as well-proven pharmaceutical interventions.[60] Although several trials have found acupuncture superior to placebo, and verum acupuncture to have divergent effects compared to sham needling which sometimes is referred to as a kind of 'placebo needling'[61,62] (although sham acupuncture is reported to provoke clearly measurable physiological effects that are distinct of those of a placebo),[63] a proportional placebo effect cannot be ruled out to have played a certain role in the present study.

Limitations and Bias

Several possible limitations and biases need to be considered: Limitations are inherent in the single case study design and the single pre-intervention data collection. A risk of interviewer bias and respondent bias (social desirability bias; friendliness bias) is inherent in interview methodology.[64]

Moreover, the risk of language-related bias,[65] a pre-existing therapeutic relationship, the modalities of metric data collection, as well as the fact that the author, researcher, and intervention-providing practitioner were the same person, may have biased the outcome. Furthermore, unidentified confounding factors, as pointed out in 'Quantitative data-related observations', may have impacted the measured variables[65] associated with the participant's perception.

The application of a mixed methods approach, a comprehensive transparent study report, and a triangulation exercise partially compensated these inherent weaknesses to enhance the study's construct validity[66] to make it potentially replicable. The precisely outlined triangulation found that both data sources addressed the entirety of the research question.

According to Dick,[67] such techniques can reduce the subjectivity inherent in the case study method. Therefore, 'a chain of evidence' may be observed from the onset of the research question throughout the course of the project to the final conclusions.[68]

Qualitative Data-Related Observations

The comprehensive analysis of the interviews provided extensive insights in the participant's condition. He was found to have distinct introspection skills and, although very unstructured in his self-expression, gave very differentiated replies to questions. Emotional uncontrollability (reported to have increased over time during the pre-intervention phase), restlessness, and

increased forgetfulness were described as the most challenging. 'Restlessness' appeared to be the participant's individual term for the 'professional term' 'hyperactivity'.

Furthermore, a pronounced anxiety was stated. The fact that his complaints were "changing all of a sudden", was perceived as very burdensome, and in turn, intensified his anxiety. Moreover, a continued, chronic inner loneliness and lack of consistency appeared as seriously challenging.

These findings illustrated difficulties regarding the clear ability to link symptoms to either the investigated subject (ADHD), or the participant's simultaneously existing comorbidities respectively. However, stress was found to be a key issue, congruent with the findings of previous research.

Quantitative Data-Related Observations

The analysis of both questionnaires showed differences between pre-intervention data and values taken during the intervention phase and post-intervention. All total scores and subgroup scores showed a recognisable improvement. As outlined above (Data analysis section), the low number of data points implies that no analysis of the data collected in the context of the present project can reach significance.[69] The small amount of available data due to the single case study design must therefore be considered in any discussion of the results. In particular, since there was only one pre-intervention data collection point, any comparison with data collected during the intervention or post-intervention refers to this single measurement value only. Thus, it remains unclear which variables might have potentially influenced the pre-intervention outcome. For these reasons, any subjectively perceived improvements with the investigated intervention remain tentative. Nevertheless, changes in the measurement values occurred over time during the treatment course, and might thus be associated with the applied intervention.

Specificity

Can observed changes in the investigated parameters justifiably be linked to the given treatment? Due to the design-associated limitations and ROBs as discussed above, no satisfactory answer can be given. Partially remarkable trends were observed in the quantitative data. As outlined above, they partially allowed the detection of a process of change that may have been associated with the given intervention but require further, larger studies that may allow evaluation for a potentially provable statistical significance. Specificity in acupuncture research is a general challenge: as outlined by Langevin et al.[70] In acupuncture treatments, three areas and their respective intersections come into effect: needling-related aspects (style, theory, needling parameters, number of sessions, and duration of sessions), specific non-needling aspects (psychological, patient history, diagnosis, explanations, lifestyle advice; physiological aspects such as palpation and tonus), and non-specific aspects (time, attention, empathy, credibility, patient expectations, and practitioner expectations).

Considering all aspects of the three outlined areas within a rigorous design, while also trying to isolate the purely needle-related aspects for analysis, makes the evaluation of the effectiveness of acupuncture intervention truly challenging.

External Validity And Construct Validity

Since an in-depth single case study design was applied, the results are not generalisable, and assessment of external validity is not applicable.[66,71] However, construct validity still warrants examination, since it addresses whether sufficient operational measurement methods for the investigated topic have been applied.[55,72] A structured interviewing guide supported a systematic interview process.[68] In combination with a structured transcription process and analysis of the data, this reduced the inherent subjectivity of a (single) case study.[67,73]

Triangulation of findings, as conducted in the present study, was found to substantiate hypothetical constructs that may assist the potential generalisability of findings gained by case study research.[74]

Conclusion

This article examined an in-depth single case study with a mixed-methods design which investigated to what extent acupuncture impacts self-perceived stress and ADHD core symptomatology in an adult, atomoxetine-taking ADHD participant.

The application of a mixed methods approach, a comprehensive transparent study report, and triangulation of qualitative with quantitative data partially compensated for the inherent design-related weaknesses and enhanced the study's construct validity[66] making it potentially replicable.

Both sources of data collection revealed recognisable alterations regarding both parts of the research question. According to the PSS, the participant's extent of self-perceived stress notably decreased (by 31%). The interviews suggested that while the number or intensity of stressful experiences did not decrease, the participant did perceive increased (self-) awareness, improved centeredness, the increased ability to focus, and enhanced self-efficacy that enabled him to overcome stressful experiences more quickly. It was further reported that he perceived the combined therapy as more successful than the pharmacological therapy alone.

The total score of the CSS (i.e., the extent of the ADHD core symptomatology) decreased by 47% between pre- and post-interventional measurements. The subgroup score measuring the extent of the participant's attention-deficit-related behaviour decreased by 39%, the score addressing the extent of impairment of the participant's functionality in various areas of life decreased by 55%, and the score addressing the extent of his hyperactive/impulsive behaviour decreased by 53%.

Considering the limitations of the small amount of data due to the design, these four measurement values were still compelling since a sufficient standard deviation was detected regarding those measurement points taken *during* the intervention phase, which allowed for the detection of a process of change.

Although mathematically not demonstrable, this process may have been associated with the intervention. An irrefutable weakness of the study was that due to the low amount of data, no analysis of the data collected could reach statistical significance.

The post-intervention interview revealed that acupuncture treatments were stated to have positively affected the participant's hyperactivity (in terms of reduced hyperactivity), his states of inner tension, as well as his attention deficit. Compared to the treatment with ATX only, the combined therapy was perceived as more successful. The participant reportedly assessed the acupuncture treatments as beneficial and noted that they had "positively impacted his life". Recognisable changes were perceived from the beginning of the intervention phase.

The present study is a first step towards closing the gap in the literature review regarding the possible impact of acupuncture on the perception of stress. Insights were gained regarding a potentially positive impact of acupuncture on the perception of stress and the modalities of dealing with stressful experiences through increased self-control, centeredness and an enhanced ability to focus. Regarding the potential impact of the acupuncture-based intervention on the severity of ADHD core symptomatology, strong findings were made.

Nevertheless, due to various risks of bias and other limitations associated with the design, no concrete conclusions can be drawn regarding the question to what extent the detected changes in both the participant's stress-perception and his ADHD core symptomatology may be specifically associated with the method acupuncture. This critical objection should be considered in future investigations in the field.

However, the findings of the present study can be considered as promising. Further research with a more robust design that avoids the shortcomings and limitations of the present project, therefore, appears well-justified and highly recommended.

Authors' Contribution

Nils May: Conceptualisation, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, and Funding acquisition. Dr. Ashley Bennett: Supervision.

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Declaration of Competing Interests

The authors would like to declare that there is no issue related to competing interests for this study.

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Data Availability

The participant of this study did not agree for their data to be shared publicly, therefore, supporting data is not made available.

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