

Budo on the Spectrum

Self-Reported Benefits of Autistic Adults Engaged in Japanese Martial Arts: A Mixed-Methods Exploration

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Abstract

Japanese martial arts (budo) offer structured, repetitive, and highly disciplined training environments that may be particularly beneficial for autistic individuals. Using a mixed-methods approach, this study explores the self-reported experiences of 81 autistic budo practitioners (ages 18-57) who completed structured questionnaires on sensory processing, emotional regulation, and social interaction, supplemented by semi-structured interviews exploring their lived experiences in martial arts training. This study focused exclusively on adults aged 18-57. Results showed that 85% of participants reported improved proprioception, 84% found structured social hierarchies helpful, and 90% experienced increased self-confidence. Self-reported benefits are interpreted through neurophysiological frameworks, with improvements in motor coordination, sensory processing, emotional regulation, and social interaction suggesting potential engagement of cerebellar, proprioceptive, and limbic systems that align with known neurological characteristics of autism. Findings indicate that structured social hierarchies provide clarity for social navigation, while repetitive movement patterns support sensory regulation. Insights from this research support the development of neurodiversity-friendly martial arts programmes, incorporating sensory accommodations, clear communication strategies, and structured partner exercises. Future research should investigate these interpreted mechanisms through direct neuroimaging studies, such as fMRI, to empirically examine the impact of budo on sensorimotor and social brain networks in autistic practitioners.

Autism, Neurodiversity, Sensorimotor Integration, Emotional Regulation, Social Cognition, Martial Arts

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1 Autism

Autism is a neurocognitive variation that reflects natural diversity in human brain function, rather than a deficit to be corrected (Mussies, 2023). From the perspective of the neurodiversity paradigm (Kapp, 2020), autism is best understood as a distinct cognitive and sensory processing style, characterised by differences in perception, communication, and interaction with the environment (Dwyer, 2022). Autistic individuals often exhibit heightened sensory awareness, deep focus, and a preference for structured, repetitive patterns—traits that can be either advantageous or challenging, depending on the context. This includes differences in interoceptive awareness—the perception of internal bodily signals—which can affect self-regulation and emotional processing in autistic individuals. These differences are rooted in neurobiological factors, including variations in connectivity between brain regions, atypical sensory processing, and distinct patterns of motor coordination. Research suggests that the cerebellum, which plays a crucial role in motor learning, balance, and sensorimotor integration, functions differently in autistic individuals, potentially influencing movement patterns and proprioception (Elandalousi et al., 2023). Additionally, the mirror neuron system (MNS) - central to observational learning and social cognition - may operate in a divergent manner, contributing to unique approaches to skill acquisition and social interaction (Vivanti & Rogers, 2014). As this research also exemplifies, autism is not a singular experience but a spectrum of cognitive profiles, where each individual navigates their environment in ways that align with their neurological wiring. Within structured disciplines such as budo, these neurological traits can manifest in both strengths—such as precision, consistency, and a strong sense of discipline—and challenges, such as sensory sensitivity or differences in social communication (Mussies, 2023b). The present study seeks to explore how these characteristics interact with martial arts training, bridging self-reported experiences with neuroscientific insights. Understanding these neurological foundations of autism provides essential context for examining how structured martial arts training might interact with autistic cognitive and sensory processing patterns.

Social interaction

Social interaction is a complex cognitive process that relies on the dynamic coordination of multiple neural systems (Kingsbury & Hong, 2020). Key structures involved include the prefrontal cortex, the amygdala, the MNS, and the superior temporal sulcus (STS), each contributing to different aspects of social cognition, from emotional regulation to the interpretation of social cues. The prefrontal cortex (PFC), particularly the medial and orbitofrontal regions, plays a crucial role in higher-order social functions such as perspective-taking, impulse control, and decision-making in social contexts (Grossmann, 2013). The PFC enables individuals to regulate their responses, interpret social norms, and engage in reciprocal interactions (Armbruster et al. 2012). Differences in prefrontal connectivity have been linked to variations in social behaviour, including challenges in flexible thinking and social adaptation observed in neurodivergent populations. The amygdala, a key structure in the limbic system, is central to the processing of emotional stimuli and the modulation of social behaviour (Šimić et al., 2021). It helps assign emotional significance to facial expressions, body language, and vocal tones, contributing to the rapid assessment of social situations. In autistic individuals, atypical amygdala activation has been associated with differences in emotional reactivity and social attention, potentially influencing interpersonal dynamics (Zalla & Sperduti, 2013). The MNS, primarily located in the premotor cortex and inferior parietal lobule, is essential for observational learning and understanding the actions and intentions of others (Coudé et al., 2016). This system enables an

individual to mentally simulate observed movements, facilitating non-verbal communication and embodied social cognition. Some research - e.g. in the realm of music studies - suggests that autistic individuals may engage the MNS differently, leading to unique patterns of social learning and motor imitation (Molnar-Szakacs et al., 2009). The superior temporal sulcus (STS) is involved in the perception of biological motion, gaze direction, and subtle facial expressions (Engell & Haxby, 2007). It acts as a crucial interface between sensory input and social interpretation, allowing individuals to infer emotions, intentions, and mental states from observed behaviour. Differences in STS activation in autism have been linked to variations in gaze processing and responsiveness to social cues (Zilbovicius et al., 2013).

Social interaction is not merely a cognitive task but an embodied process that integrates sensory perception, motor coordination, and emotional regulation. In structured disciplines such as budo, where social engagement follows explicit protocols and embodied learning is central, these neurological mechanisms interact in ways that may provide unique benefits for autistic individuals. This study aims to examine how self-reported social experiences of autistic budo practitioners align with existing knowledge about these neural systems, providing a foundation for future neuroimaging research within martial arts contexts.

Movement

It is important to note that the brain regions discussed below do not function in isolation but operate within interconnected neural networks. The following descriptions highlight key contributions of specific regions while acknowledging that movement regulation emerges from dynamic interactions across multiple brain systems. Movement and its regulation are deeply intertwined with multiple brain structures that not only govern motor coordination but also ensure the smooth integration of sensory input and cognitive processing. Key brain regions involved in these processes include the cerebellum, the basal ganglia, the sensory processing systems, and the MNS, all of which play distinct yet interrelated roles in the execution and regulation of movement.

The cerebellum, as part of broader sensorimotor networks, plays a crucial role in the coordination, precision, and timing of voluntary motor movements through its connections with cortical and subcortical regions. It integrates sensory input related to body position and movement, continuously adjusting and refining motor actions for smooth execution (Manto et al., 2012). The cerebellum's role in movement timing is particularly critical in activities such as martial arts, where precision, rhythm, and coordination are paramount. The cerebellum also contributes to motor learning (Fine et al., 2002), an essential component in martial arts practice, enabling practitioners to improve performance through repeated action and feedback. In neurodivergent individuals, atypical cerebellar function may manifest as motor coordination challenges, but structured training can facilitate cerebellar adaptation through repeated motor practice, leading to improved motor performance over time, as the cerebellum's role in motor learning enables practitioners to refine performance through feedback (Manto et al., 2012).

The basal ganglia, a group of interconnected structures including the striatum, substantia nigra, and globus pallidus, is primarily involved in the modulation and refinement of motor movements (Stocco et al., 2010). This system is essential for movement adjustment, procedural learning, and the automation of repetitive tasks. Research on basal ganglia function indicates these structures facilitate the automation of repetitive motor tasks (Chakravarthy et al., 2010). This mechanism likely contributes

to the smooth execution of learned martial arts techniques, such as kata or sparring motions, as practitioners develop motor automaticity through repeated practice. Dysfunctions within the basal ganglia, such as those seen in Parkinson's disease, can lead to motor control issues such as rigidity or involuntary movements (Mazzoni et al., 2012). In the context of neurodiversity, individuals may experience challenges in motor planning or movement fluidity, and my findings suggest that structured martial arts training may improve motor function through enhanced procedural learning, consistent with basal ganglia involvement in motor skill automation.

Sensory integration refers to the brain's ability to process and organize sensory information from various sources (e.g., proprioception, tactile feedback, visual and auditory input) to produce an appropriate motor response (Guardado & Sergeant, 2023). Individuals with autism often have an atypical "porosity" (Mussies, 2023), meaning that sensory sensitivities can be either heightened or diminished, which may affect their perception of and response to physical stimuli in martial arts. For example, an individual might be overly sensitive to tactile contact during sparring or underresponsive to proprioceptive feedback, which is critical for body awareness during movement. Certain aspects of martial arts training, particularly structured exercises such as kata, kihon (basic techniques), and pre-arranged partner drills, offer controlled and predictable sensory input. These training modalities allow individuals to gradually improve sensory processing and integration through repetitive movements within a stable framework. While free sparring introduces unpredictable sensory challenges, the foundation built through structured practice can enhance an individual's ability to process and respond to variable sensory input. This progressive approach to sensory integration can help regulate both emotional responses and motor coordination across different training contexts.

As previously discussed, the MNS also plays a critical role in both social interaction and motor imitation (Jeon & Lee, 2018). In martial arts, where precise movements are often learned through observation and imitation of a teacher or partner, the MNS is crucial for absorbing, understanding, and replicating these movements. The system allows for the "mirroring" of observed actions, which is foundational for learning motor patterns, especially in a partner-based context such as sparring or form practice. This social-cognitive mechanism is particularly relevant in the context of autistic individuals, as it provides a pathway for motor learning that transcends verbal instruction. The MNS also plays a role in social cohesion within martial arts communities, as practitioners can tune into the actions and emotional states of others through embodied mimicry, which contributes to a sense of shared experience.

These neurological mechanisms – cerebellar function, basal ganglia processing, sensory integration, and mirror neuron engagement – work together to facilitate the precise and regulated movements required in martial arts. The structured, repetitive nature of budo training may engage these systems in ways that align with the learning preferences of many autistic individuals (Mussies, 2023b). While similar mechanisms are involved in other structured motor interventions for autistic individuals (Srinivasan & Bhat, 2013), the specific combination of predictable patterns, clear hierarchical frameworks, and embodied learning found in traditional martial arts creates a unique training environment. The self-reported benefits described by participants in this study suggest that budo training may support motor coordination, sensory processing, and social interaction development, though further research using neuroimaging techniques would be needed to establish the specific neural correlates of these reported improvements. These neurophysiological mechanisms underlying

movement and social interaction provide the theoretical framework for understanding how budo practice might specifically benefit autistic individuals.

2 Budo as a Motor and Cognitive System

In the realm of budo, the way in which physical and mental aspects are harmoniously cultivated forms the essence of the practice (Cynarski, 2022). As a discipline that extends beyond mere physical exertion, budo represents a profound journey of self-development, where mind and body are intricately woven together in the pursuit of mastery and peace (Korhonen, 2022). Through consistent practice, the practitioner refines not only their physical skills but also their mental fortitude and emotional regulation, embodying the principle of *shin-gi-tai* – the integration of the heart (mind), technique (body), and spirit (Espartero et al., 2011). These principles are deeply rooted in the very mechanics of martial arts training and map onto the neurophysiological processes outlined above, resulting in improved physical fitness, enhanced cardiovascular health, and better stress management outcomes (Chang et al., 2018).

Budo is, at its core, a structured system of movement that involves the repetition of motor sequences – kata, kihon, and kumite – designed to refine both motor coordination and cognitive awareness (Tong, 2022). These forms of training offer a rhythmic, almost meditative structure where every action, from the initial stance to the final strike, is performed with deliberate precision. Kata, as a series of fixed patterns, is not just a physical exercise; it is a way to learn the deeper meaning of movement (Tokitsu, 2010). Through repetitive practice of these movement patterns, practitioners develop enhanced motor coordination and proprioceptive awareness. This improvement may be mediated by cerebellar adaptation, as this brain region specializes in refining movement timing and precision through repeated motor experiences. Research on kata practice suggests that structured movement patterns facilitate embodied learning through repetitive motor sequences that enhance proprioceptive awareness (Tokitsu, 2010). This systematic approach to movement training may support the development of motor coordination through consistent sensory feedback. In my own experience, kata has provided a powerful means of connecting with my body on a deep, intuitive level, almost as if my movements are guided by an internal rhythm – a rhythm that the body and mind learn to synchronise with over time. This neuroplasticity is evident in the way a seasoned practitioner can perform almost without conscious thought, where technique becomes second nature and the body responds almost reflexively and thus at high speed (Coşkun et al., 2014).

In addition to the motoric repetition, kihon (basic techniques) and kumite (sparring) also contribute to refining motor control (Keshishian, 2013). In kihon, basic techniques are performed in isolation, focusing purely on the execution of form and power. Here, the basal ganglia networks, in coordination with cerebellar and cortical circuits, contribute to the automation of these movements through distributed neural processing, allowing them to become engrained and performed fluidly. Through kumite, the practitioner applies their techniques in dynamic situations, engaging in spontaneous movements while adapting to the actions of their partner (Ross, 2009). This requires an ongoing integration of sensory input, cognitive decision-making, and motor output, much like the sensorimotor integration we see in the cerebellum and MNS. In sparring, the practitioner must continually assess the environment, anticipate the opponent's actions, and execute the appropriate response. This dynamic feedback loop is integral to the development of social cognition in budo, as the mind and body constantly adjust to new challenges and stimuli.

Another critical aspect of budo, often overlooked in the physical realm, is the regulation of the sympathetic and parasympathetic nervous systems through breathing and meditation (Overchuk, 2002). Breath control in budo – whether in *zazen* (seated meditation) or during the practice of *kihon* – plays an essential role in regulating the body's response to stress and physical exertion. Through mindful breathing, we engage the parasympathetic nervous system, activating the “rest and digest” response, which fosters relaxation and enhances the body's recovery between exertions. This direct regulation of the autonomic nervous system has profound implications for emotional control and mental clarity. It allows the practitioner to find balance and focus even in high-pressure situations, such as *kumite* or self-defence scenarios. The integration of breath into every movement helps to cultivate mindfulness – a state of heightened awareness that bridges the conscious and subconscious mind. This is the practice of being present in the moment, which is key to not only optimal physical performance but also emotional resilience.

Moreover, proprioception, the awareness of one's own body in space, is heightened throughout budo practice (Warner, 2024). The internal feedback loops established in *kata*, *kihon*, and *kumite* enable practitioners to develop a deep connection with their body. This sense of embodiment is cultivated through mindful repetition, where the practitioner learns not only to execute movements but to feel each one in the body's core. The increase in proprioceptive awareness is akin to the enhanced sensory integration that neurodivergent individuals may experience through structured, repetitive movement. In martial arts, proprioception becomes not just about movement, but about a deeper understanding of how one's body interacts with both the environment and other people. This is especially significant in the context of social interaction, as understanding one's physicality is often linked to understanding others, whether in sparring or in cooperation.

These neurophysiological and embodied aspects of budo training suggest multiple pathways through which structured martial arts practice might benefit autistic individuals. To systematically examine these potential benefits and understand the lived experiences of autistic budo practitioners, this study employs a mixed-methods approach combining self-report measures with in-depth interviews.

Based on the neurophysiological mechanisms outlined above, this exploratory study addresses the following research questions: 1. How do autistic individuals experience sensorimotor benefits from structured budo training, particularly in relation to proprioception, balance, and motor coordination? 2. What role does the predictable, ritualized structure of budo play in emotional regulation and stress management for autistic practitioners? 3. How do the hierarchical social frameworks and partner interactions in budo influence social comfort and skill development in autistic individuals? 4. Which specific aspects of budo training (*kata*, *kumite*, breathing techniques, *dojo* etiquette) are most beneficial for autistic practitioners, and why? Given the limited research on autism and martial arts, this study adopts an exploratory mixed-methods approach to capture both quantifiable patterns and rich individual experiences. Rather than testing specific hypotheses, the research aims to identify themes and mechanisms that can inform future controlled studies and evidence-based practice guidelines for neurodiversity-friendly martial arts programs.

3 Methodology

This study employs a mixed-methods approach, integrating both qualitative and quantitative components to examine the experiences of autistic budo practitioners. This design was chosen to

ensure a comprehensive and nuanced understanding of the interplay between martial arts training, neurological mechanisms, and self-reported experiences. Given the diversity of cognitive and sensory profiles within the autistic population, it is essential to adopt a methodological framework that is both structured enough to facilitate comparative analysis and flexible enough to capture individual lived experiences.

A key methodological component is the use of self-report questionnaires designed to assess three core areas: stress regulation, proprioceptive awareness, and social interaction. These measures focus on perceived changes in autonomic responses and emotional regulation before and after training, individual perceptions of body awareness, balance, and spatial orientation, as well as comfort levels in group settings and the perceived impact of budo on social confidence. Self-report measures were selected for their ability to capture subjective experience, a crucial factor when examining internal states such as stress regulation or sensory integration. In the context of autism, structured questionnaires allow participants to reflect on their experiences at their own pace, minimising the pressure of real-time responses. Given that many autistic individuals process and articulate experiences differently from neurotypical participants, self-report tools offer an accessible and participant-centred means of data collection. While the quantitative component of the study enables the identification of broader patterns within the data, the use of validated scales on sensory processing, emotional regulation, and social engagement allows for systematic comparisons across participants and the identification of statistically significant trends. However, recognising the inherent limitations of self-report data, particularly the challenges related to interoceptive awareness in autism, the study complements these findings with qualitative methods.

Data collection employed a sequential mixed-methods approach. Initially, all 81 participants completed online self-administered questionnaires distributed via the Japan Fans website and social media platforms. The questionnaire (see Appendix 1) combined structured Likert-scale questions with open-ended response fields, allowing participants to elaborate on their experiences at their own pace without real-time interaction pressure. Following the questionnaire phase, a subset of 15 participants volunteered for follow-up semi-structured interviews conducted via video conferencing software, with audio-only options available for those preferring this format. Each interview lasted 45-60 minutes and used a flexible guide based on questionnaire themes while allowing participants to introduce additional topics. To ensure participant comfort, interviews could be paused at any time, and participants were offered the option to submit written responses to follow-up questions. All interviews were recorded with consent and transcribed verbatim. This sequential approach was chosen to accommodate diverse communication preferences within the autistic community while enabling both breadth of data collection and depth of individual narratives.

To capture rich, in-depth insights, semi-structured interviews had been conducted with autistic budo practitioners. This method allows participants to elaborate on their experiences in their own words, offering perspectives that might not emerge through fixed-response questionnaires. Semi-structured interviews were chosen over fully structured formats to provide a balance between consistency, ensuring comparability across participants, and flexibility, allowing for the emergence of novel themes. The interviews explored how budo training influences participants' perception of their own bodies and sensory experiences, how martial arts practice affects emotional regulation and self-discipline in daily life, and how training environments shape social interaction, including experiences with hierarchy, group training, and communication with partners. By adopting an open-ended approach, participants

were encouraged to introduce new insights beyond the initial hypotheses, ensuring that the study remains grounded in the lived experiences of autistic practitioners rather than imposing a rigid theoretical framework upon them. This is particularly important given that many studies on autism tend to analyse the condition from an external perspective, rather than amplifying the voices of autistic individuals themselves. The researcher, as an autistic individual with personal experience in budo practice, brings both insider perspective and potential bias to this research, which was addressed through structured data collection protocols and transparent reporting of limitations.

This study adopts an exploratory, cross-sectional design without a control group, reflecting several methodological considerations. First, the primary aim is to document and understand the lived experiences of autistic budo practitioners—a previously under-researched population—rather than to establish causal relationships or make comparative claims. Second, the diversity within the autism spectrum makes it challenging to identify an appropriate control group, as autistic individuals who do not practice martial arts may differ systematically in ways beyond martial arts engagement. Third, recruiting a sufficient sample of autistic individuals already presents logistical challenges; requiring matched controls would further limit feasibility. These design choices have important implications for interpretation. The reported benefits cannot be attributed causally to budo practice, as they may reflect pre-existing characteristics of autistic individuals drawn to martial arts, placebo effects, or recall bias. Additionally, the findings may not generalize to autistic individuals who have not chosen to engage in martial arts. Future research should employ longitudinal designs with comparison groups to strengthen causal inference and examine the trajectory of benefits over time.

Although this study does not include direct neurophysiological measurements, it interprets self-reported experiences within existing neuroscientific frameworks, identifying patterns that may inform future neuroimaging studies of budo practitioners. This means that qualitative and quantitative findings are interpreted in relation to existing knowledge about sensorimotor function, proprioceptive processing, and stress regulation in autism. This research aims to identify patterns in self-reported experiences that may inform future empirical investigation of how budo supports autistic individuals.

The mixed-methods approach was chosen to accommodate the cognitive diversity within the autistic population while ensuring both statistical comparability and rich individual narratives. This methodological flexibility aligns with neurodiversity-affirming research principles, allowing participants to share insights through their preferred communication modes—structured questionnaires, open-ended discussion, or both. By integrating quantitative patterns with participant-led qualitative data within a neuroscientific interpretative framework, the study ensures that autistic voices remain central while contributing to broader academic discourse on autism and martial arts.

By adopting a methodologically rigorous yet flexible approach, grounded in the principles of neurodiversity-affirming research, this study aims to provide an empirically robust yet deeply human account of the role of budo in the lives of autistic practitioners. Through the integration of structured questionnaires, participant-led narratives, and a neuroscientific framework, the research not only contributes to the academic discourse on autism and martial arts but also ensures that the perspectives of autistic individuals remain central to its findings. It is important to note that this study's interpretive approach cannot directly validate neurological mechanisms. Rather, it identifies experiential patterns that align with existing neuroscientific literature, generating hypotheses for future research employing direct neuroimaging or physiological measurements.

Demographic overview

The present study involved interviews with 81 autistic practitioners of Japanese martial arts (budo), recruited primarily through online calls for participation on the website and social media platforms of *Japan Fans*. The sample consisted exclusively of adults, with an age range of 18 to 57 years. This decision was made to ensure ethical integrity and compliance with research guidelines regarding the participation of minors. The exclusion of younger participants, however, does not diminish the relevance of childhood experiences in budo, as several respondents reflected on their children's engagement with martial arts. For instance, one participant, a karateka, noted that his son practises judo, illustrating the intergenerational transmission of martial arts within autistic families.

Within the sample, there was a notable gender distribution: while men constituted the largest group (49%), there was a disproportionately high representation of non-binary individuals (20%) compared to general population estimates. This observation aligns with emerging research suggesting a significant intersection between neurodiversity and gender diversity, warranting further exploration into the ways martial arts may serve as an affirming space for autistic individuals with non-binary or otherwise gender-diverse identities.

Budo encompasses a vast array of both armed and unarmed disciplines, each with distinct training methodologies, philosophical underpinnings, and sensory demands. The martial arts represented within this study can be categorised into unarmed styles, such as karate, judo, aikido, and jiu-jitsu; armed styles, including kendo, iaido, and kyudo; and specialised traditions, such as kobudo and ninjutsu. The distribution of primary budo practices among participants is presented in Table 1. Each participant identified their primary budo discipline, with the distribution shown in Table 1. Many participants practiced multiple disciplines, but reported results are based on their primary focus. Many participants practiced multiple budo styles, with several respondents indicating transitions between disciplines over time, suggesting that martial arts choice evolves in response to individual needs and preferences. The high representation of karate and kendo may reflect both the accessibility of these disciplines and the recruitment strategy through *Japan Fans*' networks.

Table 1: Primary budo disciplines reported by participants

Martial Art	n	%
Karate	32	39.5
Kendo	16	19.8
Judo	8	9.9
Aikido	6	7.4
Iaido	4	4.9
Kyudo	3	3.7
Jiu-jitsu	3	3.7
Shorinji Kempo	2	2.5
Other*	7	8.6

*Other includes Kobudo, Naginata, Jodo, and Ninjutsu (n=2 each)

Additionally, 18 participants (22%) practiced secondary disciplines alongside their primary focus, reflecting the interconnected nature of budo training.

Contextual factors

A geographical trend emerged within the data, with a significant proportion of respondents based in the Netherlands (42%). This concentration is likely attributable to the online recruitment strategy, as

Japan Fans has a particularly strong following in the Dutch martial arts community. Additionally, the high representation of kendo practitioners may be partially explained by the presence of kendoka within *Japan Fans'* online networks. This finding underscores the importance of considering the influence of recruitment channels on sample composition.

The age distribution of respondents followed a normal curve, with no participants over the age of 57. This absence of older practitioners may reflect the broader demographic patterns of autism diagnosis; until relatively recently, autism was underdiagnosed, particularly among adults. Consequently, many older autistic individuals may be unaware of their neurodivergence or may not have had the opportunity to engage with research studies on autism-specific experiences in martial arts. Additionally, the reliance on digital recruitment methods may have inadvertently excluded older individuals less inclined to participate in online studies. These limitations highlight the need for future research employing alternative recruitment methods, such as in-person outreach at dojos, to ensure a more representative age distribution. The findings indicate that social networks, accessibility, and historical trends in autism diagnosis all play a role in shaping participation patterns. These contextual factors must be accounted for when interpreting the broader implications of budo as a neurodiversity-affirming practice.

4 Results

The following results present both quantitative patterns and qualitative themes that emerged from this comprehensive examination of autistic practitioners' experiences. Quantitative data from Likert-scale questions were analyzed using descriptive statistics, with response categories aggregated where appropriate. All reported percentages represent descriptive statistics of this specific sample and should not be interpreted as population estimates or statistically significant findings. For questions with multiple positive response options (e.g., "Yes, very much" and "Yes, somewhat"), these were combined to provide overall positive response rates while preserving granular data for more detailed analysis. Qualitative data from open-ended questions were analyzed using thematic analysis to identify recurring patterns in participant experiences. No inferential statistical tests were conducted due to the exploratory nature of the study and absence of a control group. All percentages reported are rounded to the nearest whole number; precise fractional values are available upon request.

Demographic and Training Characteristics

The sample consisted of 81 autistic budo practitioners, with ages ranging from 18 to 57 years (mean age not calculated due to categorical reporting). Gender distribution was: 40 participants (49%) identified as male, 25 (31%) as female, 16 (20%) as non-binary. All participants had received either formal autism diagnoses (n=73, 90%) or self-identified as autistic (n=8, 10%).

Training experience varied considerably: 15 participants (19%) had less than one year of experience, 28 (35%) had 1-3 years, 18 (22%) had 3-5 years, and 20 (25%) had more than 5 years of experience. The most commonly practiced disciplines were Karate (n=32, 39.5%), Kendo (n=16, 19.8%), and Judo (n=8, 9.9%).

Sensory Processing

Regarding sensory sensitivities affecting training, 65 participants (80%) reported experiencing such challenges, with 12 (15%) reporting no sensitivities and 4 (5%) reporting occasional issues. The most frequently mentioned sensitivities in open-ended responses included noise from kiai and weapon contact, sudden tactile interactions, and visual overstimulation from rapid movements.

When asked about the helpfulness of repetitive movements for sensory processing, 49 participants (60%) responded "Yes, very much," 20 (25%) responded "Yes, somewhat," 8 (10%) were unsure, and 4 (5%) responded "No."

Proprioception and Body Awareness

Regarding the impact of martial arts on body awareness, 40 participants (49%) reported significant improvement, 29 (36%) reported some improvement, 10 (12%) noticed no change, and 2 (2%) reported worsening.

Motor Coordination and Balance

For balance and coordination experiences: 28 participants (35%) reported that martial arts improved their coordination, 24 (30%) reported no issues, 24 (30%) reported some struggles, and 5 (6%) reported significant struggles.

Movement Preferences

When asked about preferences for structured movement patterns versus free sparring, 49 participants (60%) expressed a preference for structured patterns, 24 (30%) appreciated both but acknowledged challenges with sparring, and 8 (10%) preferred free sparring or had no strong preference.

Stress and Anxiety Management

Regarding martial arts' impact on stress and anxiety: 44 participants (54%) reported significant help, 25 (31%) reported some help, 10 (12%) noticed no effect, and 2 (2%) reported worsening.

Breathing Techniques

Use of martial arts breathing techniques outside training for emotional regulation: 31 participants (38%) used them frequently, 38 (47%) used them occasionally, 10 (12%) used them rarely, and 2 (2%) never used them.

Self-Confidence

Impact on self-confidence: 48 participants (59%) reported significant improvement, 25 (31%) reported some improvement, 7 (9%) noticed no change, and 1 (1%) reported worsening.

Executive Functioning

Regarding the impact on focus and executive functioning: 40 participants (49%) found martial arts significantly beneficial, 25 (31%) found it somewhat beneficial, 14 (17%) noticed no change, and 2 (2%) found it made focus more difficult.

Group Training Comfort

Comfort levels in group training environments: 24 participants (30%) felt very comfortable, 32 (40%) felt somewhat comfortable, 12 (15%) were neutral, 12 (15%) felt somewhat uncomfortable, and 1 (1%) felt very uncomfortable.

Dojo Etiquette

Helpfulness of dojo etiquette for social interactions: 49 participants (60%) found it very helpful, 20 (25%) found it somewhat helpful, 8 (10%) did not find it helpful, and 4 (5%) were unsure.

Partner Exercises

Attitudes toward partner exercises: 40 participants (49%) enjoyed them, 24 (30%) tolerated them despite difficulties, 12 (15%) found them challenging, and 5 (6%) avoided them when possible.

Hierarchical Structure

Perceived clarity provided by the martial arts hierarchy: 40 participants (49%) found it very clarifying, 28 (35%) found it somewhat clarifying, 8 (10%) found no benefit, and 5 (6%) were unsure.

Social Connections

Formation of social connections through martial arts: 20 participants (25%) formed close friendships, 40 (49%) established acquaintances, 12 (15%) enjoyed the social setting without forming connections, and 9 (11%) struggled with social interaction.

Challenges in Training

The most frequently reported challenges in open-ended responses included: sensory overload (mentioned by 35 participants), unpredictability in sparring (28 participants), social interaction difficulties (22 participants), and motor coordination issues (18 participants).

Perceived Benefits

The most commonly reported benefits were: increased self-confidence (mentioned by 52 participants), improved emotional regulation (45 participants), enhanced physical fitness and coordination (38 participants), and social structure providing clarity (32 participants).

Suggestions for Improvement

Participant suggestions for making martial arts more inclusive included: instructor training on autism awareness (mentioned by 28 participants), quieter training environments or noise accommodation (24 participants), clearer communication and instructions (20 participants), and flexible participation options (15 participants).

Study Limitations

Several important limitations must be acknowledged. This study employed a cross-sectional design without a control group, limiting the ability to establish causal relationships between martial arts practice and reported benefits. The self-report nature of the data introduces potential recall bias and social desirability effects. The sample was recruited primarily through online networks, which may have introduced selection bias toward participants comfortable with digital communication and potentially more positive about their martial arts experiences.

The absence of objective measures (such as physiological assessments or standardized psychological instruments) means that all reported benefits reflect subjective experiences rather than empirically validated improvements. Additionally, the sample's geographic concentration (42% from the Netherlands) and the over-representation of certain martial arts disciplines may limit generalizability to the broader autistic population or other martial arts communities.

The demographic composition also presents limitations, with the exclusion of participants under 18 and the relatively recent nature of many adult autism diagnoses potentially affecting the representativeness of the sample. Finally, no statistical significance testing was conducted, meaning the reported percentages represent descriptive patterns rather than statistically validated differences or relationships.

5 Discussion

This exploratory study examined the self-reported experiences of 81 autistic individuals engaged in Japanese martial arts (budo), revealing predominantly positive impacts across sensory, motor, emotional, and social domains. The findings highlight the nuanced experiences of autistic practitioners, who report significant benefits including increased self-confidence, improved proprioception, and enhanced emotional resilience, while also identifying ongoing challenges such as sensory overload and unpredictability in sparring. The structured training environments and clear social hierarchies appear to provide a sense of clarity and predictability that supports both skill acquisition and social adaptation.

Sensory Processing and Motor Coordination

The finding that 85% of participants reported improved proprioception through budo training aligns with existing research on structured movement interventions for autistic individuals (Srinivasan & Bhat, 2013). The preference for structured movement patterns over free sparring (60% of participants) may reflect the need for predictable sensory input that characterizes many autistic individuals' learning preferences.

These self-reported improvements in body awareness and coordination align with patterns observed in research on structured movement interventions. This could potentially be explained through several neurological mechanisms, though direct measurement would be required to confirm these hypotheses. The cerebellum's role in motor learning and sensorimotor integration (Manto et al., 2012) suggests that the repetitive, precise movements characteristic of kata and kihon might engage cerebellar adaptation processes. The reported improvements in balance and coordination (35% of participants) may reflect enhanced cerebellar function through structured motor practice.

Similarly, the basal ganglia's involvement in procedural learning and movement automation (Chakravarthy et al., 2010) could theoretically explain participants' reports of improved motor control through repetitive technique practice. The structured progression from basic techniques (kihon) to complex forms (kata) to dynamic application (kumite) mirrors established principles of motor skill acquisition.

The high rate of sensory sensitivities affecting training (80% of participants) underscores the importance of sensory considerations in martial arts instruction for autistic individuals. The reported benefits of repetitive movements for sensory processing (85% positive responses) might be

understood through sensory integration theory, where controlled, predictable sensory input can support regulatory processes (Guardado & Sergeant, 2023).

Emotional Regulation and Autonomic Function

The substantial reported improvements in stress and anxiety management (85% of participants) represent a particularly significant finding, given that anxiety disorders are highly prevalent in autism. The widespread use of martial arts breathing techniques outside of training (85% of participants) suggests effective generalization of self-regulation skills to daily life.

These findings may be interpreted through the lens of autonomic nervous system regulation. Structured breathing practices, common in budo training, are known to activate parasympathetic responses and reduce physiological arousal. The ritualistic and meditative aspects of kata practice might similarly engage relaxation responses, though this remains speculative without physiological measurement.

The reported improvements in self-confidence (90% of participants) and executive functioning (80% positive responses) could potentially reflect the structured goal-setting inherent in martial arts ranking systems, which provides clear milestones for achievement and self-efficacy development.

Social Interaction Within Structured Frameworks

The finding that 70% of participants felt at least somewhat comfortable in group training environments is noteworthy given that social challenges are a defining characteristic of autism. The perceived benefits of dojo etiquette (85% positive responses) and hierarchical structures (84% positive responses) suggest that explicit social frameworks may facilitate social engagement for autistic individuals.

These findings align with research indicating that autistic individuals often navigate social situations more successfully when expectations are clearly defined and ritualized (Dwyer et al., 2022). The senpai/kohai mentorship structure and belt ranking system provide explicit social roles that may reduce the ambiguity that often makes social interaction challenging for autistic individuals.

However, the mixed responses to partner exercises (49% enjoyed, 30% tolerated, 21% found difficult or avoided) highlight that social interaction remains challenging for many participants, even within structured frameworks. This variability underscores the diversity within the autism spectrum and the need for individualized approaches.

The MNS's role in observational learning and social cognition (Vivanti & Rogers, 2014) may be relevant here, as martial arts instruction relies heavily on demonstration and imitation. However, research suggests autistic individuals may engage this system differently, which could explain both the benefits some participants derive from structured imitation and the challenges others experience.

Practical Implications for Neurodiversity-Friendly Budo Programmes

The insights derived from this study suggest several evidence-based modifications that can enhance the inclusivity of budo for autistic individuals. These recommendations emerge directly from participant experiences and align with established principles of neurodiversity-affirming practice.

Instructor Training and Awareness

The participants' emphasis on instructor awareness (mentioned by 28 participants) highlights a critical need for education about autism and neurodiversity within martial arts communities. Instructors should receive training on recognizing and accommodating sensory sensitivities, understanding diverse communication styles, and implementing flexible teaching approaches. This includes recognizing that autistic students may process information differently, require additional processing time, or benefit from alternative explanation methods.

Greater awareness among instructors regarding sensory sensitivities and individualized learning preferences is crucial for creating inclusive environments. Training programmes should integrate knowledge about autism characteristics, moving beyond stereotypes to understand the diversity within the autism spectrum and how these differences can manifest as both strengths and challenges in martial arts contexts.

Environmental and Sensory Modifications

Environmental modifications addressing sensory sensitivities represent a fundamental accessibility consideration. Based on participant feedback, key adaptations include acoustic accommodations such as providing noise-reducing options, designated quiet spaces for sensory recovery, and advance warning for activities involving loud sounds (such as kiai or weapon contact). Lighting considerations should include adjusting fluorescent lighting, minimising sudden brightness changes, and creating visually calm training spaces. Tactile accommodations involve respecting personal space preferences, providing advance notice of physical contact requirements, and offering alternatives for tactile-sensitive individuals. Structured sensory breaks should incorporate planned pauses that allow practitioners to self-regulate when experiencing overstimulation.

Communication and Instructional Strategies

Communication strategies should be diversified to include multiple modalities, ensuring that verbal explanations are supplemented with visual aids, written instructions, and clear demonstrations. The structured and ritualistic nature of budo already provides a foundation for predictable engagement; however, further refinements can enhance accessibility through multimodal instruction that combines verbal explanations with visual demonstrations, written technique descriptions, and hands-on guidance. Clear expectations should explicitly state goals for each training segment, explain the purpose of exercises, and provide structured timelines. Consistent routines should maintain predictable class structures while clearly communicating any changes in advance. Partner communication should teach all students respectful ways to communicate preferences and boundaries during paired exercises.

Flexible Participation Models

The suggestion for flexible participation options (mentioned by 15 participants) acknowledges the heterogeneity within the autism spectrum and the need for individualized approaches. This might include graduated sparring exposure by offering structured, controlled sparring experiences before progressing to free sparring. Alternative assessment methods should provide multiple ways to demonstrate proficiency beyond traditional testing formats. Participation choices should allow opt-out options for particularly challenging exercises while providing alternative activities. Paced

progression should respect individual learning timelines rather than enforcing uniform advancement schedules.

Leveraging Hierarchical Structure

The hierarchical structure of budo should be leveraged as a tool for social scaffolding, ensuring that mentorship dynamics within the senpai-kohai system are used constructively to support neurodivergent students. The finding that 84% of participants found hierarchical structures beneficial suggests this framework can provide valuable social clarity when implemented thoughtfully.

Creating safe spaces within the dojo for sensory recovery can help autistic practitioners self-regulate when experiencing overstimulation. Encouraging flexible participation in sparring and partner exercises, based on individual comfort levels, can also contribute to a more supportive training environment.

Limitations and Interpretive Cautions

Several critical limitations constrain the interpretation of these findings. The cross-sectional design with self-selected participants prevents causal inferences about the relationship between martial arts practice and reported benefits. Participants who choose to engage in and continue martial arts training may systematically differ from those who do not, potentially inflating reported benefits.

The self-report methodology, while capturing valuable subjective experiences, is subject to recall bias and social desirability effects. The absence of validated assessment instruments limits comparability with other research and prevents standardized measurement of outcomes. Additionally, all neurological interpretations presented here remain speculative, as no direct neurophysiological measurements were conducted.

The sample characteristics also limit generalizability. The geographic concentration in the Netherlands (42% of participants), recruitment through specific online networks, and focus on adults may not represent the broader autistic population or their potential responses to martial arts training. The over-representation of certain martial arts styles may limit applicability to other budo disciplines.

The absence of a control group means that reported benefits cannot be attributed specifically to martial arts practice versus other factors such as regular physical activity, social engagement, or structured routine. Longitudinal research with appropriate comparison groups would be necessary to establish causality and examine the trajectory of benefits over time.

Theoretical Implications and Future Research Directions

Despite these limitations, the findings contribute to understanding how structured physical activities might support autistic individuals. The convergence of reported benefits across sensory, motor, emotional, and social domains suggests that martial arts may offer a holistic intervention approach, though this requires empirical validation.

Future research should employ rigorous experimental designs with control groups and validated outcome measures. Neuroimaging studies using fMRI could examine cerebellar activation, sensorimotor integration, and social brain networks in autistic martial artists compared to controls. Longitudinal studies could track changes in proprioception, executive function, and social confidence over time.

Physiological measures, such as cortisol levels, heart rate variability, and sensory processing assessments, could provide objective correlates of the self-reported benefits. Comparative studies across different martial arts disciplines could identify which specific elements (structured movement, social hierarchy, breathing practices, philosophy) are most beneficial for autistic practitioners.

Research should also examine potential negative effects or dropout rates, as the current study's focus on active practitioners may obscure challenges that lead some autistic individuals to discontinue training. Understanding barriers to participation and retention could inform more inclusive programme development.

Broader Implications for Neurodiversity-Affirming Interventions

This study's findings align with broader principles of neurodiversity-affirming interventions, which emphasise building on autistic strengths rather than attempting to normalise behaviour. The reported benefits of structure, predictability, and clear social frameworks reflect autistic individuals' often-strong preference for systematic approaches to learning and social interaction.

The emphasis on embodied learning through martial arts also connects to growing recognition of the importance of sensorimotor experiences in autism intervention. Rather than focusing solely on behavioural or cognitive approaches, interventions that engage the whole person through structured physical activity may offer unique benefits.

However, the variability in responses underscores that no single intervention will benefit all autistic individuals. The diversity within autism requires diverse intervention approaches, with martial arts representing one potentially valuable option within a broader toolkit of neurodiversity-affirming supports.

6 Conclusion

This exploratory study provides preliminary evidence that structured martial arts training may offer multifaceted benefits for autistic practitioners, particularly in areas of sensorimotor integration, emotional regulation, and structured social engagement. However, the significant limitations in study design preclude definitive conclusions about causality or generalizability.

The findings suggest directions for future rigorous research and provide practical guidance for developing inclusive martial arts programmes. Most importantly, this study amplifies autistic voices and experiences, contributing to a more nuanced understanding of how structured physical activities might support neurodivergent individuals within their own frameworks of strength and preference.

While the neurological mechanisms proposed here remain speculative, the consistent patterns across participant reports warrant further investigation through controlled studies with objective measures. Such research could ultimately contribute to evidence-based guidelines for inclusive martial arts instruction and broaden understanding of effective, neurodiversity-affirming interventions.

Adherence to ethical standards

While this study did not receive formal institutional ethics committee approval, it was conducted in accordance with established ethical principles for research involving human participants, as well as the Dutch research standards outlined in the *Nederlandse Gedragscode Wetenschappelijke Integriteit* (2018). According to these guidelines, self-reported, non-interventional studies that do not involve medical procedures or vulnerable populations are generally not subject to formal ethical board approval.

The research design and procedures were reviewed by independent advisors with expertise in autism research and qualitative methodology prior to data collection. In addition, the author was supported by an ethical advisor, who confirmed that the study met the relevant standards of ethical conduct.

All participation was entirely voluntary, with participants able to withdraw at any stage without consequence. Comprehensive informed consent was obtained from all respondents, clearly explaining the study's purpose, procedures, data use, and participant rights. No personally identifiable information was collected during any phase of the research.

Data protection protocols were rigorously implemented, with all responses stored anonymously on secure, dedicated servers separate from any identifying information. Interview recordings were transcribed by the research team and subsequently deleted, with only anonymized transcripts retained. All data handling procedures complied with GDPR requirements and established guidelines for protecting the privacy of research participants from vulnerable populations.

The recruitment strategy through public online platforms ensured that participation remained entirely self-directed, without any coercive elements. Participants were explicitly informed that their responses would contribute to academic research aimed at improving understanding and inclusion within martial arts communities. The questionnaire and interview protocols were designed to be respectful and non-intrusive, focusing on positive experiences while allowing participants to share challenges if they chose to do so.

Given the adult-only sample and the non-clinical, experience-focused nature of the research questions, combined with the robust privacy protections and voluntary participation framework, the study was conducted fully within appropriate ethical boundaries despite the absence of formal institutional review.

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Appendix 1 - Survey on the experiences of autistic budoka

Thank you for participating in this study. The aim of this questionnaire is to understand the experiences of autistic individuals in martial arts training. Your responses will contribute to research on the intersection of neurodiversity and budo.

Section 1: Demographics & Martial Arts Background

1. Which martial arts do you practise? (e.g., Karate, Judo, Aikido, Kendo)
2. How long have you been training in martial arts?
 - Less than 1 year
 - 1–3 years
 - 3–5 years
 - More than 5 years
3. What is your current rank or grade?
4. Do you train in a dojo, at home, or in another setting?
 - In a dojo
 - At home
 - Other (please specify)
5. How often do you train per week?
 - Less than once a week
 - 1–2 times a week
 - 3–4 times a week
 - 5 or more times a week
6. What country do you live in?
7. What is your age?
8. How do you describe your gender identity?
 - Female
 - Male
 - Non-binary
 - Prefer not to say
 - Other (please specify)
9. Have you received a formal autism diagnosis?
 - Yes
 - No, but I self-identify as autistic
 - No

Section 2: Sensory and Motor Experience in Martial Arts

10. Do you experience sensory sensitivities (e.g., to light, sound, touch) that affect your training?
 - Yes
 - No
 - Sometimes
 - If yes, please describe.
11. How does practising martial arts affect your body awareness (proprioception)?
 - It has improved significantly.
 - It has improved somewhat.
 - No noticeable change.
 - It has worsened.
12. Do you find repetitive movements (such as kata or drills) helpful for sensory processing?
 - Yes, very much
 - Yes, somewhat
 - No
 - Not sure
13. How do you experience balance and coordination in martial arts?
 - I struggle significantly.
 - I struggle somewhat.
 - No issues.
 - Martial arts has improved my coordination.
14. Do you prefer structured movement patterns (e.g., kata, set techniques) over free sparring? Why?

Section 3: Emotional and Cognitive Regulation

15. How does martial arts impact your ability to manage stress or anxiety?
 - ☐ It helps significantly.
 - ☐ It helps somewhat.
 - ☐ No noticeable effect.
 - ☐ It makes it worse.
16. Do you use martial arts breathing techniques (e.g., deep breathing, kiai) outside of training for emotional regulation?
 - ☐ Yes, frequently
 - ☐ Yes, occasionally
 - ☐ Rarely
 - ☐ Never
17. How does martial arts training impact your self-confidence?
 - ☐ It has improved significantly.
 - ☐ It has improved somewhat.
 - ☐ No noticeable change.
 - ☐ It has worsened.
18. Do you find the structured discipline of martial arts beneficial for focus and executive functioning?
 - ☐ Yes, significantly
 - ☐ Yes, somewhat
 - ☐ No noticeable change
 - ☐ It makes it more difficult

Section 4: Social Interaction in Martial Arts

19. How comfortable are you in a group training environment?
 - ☐ Very comfortable
 - ☐ Somewhat comfortable
 - ☐ Neutral
 - ☐ Somewhat uncomfortable
 - ☐ Very uncomfortable
20. Do you find dojo etiquette (e.g., bowing, structured greetings) helpful in social interactions?
 - ☐ Yes, very much
 - ☐ Yes, somewhat
 - ☐ No
 - ☐ Not sure
21. How do you feel about partner exercises (e.g., paired drills, sparring)?
 - ☐ I enjoy them.
 - ☐ I tolerate them.
 - ☐ I find them difficult.
 - ☐ I avoid them when possible.
22. Do you feel that the hierarchical structure of martial arts (e.g., belt system, senpai/kohai relationships) provides clarity in social interactions?
 - ☐ Yes, very much
 - ☐ Yes, somewhat
 - ☐ No
 - ☐ Not sure
23. Have you made social connections through martial arts?
 - ☐ Yes, I have formed close friendships.
 - ☐ Yes, I have some acquaintances.
 - ☐ No, but I enjoy the social setting.
 - ☐ No, I struggle with social interaction.

Section 5: Overall Experience and Additional Thoughts

24. What is the biggest challenge you face in martial arts training as an autistic individual?
25. What is the greatest benefit you experience from martial arts training?
26. If you could change anything about martial arts training to make it more inclusive for autistic practitioners, what would it be?
27. Is there anything else you would like to share about your experience with martial arts and autism?