

(DSM-5) [1], a diagnosis of ASD precluded a diagnosis of ADHD, there has been a considerable amount of research focusing on the co-occurrence between ADHD and ASD and many questions have been posed about the relationship between the two disorders. So far, the body of literature is, for the vast majority, based on childhood data. Research data show that 18 to 50% of children with ADHD present with clinical levels of ASD symptoms [7–10]. Conversely, ADHD is the most common co-occurring disorder in children with ASD, with co-occurrence rates in the 40–70% range [11–13]. Moreover, it has been reported that the overshadowing of symptoms in co-occurring cases that had been diagnosed with ADHD first may lead to a delay in the diagnosis of ASD [14]. Research data on the co-occurrence of ADHD and ASD in adulthood are scarce. The proportions of current or past diagnoses of ADHD in ASD adult patients have been reported to be from 9.7 to 43%, with most reports being within the range of 37–43% [6,15–19], while Edvinsson et al. [20] found that over 10% of a sample of patients diagnosed with ADHD in adulthood had a current or past diagnosis of ASD. Some researchers have even categorized ADHD and ASD as falling on the same continuum of neurodevelopmental disorders, with ADHD representing a less severe presentation of ASD [21,22].

Although carrying out a diagnosis following the DSM or International Classification Diseases (ICD) criteria has been the norm in child and adult psychiatry, a dimensional or hybrid model approach has been adopted for polythetic syndromes [23]. There is increasing recognition that dimensions of behavior can cut across diagnostic categories and those dimensions can be helpful in successfully categorizing individuals with neurodevelopmental disorders. Consistent with the hypothesis that co-occurrence of ADHD and ASD is better examined using dimensional traits are studies that investigate mechanisms underlying the co-occurrence of the two disorders. Polderman et al. [24] investigated specific patterns in the co-occurrence of ASD and ADHD traits in adults. Five trait-based dimensions of ASD (social skill impairments, strong routine preferences, attention-switching problems, imagination impairments, and a strong fascination for numbers and patterns), and two dimensions of ADHD (inattentive (IA) and hyperkinetic/impulsive (HI)) were jointly examined in a population-based adult sample. HI problems did not correlate substantially with the ASD trait dimensions, whereas IA problems correlated only with the ASD dimension assessing attention-switching difficulties. Furthermore, Polderman et al. [25] examined the genetic and environmental etiology of the association between specific ASD and ADHD disorder dimensions. In a community sample of adult twins, they assessed self-reported data on the ASD social and communication difficulties (ASD_{sc}) and repetitive and restricted behavior and interests (ASD_r) dimensions and the ADHD IA and HI dimensions. They concluded that ASD_r problems form an important link between ASD and ADHD comorbidity. Ghirardi et al. [26] studied individuals aged 20–28 years from the Swedish Study of Young Adult Twins. They estimated the phenotypic and etiological overlap between self-rated trait dimensions of ADHD and ASD. At the phenotypic level, HI was correlated more strongly with repetitive and restricted behaviors (RRB) than social interaction and communication (SIC), whereas IA was equally associated with both dimensions of ASD traits. Their findings suggest a dimension-specific phenotypic and etiological overlap between ADHD and ASD traits.

It has also been reported that ADHD prevalence in ASD decreases with age and preliminary data suggest that the association between ASD and ADHD traits may be somewhat lower in adulthood than in childhood/adolescence [27]. Hartman et al. [28] reported that both ADHD and ASD symptom constellations are not at all stable across development, with some symptom dimensions (attention problems and social problems) being much more persistent than other symptom dimensions (hyperactivity/impulsivity and repetitive behaviors). In a meta-analysis of social cognition [29], it was reported that the developmental trajectories of social cognition probably differ between ADHD and ASD as social cognitive deficits in ADHD might improve with age in most individuals. Lai and Baron-Cohen [6] stated that ADHD is seen in up to 40% of adults with ASD and support the view that the important point of differentiation is the nature of surface-level inattentiveness.

Table 1. Sample characteristics by group.

Demographics	Diagnosis			Test Statistic (df) *	p
	ADHD N = 151	ASD N = 58	ADHD + ASD N = 29		
Age (years), mean (SD)	31.0 (10.0)	28.7 (9.2)	28.8 (10)	1.41 (2, 234)	0.246
Sex, N (%)					
Men	106 (70.2)	47 (81)	19 (65.5)	3.21 (2)	0.201
Women	45 (29.8)	11 (19)	10 (34.5)		

* F (df₁, df₂) for ANOVA, χ^2 (df) for Pearson’s chi-square test. ADHD: attention deficit hyperactivity disorder, ASD: autism spectrum disorder.

The self-reported measures of ADHD subscales for the three study groups are shown in Table 2. As expected, subjects with ADHD had significantly higher scores on all ADHD traits compared to the ASD subjects. Furthermore, subjects having both ADHD and ASD diagnoses had significantly greater scores on all ADHD traits compared to ASD ones. No significant differences concerning ADHD trait scores were found between subjects with ADHD and those having both ADHD and ASD.

A comparison of the self-reported measures of AQ and EQ scores between the three study groups are presented in Table 3. Scores in the AQ traits were found to be significantly greater in the ASD subjects compared to the ADHD subjects, as expected, with the exception of attention to detail. Additionally, all AQ trait scores were found to be significantly greater in those having both ADHD and ASD in comparison to those having ADHD alone. Furthermore, the attention to detail score was found to be greater in those having both ADHD and ASD compared to those with ASD. The total EQ score was greater in ADHD subjects compared to ASD cases and those that had both ADHD and ASD.

The results from the stepwise logistic regression analyses (Table 4) showed that hyperactivity at ages 5–12, inattention in the last 6 months, impulsivity in the last 6 months, attention switching, communication, imagination, and the total EQ score could discriminate ADHD patients from ASD patients. Furthermore, multiple analyses showed that attention to detail, imagination, and the total EQ score could discriminate ADHD cases from those having both ADHD and ASD, while hyperactivity at ages 5–12 and impulsivity in the last 6 months were found to significantly discriminate between ASD and ADHD/ASD subjects.

compared to ADHD/ASD patients. The same applied to all ADHD trait subscales (Table 2). In the stepwise logistic regression analysis (Table 4), the ADHD traits subscale scores that could discriminate ADHD patients from ASD were hyperactivity at ages 5–12, inattention in the last 6 months, and impulsivity in the last 6 months. Furthermore, the scores of hyperactivity at ages 5–12, together with impulsivity in the last 6 months, could discriminate ADHD/ASD patients from ASD patients. It seems that the following four ADHD items that describe current impulsivity—(1) talked excessively, (2) blurted out answers before questions had been completed (completed others' sentences or jumped the gun), (3) had difficulty waiting their turn, and (4) interrupted or intruded on others (battered into conversations or activities without permission or took over what others were doing)—may be very useful for the discrimination between adults with a dual ADHD/ASD diagnosis and those patients having ASD as a sole diagnosis. The fact that impulsivity at ages 5–12 was not among the discriminant factors could be explained by the suggestion made by Barkley [45] stating that symptoms of impulsivity, especially verbal impulsivity, begin to emerge as a semi-distinct dimension of ADHD symptoms in adulthood and is not so distinct from hyperactivity in children's ratings or in the retrospectively recalled symptoms of childhood, as reported by adults. Furthermore, in accordance with our findings, Barkley et al. [58] noted that in a free interview context, patients' responses for the symptoms (1) making decisions impulsively and (2) having difficulty stopping activities or behavior when they should do so are the best discriminating symptoms for ADHD from other forms of psychopathology. The above symptoms were also found useful in order to screen for ADHD among anxious and depressive adult psychiatric outpatients [39]. There are very few disorders apart from ADHD where impulsivity is part of the diagnostic criteria, such as borderline personality disorder or some obsessive-compulsive spectrum disorders [1,59]. Therefore, current impulsivity may be viewed as a red flag for a possible co-occurring ADHD in patients with other diagnoses. Impulsivity is also considered to play a central role in understanding ADHD/ASD comorbidity. Sokolova et al. [60] studied the relationship between ASD and ADHD symptoms by applying causal modeling. They used a large phenotypic dataset of 417 children with ASD and/or ADHD, 562 affected and unaffected siblings, and 414 controls to infer a structural equation model using a causal discovery algorithm. The strongest links they found were between social communication difficulties, inattention, and impulsivity, and suggested that impulsivity has a causative effect on social ineptness.

In clinical practice, the finding that self-reports of current impulsivity can discriminate ASD patients from ASD/ADHD patients has both diagnostic and treatment implications. Interviewing adults of normal intelligence with an ASD diagnosis for current impulsivity may lead to a co-occurring ADHD diagnosis, which has to be treated accordingly (i.e., with stimulants).

4.3. AQ Dimensions

As expected, the total AQ score and most of the AQ subscale scores were higher in adults with ASD compared to adults with ADHD, with the exception of the subscale score of attention to detail. Furthermore, patients with ADHD/ASD scored higher in all AQ scores compared to patients with ADHD.

When comparing patients with ASD to patients with ADHD/ASD, no difference was found, with the exception of the subscale attention to detail, whose scores were higher in the combined group. It seems that attention to detail scores did not significantly differ between ADHD and ASD, but the co-occurrence of the two disorders significantly increased the score in this subscale. Furthermore, stepwise logistic regression multiple analysis showed that attention to detail, along with imagination, were two of the three dimensions (the third one being EQ score) that discriminated ADHD/ASD cases from those having ADHD, with imagination being lower, while attention to detail being higher in the dual-diagnosed group.

Our results for “attention to detail” are in line with previous reports separating this subscale from the other subscales of AQ. In confirmatory factor analyses in both a general population and a student sample [61], four out of the five domains of the AQ (social skill, communication, attention switching, and imagination) were highly correlated. The authors proposed a hierarchical model, allowing these four domains to cluster together as a “social interaction” factor, while a small second factor, consisting of items focusing on a preference for details and patterns (the domain “attention to detail”) was also identified. The usefulness of the AQ in differentiating between adult ASD and adult ADHD was also studied by Sizoo et al. [62], who explored whether substance use disorder (SUD) comorbidity affects AQ scores. Once more, the total AQ score and most of the AQ subscale scores were higher in adults with ASD compared to adults with ADHD, except for the subscale score attention to detail. The attention to detail subscale is composed of items referring to a perceptual style with a preference for details and patterns. It might be that this autistic dimension scale does not discriminate between patients with ASD and patients with ADHD because it refers to a strategy for dealing with aspects of attention deficit that is common to both disorders. Patients with ASD present attention deficit distress when they are overwhelmed by perceptual stimuli. The distress is said to decrease when focusing on logical sequences, such as patterns, telephone numbers, or car license plates. On the other hand, patients with ADHD might try to compensate for their attention deficits by focusing on patterns and details. It seems that the co-occurrence of ADHD/ASD further increases the attention deficit and consequently a stereotyped behavior that is registered as an increased score in the attention to detail subscale. Attention to detail could also be an underlying psychological mechanism that explains why ASD repetitive and restricted behavior and interests seem to form a link between ASD and ADHD [24,26].

Imagination was the other dimension deriving from the AQ that differentiated individuals with ADHD from individuals with ASD or ADHD/ASD, indicating that a lack of imagination could be considered a discriminating trait in adults with ASD, regardless of ASD being a sole or co-occurring diagnosis. It is well known that people with ASD form a group of individuals for whom spontaneous and fantastical acts of imagination appear to be a challenge. Children with autism do not engage in spontaneous pretend play in the ways that typically developing children do, engaging instead in repetitive activities, and adults with autism are less interested in fiction [63–66].

4.4. EQ Score

The EQ total score was lower in ASD and ADHD/ASD patients compared to ADHD patients, while no difference was found between ASD and ADHD/ASD patients (Table 3). Furthermore, stepwise logistic multiple regression analysis showed that the EQ score was among the factors that discriminated both ASD and ADHD/ASD cases from ADHD cases (Table 4). It seems that a low EQ score, similarly to low imagination, is indicative of the presence of ASD either as a sole diagnosis or as a co-occurring disorder.

The EQ has not been systematically studied in adults with clinical ADHD diagnosis. Groen et al. [36] reported reduced EQ scores in adults with a subclinical DSM-5 ADHD diagnosis compared to the control group, although still within the normal range. They considered that the reduced EQ score may be related either to a reduced emotion regulation/emotional lability in patients with ADHD or ASD comorbidities. The latter is supported by our finding that EQ was reduced only in the group with ADHD/ASD co-occurrence and not the ADHD group.

The EQ is designed to measure how easily a person can detect other people’s feelings and is affected by them. Since empathy is a core skill that facilitates effective social interaction [30], a lower empathetic ability may reflect less social adaptability and may be the key factor in understanding reasons for referrals in adulthood [67]. Lower empathizing traits, as measured by the EQ in individuals that are referred and diagnosed in adulthood, may be especially important in understanding challenges with social adaptability. Measures assessing social cognition may not be sensitive enough to detect difficulties in functioning for

adults of normal intelligence because of the “camouflaging” of ASD-related characteristics in social situations where a patient is motivated by the desire to fit in with others [68].

The finding that EQ discriminates adults of normal intelligence with co-occurring ADHD/ASD from patients with ADHD has important clinical implications. Interviewing for the capacity to detect other people’s feelings when assessing adults for a possible ADHD diagnosis might reveal symptoms indicating the possible co-occurrence of ASD. Treating ADHD with co-occurring ASD is much more complex than treating ADHD as a sole diagnosis.

4.5. Limitations

A number of limitations of this study should be taken into consideration. First, our subjects represent a specific clinical population, and thus, the results cannot be generalized to other samples, such as community or low-functioning samples. Second, the study population was not very large, especially the combined ADHD/ASD population. Third, we used structured interviews only in selected cases that were considered to be more complicated. However, previous research has shown that there is a moderate agreement between clinical diagnoses and ADOS4, while ADI-R might not be reliable in adults without an intellectual disability [69–71]. An extended psychiatric interview made by an experienced psychiatrist, combined with collateral information, is probably the most essential part of the diagnostic assessment in high-functioning adults. Furthermore, the BAARS-IV is based on the DSM-IV criteria for ADHD. Nevertheless, the 18 items of the BAARS-IV are similar in terms of the number and quality of the DSM-5 items and the BAARS-IV is the only screening instrument where the three dimensions of ADHD (inattention, hyperactivity, and impulsivity) are considered separately [45]. Another limitation of the study is the low Cronbach’s α for the attention switching and imagination subscales of the AQ. It is noteworthy that a low degree of internal consistency for some subscales of the AQ, and in particular for the imagination subscale, has been reported in previous studies too [61,72–75]. Therefore, findings regarding these particular dimensions should be considered with caution. Finally, researchers must always be prudent with the interpretation of results of self-reported questionnaires when used for individuals with neurodevelopmental disorders where self-reflection and metacognitive skills might be impaired. This is particularly an issue with people having an ASD examination, where a poor awareness of autism-related traits may lead to an under-reporting of autism symptoms and over-reporting of social competency [50,76].

5. Conclusions and Research Implications

Despite the limitations, our results illustrate that apart from considering diagnostic categories, individual trait-based dimensions deriving from screening instruments (BAARS-IV, AQ, and EQ) might be of particular help in the comprehensive assessment and differential diagnosis of adults of normal intelligence with a suspected ADHD or ASD diagnosis, and in particular, of those with the more perplexing ADHD/ASD diagnosis. Being able to successfully categorize individuals with ADHD, ASD, or ADHD/ASD by using clinical dimensions is an important first step toward identifying the atypical brain function and structure underlying these clinical features. Our findings highlight the importance of the dimensions of current impulsivity, attention to detail, imagination, and empathy when discriminating adults with ADHD, ASD, and co-occurring ADHD/ASD. They also suggest the need to study the neural underpinnings of these particular traits using a lifespan approach in order to understand the persistence and co-occurrence of ADHD and ASD in adulthood.

Author Contributions: Conceptualization: A.P., K.P., and C.P.; methodology: A.P. and K.P.; formal analysis: A.P. and K.P.; data curation: A.P., K.P., K.K., E.K., V.M., and D.P.; writing—original draft preparation A.P. and K.P.; supervision: C.P. funding acquisition: A.P. and C.P. All authors have read and agreed to the published version of the manuscript.

70. Brugha, T.S.; McManus, S.; Smith, J.; Scott, F.J.; Meltzer, H.; Purdon, S.; Berney, T.; Tantam, D.; Robinson, J.; Radley, J.; et al. Validating two survey methods for identifying cases of autism spectrum disorder among adults in the community. *Psychol. Med.* **2012**, *42*, 647–656. [[CrossRef](#)]
71. Fusar-Poli, L.; Brondino, N.; Rocchetti, M.; Panisi, C.; Provenzani, U.; Damiani, S.; Politi, P. Diagnosing ASD in Adults Without ID: Accuracy of the ADOS-2 and the ADI-R. *J. Autism Dev. Disord.* **2017**, *47*, 3370–3379. [[CrossRef](#)] [[PubMed](#)]
72. Austin, E.J. Personality correlates of the broader autism phenotype as assessed by the Autism Spectrum Quotient (AQ). *Personal. Individ. Differ.* **2005**, *38*, 451–460. [[CrossRef](#)]
73. Bezemer, M.L.; Blijd-Hoogewys, E.M.A.; Meek-Heekelaar, M. The Predictive Value of the AQ and the SRS-A in the Diagnosis of ASD in Adults in Clinical Practice. *J. Autism Dev. Disord.* **2020**, 1–14. [[CrossRef](#)] [[PubMed](#)]
74. Hurst, R.; Mitchell, J.; Kimbrel, N.; Kwapil, T.; Nelson-Gray, R. Examination of the reliability and factor structure of the Autism Spectrum Quotient (AQ) in a non-clinical sample. *Pers. Individ. Differ.* **2007**, *43*, 1938–1949. [[CrossRef](#)]
75. Stewart, M.E.; Austin, E.J. The structure of the Autism-Spectrum Quotient (AQ): Evidence from a student sample in Scotland. *Personal. Individ. Differences* **2009**, *47*, 224–228. [[CrossRef](#)]
76. Johnson, S.A.; Filliter, J.H.; Murphy, R.R. Discrepancies Between Self- and Parent-Perceptions of Autistic Traits and Empathy in High Functioning Children and Adolescents on the Autism Spectrum. *J. Autism Dev. Disord.* **2009**, *39*, 1706–1714. [[CrossRef](#)]