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FUNCIONES EJECUTIVAS Y COMPETENCIA SOCIAL EN NIÑOS CON TRASTORNO DEL ESPECTRO AUTISTA Y DÉFICIT DE ATENCIÓN CON HIPERACTIVIDAD

TESIS DOCTORAL

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CERTIFICAN, que la tesis titulada, Funciones Ejecutivas y Competencia Social en niños con Trastorno del Espectro Autista y Déficit de Atención con Hiperactividad**,** presentada por CARMEN BERENGUER FORNER para optar por el grado de Doctor, ha sido realizada en el Departamento de Psicología Evolutiva y de la Educación de la Universidad de Valencia, Programa de Investigación en Psicología bajo nuestra dirección, cumpliendo los requisitos necesarios de calidad y originalidad para su defensa.

Y para que conste, expedimos la presente en Valencia, a 31 de enero de 2018

Ana Miranda Casas	Belén Roselló	Carla Colomer
Fdo.	Fdo.	Fdo.

A Irene, Ignacio, Martín y Carolina

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RESUMEN

Recientes estudios han señalado la necesidad de conocer los mecanismos subyacentes del trastorno del espectro del autismo (TEA) y el trastorno por déficit de atención con hiperactividad (TDAH), así como la comorbilidad de ambos. Los déficits en las funciones ejecutivas (FE) y en cognición social (COS) han sido los procesos más intensamente investigados, con hallazgos que no son unánimes. La presente investigación se propuso profundizar en el FE y en las habilidades de COS que contribuyen al funcionamiento social, conductual y adaptativo de niños con TEA de alto funcionamiento, TDAH y TEA+TDAH. Los participantes fueron 124 niños entre 7 y 11 años, distribuidos en cuatro grupos: 37 con desarrollo típico (DT), 35 con TDAH, 30 con TEA y 22 con TEA+TDAH, igualados en edad y CI. Se aplicaron diferentes medidas de funcionamiento ejecutivo, cognición y competencia social. Los resultados mostraron un perfil de déficits ejecutivos similar entre el TDAH y el TEA+TDAH. Sin embargo, en procesos de COS los grupos con TEA con y sin comorbilidad con TDAH presentaron más dificultades. Además, los síntomas de inatención agravaron la competencia social en niños con TEA. Estos hallazgos refuerzan la necesidad de tener en cuenta los síntomas de TDAH, junto al entrenamiento en FE y habilidades mentalistas, en el diseño de tratamientos para niños con TEA.

Palabras clave. Funcionamiento ejecutivo. Cognición social. Competencia social. Comorbilidad. TEA.TDAH.

ABSTRACT

Recent studies have pointed out the need to understand the underlying mechanisms of autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD), as well as the comorbidity of both. The deficits in executive functions (EF) and in social cognition (SC) have been the most intensively researched processes, with findings that, are not unanimous. The main objective of the present investigation is to study the EF and the abilities of SC that contribute to the social, behavioral and adaptive functioning of children with high functioning ASD, ADHD and ASD + ADHD. The participants were 124 children between 7 and 11 years old, divided into four groups: 37 typically developing (TD), 35 ADHD, 30 ASD and 22 ASD + ADHD, matched in age and IQ. Different measures of executive functioning, cognition and social competence were applied. The results showed a profile of similar executive deficits between ADHD and ASD + ADHD. However, in social cognition processes, groups with ASD with and without comorbidity with ADHD presented more difficulties. In addition, the symptoms of inattention aggravated social competence in children with ASD. These findings reinforce the need to take into account the symptoms of ADHD, along with executive functioning training and mentalist skills, in the design of treatments for children with ASD.

Key words. ADHD. ASD. Comorbidity. Executive functioning. Social cognition. Social competence.

ÍNDICE

GLOSARIO DE ABREVIATURAS PRINCIPALES

APA: Asociación Americana de Psiquiatría

CI: Cociente intelectual

COS: Cognición social

DI: Discapacidad intelectual

DSM: Manual estadístico y diagnóstico de los trastornos mentales

DT: Desarrollo típico

FE: Funciones ejecutivas o funcionamiento ejecutivo

MT: Memoria de trabajo

RE: Reconocimiento de emociones

TDAH: Trastorno por déficit de atención con hiperactividad/impulsividad

TEA: Trastorno del espectro autista

TEA+TDAH: Trastorno del espectro autista con síntomas comórbidos de TDAH

TEA+: Trastorno del espectro autista con síntomas comórbidos de TDAH

ToM: Teoría de la mente.

INTRODUCCIÓN GENERAL

Los trastornos del neurodesarrollo son un grupo de condiciones heterogéneas que tienen su origen durante etapas tempranas del desarrollo y se caracterizan por déficits a nivel cognitivo y funcional (Asociación Americana de Psicología [APA], 2013). Este tipo de trastornos causa un deterioro en el funcionamiento adaptativo no sólo en los individuos que lo sufren sino también en el núcleo familiar próximo, debido a la gravedad y persistencia de los síntomas a lo largo del ciclo vital. Por tanto, es esencial su estudio y comprensión, para la planificación de estrategias que optimicen los programas de prevención e intervención.

El trastorno del espectro autista (TEA) y el déficit de atención con hiperactividad (TDAH) son dos de los trastornos del neurodesarrollo más comunes. La prevalencia del TDAH se sitúa alrededor del 6.5% (Willcutt, 2012) en estudios poblacionales. El TEA ha multiplicado su prevalencia por 4 en la última década con una tasa de 1/68 in EE UU (U.S. Department of Health and Human Services, 2014). El mayor incremento se ha producido en el subgrupo de TEA que no presenta discapacidad intelectual, el autismo de alto funcionamiento o severidad de nivel 1, con una prevalencia del 62% (Baron-Cohen et al., 2009; Christensen, Baio & Braun, 2016). En España no contamos con un censo riguroso, pero, de acuerdo con la Confederación Española de Autismo, el porcentaje actual se sitúa en1/100.

El TEA se caracteriza por déficits en la comunicación e interacción social y en la existencia de patrones de conducta, intereses o actividades restringidos y repetitivos (APA, 2013). Por su parte el TDAH se caracteriza por síntomas de inatención, hiperactividad e impulsividad. En los dos trastornos a menudo se observan dificultades en atención y diferentes grados de impulsividad e inquietud. Ambos comparten un inicio temprano, retrasos en el desarrollo cerebral, tanto estructurales como funcionales, dificultades en el funcionamiento ejecutivo, un claro predominio masculino y factores de

riesgo genético y biológico (Rommelse & Hartman, 2016; Visser, Rommelse, Greven, & Buitelaar, 2016). Además, estos dos trastornos del neurodesarrollo tienen consecuencias negativas en múltiples áreas de funcionamiento, que ocasionan consecuencias negativas en la adaptación y competencia social del individuo a largo plazo. Concretamente los niños con TEA sufren consecuencias relacionadas con los déficits de interacción social, como menor apoyo social y más soledad que sus compañeros con desarrollo típico (Bauminger & Kasari, 2000). De manera similar, el TDAH se asocia con una disminución de las habilidades para interactuar socialmente con éxito, incluyendo pobres relaciones con los compañeros y la familia. Entre los múltiples factores determinantes del rechazo de los iguales destaca la incapacidad para participar en intercambios sociales que se observa en conductas tales como compartir, iniciar, cooperar y esperar el turno. A largo plazo el rechazo de los compañeros se asocia con problemas emocionales y conductuales, conductas delictivas y déficits en el funcionamiento global (Mrug et al., 2012).

Recientemente el Manual diagnóstico y estadístico de los trastornos mentales en su quinta edición (DSM-5; APA, 2013) permitió por primera vez el diagnóstico conjunto de TEA y de TDAH (TEA+TDAH), fundamentado en la alta comorbilidad que presentan ambos trastornos.

La revisión de la literatura de los últimos años demuestra que la prevalencia media de comorbilidad TEA y TDAH está comprendida entre el 37-85% (Gjevik, Eldevik, Fjæran-Granum, & Sponheim, 2011; Leitner, 2014; Stratis & Lecavalier, 2013) incluso en muestras con discapacidad intelectual (DI) (Amr et al., 2012). Es más, un reciente estudio basado en una extensa muestra poblacional de gemelos entre 9 y 12 años, concluyó que el 82% de niños y el 95% de niñas con marcados rasgos de TEA mostraron déficits en al menos uno de los síntomas nucleares del TDAH (inatención,

hiperactividad, impulsividad). A su vez, un 42% de niños y 62% de niñas con rasgos de TEA mostraron déficits en al menos dos síntomas nucleares del TDAH (Ronald, Happé, & Plomin, 2008; Ronald, Larsson, Anckarsäter, & Lichtenstein, 2014). No obstante, existen datos del 53% (Caamaño et al., 2013), 68% (Mannion, Leader, & Healy, 2013), o inferiores (Russell, Rodgers, Ukoumunne, & Ford, 2014). Las variaciones pueden obedecer al reducido número de participantes, a la extracción de la muestra en centros específicos de TEA, o a una mayor coexistencia con otros trastornos. En líneas generales, las investigaciones coinciden en que el TDAH es una de las condiciones comórbidas más comunes en niños con TEA (Simonoff et al, 2008). Por el contrario, un 15-25% de niños con TDAH presentan síntomas clínicos de TEA (Kotte et al., 2013).

La literatura muestra la existencia de una predisposición genética y perfiles cognitivos similares en el TEA y el TDAH. Ambos comparten teorías explicativas basadas en déficits en el funcionamiento ejecutivo (Barkley, 1997; Pennington & Ozonoff, 1996) y experimentan dificultades en procesos de cognición social como teoría de la mente o reconocimiento de emociones (Bora & Pantelis, 2016; Demopoulos, Hopkins, & Davis, 2013; Happé & Ronald, 2008; Happé & Frith, 2014). Por otra parte, el fenotipo combinado TEA+TDAH parece reflejar una comorbilidad "aditiva", más que una condición separada con distintos déficits (Oerlemans et al., 2016; Rommelse, Geurts, Franke, Buitelaar, & Hartman, 2011).

La comorbilidad de los síntomas de TDAH está asociada con un peor funcionamiento ejecutivo (FE) y más dificultades en los procesos de cognición social (COS) en niños con TEA (Antshel, Zhang-James, Wagner, Ledesma, & Faraone, 2016; Dajani, Llabre, Nebel, Mostofsky, & Uddin, 2016), con importantes repercusiones en la competencia social (Factor, Ryan, Farley, Ollendick, & Scarpa, 2017; Luteijn et al., 2000). Los pocos

estudios que han abordado la adaptación socio-emocional en la condición comórbida muestran que los niños con TEA+TDAH presentan déficits más graves de adaptación que los niños con TDAH, especialmente en el dominio de la socialización (Ashwood et al., 2015). Otro hallazgo aún con más relevancia si cabe, es la mayor similitud del grupo comórbido con el grupo TEA que con el grupo TDAH en cuanto al perfil de déficits en conductas adaptativas, focalizados en habilidades de comunicación, socialización y del día a día (Craig et al., 2015). Un último estudio en la misma línea ha encontrado que los niños con TEA+TDAH tienen peor calidad de vida, tanto psicosocial como de salud física, y mayores problemas con los compañeros en comparación con el grupo TDAH (Thomas, Sciberras, Lycett, Papadopoulos, & Rinehart, 2015).

Dada la importancia que tiene la adaptación y competencia social en la vida de las personas, es de vital importancia el examen exhaustivo de los factores que pueden explicar los déficits en el funcionamiento social, concretamente el FE y procesos clave de COS como la Teoría de la Mente (ToM) y el reconocimiento de emociones (RE). No hay una evidencia concluyente de que los procesos deficitarios y los factores que originan la problemática social sean diferentes en el TEA y en el TDAH, y aún es más limitado el conocimiento que se tiene sobre ese tema en relación al subgrupo TEA+TDAH.

La presente Tesis Doctoral pretende profundizar en el conocimiento de las habilidades de FE y procesos clave de COS, en particular habilidades de ToM y RE, que contribuyen al funcionamiento social, comportamental y adaptativo de niños con TEA de alto funcionamiento, TDAH y TEA+TDAH. En primer lugar, en el Estudio 1 y 2 se explora el perfil de FE y habilidades de ToM, tanto en niños con TEA como en niños con TDAH. De acuerdo a este objetivo, el estudio 1 se centra en la comprensión del efecto de este

conjunto de procesos cognitivos en la competencia social de niños con TEA. Por su parte, el Estudio 2 examina los mecanismos subyacentes que operan entre los síntomas de TDAH, el funcionamiento ejecutivo, las habilidades de la ToM y la competencia social de niños con TDAH. En segundo lugar, el Estudio 3 pretende identificar posibles similitudes y diferencias en habilidades de ToM en niños con TEA y niños con TDAH. Así como, la interacción entre las habilidades de ToM y el funcionamiento ejecutivo en niños con TEA y niños con TDAH.

Por último, teniendo en cuenta el perfil ejecutivo y de las habilidades mentalistas de ambos trastornos, el Estudio 4 intenta explorar el FE y las habilidades de TOM en el grupo comórbido TEA+TDAH y analizar la relación entre síntomas del TEA y TDAH y FE, COS y problemas emocionales y conductuales en niños con TEA+TDAH. A pesar de la importancia de tener en cuenta la comorbilidad, especialmente en el diseño de programas de intervención, todavía se desconoce el grado de contribución de los síntomas de TDAH a los procesos ejecutivos y de cognición social en niños con TEA. Hasta el momento, al menos que sepamos, es la primera investigación en la que se estudian trastornos del desarrollo, TEA, TDAH y la presentación comórbida, desde una perspectiva con esta envergadura. Se espera que la información que se obtenga pueda mejorar los protocolos estandarizados de evaluación y el diseño de intervenciones más ajustadas a las necesidades personales de los niños con estos trastornos.

PRIMERA PARTE: MARCO TEÓRICO

1. Funcionamiento Ejecutivo en niños con TEA y TDAH

1.1. Conceptualización del Funcionamiento Ejecutivo

El funcionamiento ejecutivo hace referencia a habilidades implicadas en procesos cognitivos de alto nivel que permiten gestionar y regular la propia conducta con el fin de alcanzar una meta deseada (Barkley, 1997; Miyake & Friedman, 2012). Involucra múltiples redes neuronales que incluyen el tálamo, los ganglios basales y la corteza prefrontal (Middleton & Strick, 2001; Pennington, 2002). Este abanico de habilidades, dirige el pensamiento, la acción y las emociones, desempeñando un papel determinante en la adaptación socio personal de los individuos (Barkley, 2011).

Durante las últimas décadas se han propuesto numerosas definiciones y modelos de FE (Goldstein & Naglieri, 2013). A pesar de que las definiciones específicas varían según diferentes autores, existe un consenso general de que el FE comprende un conjunto de habilidades relacionadas que permiten la solución de problemas y la regulación de la conducta dirigida a una meta. La función ejecutiva se considera un constructo global multifacético que incluye componentes de supervisión y autorregulación, organizando y dirigiendo la actividad cognitiva, la respuesta emocional y la conducta manifiesta. Mientras algunos autores abogan por un sistema ejecutivo unitario, que no puede subdividirse en componentes específicos (Goldman-Rakic, 1987), otros proponen diversos grados de fraccionamiento (Burgess, Alderman, Evans, Emslie, & Wilson, 1998).

Estudios previos han identificado al menos tres procesos cognitivos claves en el funcionamiento ejecutivo, que posibilitan el desarrollo de funciones de alto nivel como el razonamiento, la resolución de problemas y la planificación. Estos procesos son la inhibición de respuestas ante posibles de distractores, la memoria de trabajo y la flexibilidad. La inhibición se

refiere a la capacidad de demorar una respuesta dominante para alcanzar la meta y controlar la tendencia impulsiva a responder. El fallo en la inhibición conductual repercute negativamente en funciones neuropsicológicas de autocontrol, autorregulación emocional, memoria de trabajo, y en procesos de análisis y síntesis. La memoria de trabajo es otro dominio clave del funcionamiento ejecutivo y se define como la capacidad de mantener activa la información en la mente con la finalidad de utilizarla cuando las demandas externas lo requieren. La memoria de trabajo puede dividirse a su vez en dos subdominios; la memoria de trabajo verbal y la memoria de trabajo visuo espacial. Por último, la flexibilidad hace referencia a cambiar de tarea rápidamente, o considerar diversas perspectivas y adaptarse a las circunstancias cambiantes (Diamond, 2013).

En un modelo simplificado, las FE representan procesos cognitivos "top-down" que facilitan la toma de decisiones al mantener información sobre posibles elecciones en la memoria de trabajo, de manera que integran ese conocimiento con información sobre el contexto actual para identificar cuál es la decisión óptima en cada situación (figura 1).

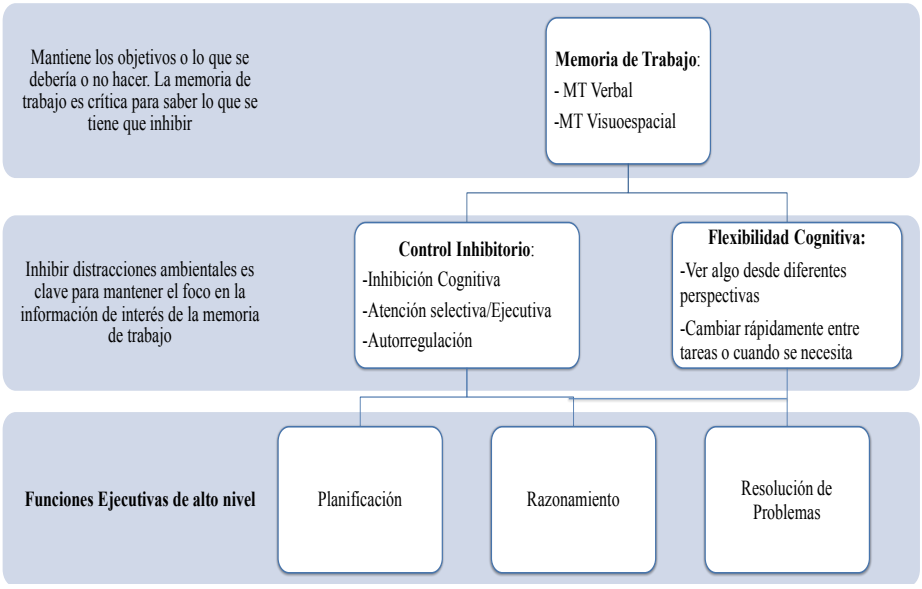


Figura 1. Adaptación de las funciones ejecutivas (Diamond, 2013)

Otros subdominos comúnmente aceptados son las habilidades para iniciar y mantener una conducta determinada, seleccionar objetivos de tareas relevantes, planificar y organizar estrategias de resolución de problemas, monitorear y evaluar el propio comportamiento (Pennington, Bennetto, McAleer, & Roberts, 1996).

En la misma línea (Gioia, Isquith, Guy, & Kenworthy, 2000) propusieron una amplia clasificación de dominios de FE que reflejan por un lado la regulación del comportamiento/emociones y por otro, los procesos metacognitivos. Tanto la regulación comportamental/ emocional como los procesos metacognitivos estarían recíprocamente relacionados con la resolución de problemas. Este modelo, fruto de una amplia revisión de otros planteamientos teóricos, define el FE como un "director de orquesta" que

dirige y controla la actividad cognitiva, la respuesta emocional y el comportamiento.

Además, otra de las cuestiones inherentemente relacionada con la complejidad teórica del constructo se refiere a cómo se operacionalizaría la evaluación de las funciones ejecutivas. En este sentido, las medidas de laboratorio han evidenciado ciertas limitaciones frente a medidas más ecológicas que pueden abarcar las demandas de situaciones cotidianas de la vida real (Goldstein & Naglieri, 2013). El modelo de FE propuesto por Gioia, et al. (2000) es un modelo ampliamente utilizado en estudios con niños con TEA y con TDAH, ya que se basa precisamente en la evaluación de múltiples dominios de FE en situaciones de la vida diaria, a través de la información aportada por diferentes observadores.

1.2. Funcionamiento ejecutivo en niños con TEA y en niños con TDAH

Actualmente la evidencia de disfunción ejecutiva en el autismo es firme (Hill, 2004, Ozonoff & Jensen, 1999). Estudios de neuroimagen han evidenciado anormalidades en el volumen cortical y disfunciones en la conectividad en áreas prefrontales, corticales y subcorticales (Nomi & Uddin, 2015), que podrían influir en los diferentes dominios de funcionamiento ejecutivo.

La literatura muestra la relación entre los déficits ejecutivos en el TEA y las otras dos teorías cognitivas dominantes del autismo como son la teoría de la coherencia central débil (Frith, 1989; Frith, Happé, & Siddons, 1994) y la teoría de la mente (ToM) (Baron Cohen, 1995). Por consiguiente, las funciones ejecutivas tienen un gran interés en el TEA, dado su papel relevante en déficits específicos en áreas de teoría de la mente (Jones et al., 2017; Pellicano, 2007), patrones de comportamiento repetitivo y restringido

(Mostert-Kerckhoffs, Staal, Houben, & de Jonge, 2015), dificultades sociales (Leung, Vogan, Powell, Anagnostou, & Taylor, 2016), y calidad de vida (de Vries, & Geurts, 2015). En esta misma línea se han observado asociaciones entre diferentes dominios ejecutivos y el funcionamiento adaptativo de niños con TEA (Pugliese et al., 2015). Además, algunos estudios han encontrado un patrón de asociaciones entre las conductas sociales adaptativas y las FE diferente en el TEA con respecto a controles con desarrollo típico (Leung et al., 2016). Así, los procesos ejecutivos de regulación conductual, incluyendo inhibición, cambio y regulación emocional, podrían tener mayor capacidad para predecir el funcionamiento social tanto en niños con TEA como con DT. Por su parte, los procesos ejecutivos metacognitivos de iniciación, memoria de trabajo, monitoreo, planificación y organización serían predictores de la adaptación social solamente en niños con TEA.

No obstante, la investigación sobre el perfil ejecutivo del autismo requiere todavía un estudio más minucioso. En general, una parte de la literatura considera que los déficits de flexibilidad cognitiva y planificación son más característicos en el perfil ejecutivo del TEA, según resultados de evaluación mediante medidas de rendimiento basadas en tareas de laboratorio. Sin embargo, los hallazgos son mixtos (Hill et al., 20004; Kenworthy, Yerys, Anthony, & Wallace, 2008). Por ejemplo, los resultados obtenidos con niños con TEA (Jahromi, Bryce, & Swanson, 2013) en edades tempranas no son claros y los pocos estudios que existen sugieren que los déficits en el dominio de cambio/flexibilidad son los más prominentes a la edad de 5-7 años y son relativamente estables en comparación con otras dificultades ejecutivas que aumentan con la edad. Por otra parte, hay estudios longitudinales y meta-análisis que señalan dificultades en procesos de control inhibitorio (ver revisión de Geurts, Bergh, & Ruzzano, 2014) y

déficits en memoria de trabajo (ver revisión de Barendse et al., 2013) en niños con TEA cuando se comparan con controles neurotípicos.

La ausencia de claros déficits ejecutivos ha sugerido que estos déficits son secundarios en el TEA (Yerys, Hepburn, Pennington, & Rogers, 2007). Es más, en un extenso y reciente meta-análisis Demetriou et al. (2017) analizaron 235 estudios que compararon el funcionamiento ejecutivo en individuos con TEA y niños con DT en un amplio rango de dominios ejecutivos. Los resultados constataron que los individuos con TEA presentan alteraciones en el FE, en relación a los controles con DT, si bien estas alteraciones reflejarían un deterioro global y no fraccionado en distintos dominios de FE.

Por su parte, uno de los modelos explicativos más respaldado del TDAH se basa en los déficits de las funciones ejecutivas (Barkley, 1997; Pennington & Ozonoff, 1996). Basado en el modelo de Barkley (1997), la presentación combinada se caracteriza por déficits en el control inhibitorio, mientras que la presentación inatenta se caracteriza por un comportamiento desorganizado. Los sujetos con TDAH muestran comúnmente deficiencias en un amplio espectro de dominios de funcionamiento neuropsicológico que son índices indirectos del sistema cerebral frontosubcortical, como el control inhibitorio, los procesos atencionales, la memoria operativa, la velocidad de procesamiento, la capacidad de planificación, o la flexibilidad cognitiva (Thorell, 2007). Los estudios han informado que las alteraciones en áreas prefrontales producirían déficits neuropsicológicos, particularmente en el funcionamiento ejecutivo, así como en conductas de impulsividad, hiperactividad e inatención (Fuster, 2008; Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2004). Además, estas alteraciones se han encontrado tanto en la infancia, adolescencia como en la edad adulta (Biederman et al., 2007).

Del mismo modo, trabajos como el de Gargaro, Rinehart, Bradshaw, Tonge, y Sheppard, (2011) han informado de la existencia de déficits constantes en tareas cognitivas, como las que miden la atención sostenida en niños con TDAH. Además, los individuos con TDAH muestran tiempos de reacción más largos y más errores de omisión y comisión cuando se han comparado con controles con DT. Recientemente, Ahmadi et al. (2013) estudiaron posibles deficiencias en la memoria icónica de niños con TDAH y niños con DT y encontraron que la memoria visual es más débil en niños con TDAH. Abundando en el tema, en una extensa revisión que incluyó 83 estudios Willcutt, Doyle, Nigg, Faraone, y Pennington, (2005) pusieron de manifiesto que los déficits ejecutivos son un componente neuropsicológico del TDAH que afectan a la inhibición de la conducta, la memoria de trabajo, la planificación y la resolución de los problemas. Sin embargo, solo la mitad de trabajos mostró claros déficits ejecutivos en participantes con TDAH, evidenciando las limitaciones de las tareas neuropsicológicas a la hora de abarcar un constructo tan complejo y multifacético como es el funcionamiento ejecutivo. Por el contrario, estudios que han utilizado cuestionarios en padres o profesores para evaluar el funcionamiento ejecutivo, ponen de relieve déficits ejecutivos en la mayoría de niños con TDAH (McAuley, Chen, Goos, Schachar, & Crosbie, 2010; Toplak, West, & Stanovich, 2013). Es más, algunos estudios han observado que casi el 80% de niños con TDAH presentan déficits en al menos un domino de FE mientras que ésto sólo ocurre en la mitad de niños con DT (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005).

Resumiendo, la literatura sobre las deficiencias de FE en el TDAH pone de relieve que, aunque no sean generalizadas, resulta esencial su estudio debido a las graves disfunciones que provocan en numerosos ámbitos, donde los individuos con TDAH fallan a la hora de aplicar habilidades de

integración y coordinación. Todo ello origina una conducta desorganizada que produce un amplio abanico de resultados negativos. Por ejemplo, se han encontrado asociaciones entre el TDAH y conductas de oposicionismo, conductas disruptivas e incluso agresividad (Wåhlstedt, Thorell, & Bohlin, 2008), así mismo el TDAH se ha relacionado con dificultades en el aprendizaje y con problemas en la adaptación social debido a las dificultades en las habilidades de interacción social (Diamantopoulou, Rydell, Thorell, & Bohlin, 2007). La asociación entre disfunciones ejecutivas y problemas sociales en el TDAH, en particular los déficits en las funciones ejecutivas de inhibición y planificación, persisten en el tiempo, prediciendo un funcionamiento social peor en la adolescencia (Mikami, 2010).

1.3. Similitudes y diferencias de FE en niños con TEA y niños con TDAH

Una de las cuestiones que continúa abierta a la investigación es la posible especificidad de la disfunción ejecutiva en el TEA y el TDAH, probablemente debido a que el FE es un constructo que engloba múltiples procesos a menudo disociables (Happé, Booth, Charlton, & Hughes, 2006).

El modelo frontoestriatal de Bradshaw (2001) proporciona un marco teórico para comprender la teoría de la disfunción ejecutiva frontoestriatal del autismo y el TDAH, y a su vez arroja luz sobre el tema de la comorbilidad entre ambos trastornos.

Cuando se ha comparado el funcionamiento ejecutivo en niños con TEA y niños con TDAH, la literatura en general ha mostrado diferentes pautas en los déficits. De modo que los niños con TEA parece que presentan más dificultades en la capacidad de planificación y en tareas que requieren flexibilidad cognitiva (Hill, 2004), mientras que los niños con TDAH evidencian mayores problemas en el control inhibitorio y en tareas de atención sostenida (Corbett, Constantine, Hendren, Rocke, & Ozonoff,

2009). Por su parte, la memoria de trabajo aparece afectada por igual tanto en el TEA como en el TDAH (Gargaro et al., 2011), apoyando la existencia de una predisposición genética y circuitos cerebrales alterados, como el somatomotor, el dorsal atencional y visual, que afectan a procesos como la planificación, la inhibición y la memoria de trabajo, entre otros dominios ejecutivos (Rommelse et al., 2011).

Aún así, los estudios que han examinado el FE en TEA y en TDAH han hallado resultados heterogéneos y más déficits globales en el TEA (Gargaro et al., 2011; Lai et al., 2017; Willcutt et al., 2005). En un amplio estudio que trató de identificar perfiles de funcionamiento ejecutivo en niños con TEA de alto funcionamiento, TDAH, y DT (con un CI significativamente más alto que los grupos clínicos) se halló en el grupo TEA déficits en todas las tareas de FE, excepto en control inhibitorio y memoria de trabajo. Estas deficiencias fueron mayores en planificación y flexibilidad cognitiva en comparación con el grupo de niños con TDAH. En el grupo con TDAH el control inhibitorio presentó mayor déficit en relación a los niños con TEA (Geurts et al., 2004). No obstante, cuando se requieren habilidades cognitivas o sociales complejas los niños con TEA fallan generalmente en tareas de inhibición (Keehn, Müller, & Townsend, 2013).

Otros estudios como el de Sanderson y Allen (2013) se centraron en los déficits en el control inhibitorio en niños y adolescentes con TEA analizando su relación con la sintomatología TDAH. Los resultados indicaron que el grupo TEA mostró un déficit significativo de control inhibitorio en la tarea de control de la interferencia, Stroop perro/cerdo, pero no en las tareas de resistencia al distractor ni en la de inhibición ante la demora. La disparidad de resultados podría estar relacionada con el tipo de tarea empleada, a causa de las diferentes demandas cognitivas y ejecutivas de cada una de ellas.

Por otra parte, Matsuura et al. (2014) encontraron un perfil de déficits ejecutivos diferenciados cuando realizaron una evaluación multidimensional que incluyó una batería de tareas neuropsicológicas y tests cognitivos. Los grupos clínicos de TEA y de TDAH se equipararon en edad, CI, sexo y estatus socioeconómico a un grupo con DT. El grupo con TEA obtuvo puntuaciones inferiores al grupo con DT en razonamiento perceptivo, mientras que el grupo con TDAH puntuó más bajo en memoria de trabajo visuo espacial que el grupo con DT. Otros estudios, por el contrario, han fracasado a la hora de poder diferenciar procesos metacognitivos, como la memoria de trabajo verbal entre niños y adolescentes con TEA y con TDAH. A pesar de que ambos grupos tuvieron una ejecución significativamente más pobre que sus iguales con desarrollo típico (Andersen, Hovik, Skogli, Egeland & ∅ie, 2013).

Componentes ejecutivos como la capacidad de planificación han sido abordados en varios trabajos con resultados mixtos. Por ejemplo, el estudio de Salcedo, Moreno, Ruiz y Ferrín (2013) en el que se comparó una muestra de 80 niños y adolescentes con TDAH con 23 niños con TEA equiparados en edad y CI en la tarea del mapa del zoo. Los niños con TEA presentaron más errores en planificación que parecían estar mediados por la velocidad de procesamiento y coordinación motora, pero no por otros problemas ejecutivos de atención, memoria de trabajo o inhibición. No obstante, también existe evidencia de déficits en planificación, cambio atencional y memoria de trabajo visuo espacial en individuos con TDAH (Kempton et al., 1999).

Otros trabajos no han respaldado la existencia de un perfil específico en FE de los niños con TEA respecto a los niños con TDAH. Sinzig, Vinzelberg, Evers y Lehmkuhl (2014) compararon los perfiles neuropsicológicos en funciones ejecutivas y atención en niños entre 4 y 9

años con TEA, con TDAH y con DT, midiendo las funciones ejecutivas con tareas de inhibición (GoNoGo), flexibilidad y atención sostenida. Los tamaños del efecto mostraron déficits notables en inhibición tanto en los niños con TDAH como en niños con TEA y fallos en la atención sostenida en niños con TEA.

Desde una perspectiva más amplia Goldberg et al. (2005) examinaron la inhibición, la planificación, flexibilidad y memoria de trabajo en una muestra de niños entre 8 y 12 años de edad con TEA, TDAH y DT, utilizando la batería neuropsicológica computerizada CANTAB. Los resultados indicaron que tanto la inhibición como la planificación y la flexibilidad eran similares entre los tres grupos de TEA, TDAH y DT y sólo la memoria de trabajo visuo-espacial estaba más afectada en el TEA y en el TDAH.

En resumen, cuando se parcela el FE en distintos componentes, el TEA y el TDAH parece que muestran patrones de funcionamiento diferenciados en algunos dominios como los déficits inhibitorios en el TDAH y los problemas de flexibilidad, planificación en el TEA (Gargaro et al., 2011). La literatura muestra un menor consenso en otros procesos neuropsicológicos como la memoria de trabajo, o el procesamiento atencional. Por lo tanto, habría que considerar la existencia de diversos factores que podrían estar modulando los resultados. Uno de ellos serían los procedimientos de evaluación. Los tests de FE basados en el rendimiento, aunque de partida midan el mismo proceso, tienen distintas exigencias y su validez se ha cuestionado por las diferencias que existen entre las demandas de un escenario de evaluación estructurado y las de la vida real. Intentando superar esta limitación metodológica las escalas de estimación recogen información de personas significativas que conocen bien al sujeto. Es más, un reciente metaanálisis ha concluido que la utilidad clínica de las medidas

neuropsicológicas basadas en test y tareas de laboratorio, es inferior a las medidas de validez ecológica, es decir aquellas que se basan en situaciones ambientales representativas para el sujeto (Demetriou et al., 2017).

Otro de los factores que merecen consideración por su impacto en los resultados son los cambios en el funcionamiento ejecutivo asociados con la edad. Los déficits ejecutivos en individuos con TDAH continúan estando presentes en la edad adulta, aunque la estabilidad de esos déficits a lo largo del ciclo vital no está clara, tal y como refleja una exhaustiva revisión (Hartman, Geurts, Franke, Buitelaar, & Rommelse, 2016). Además, muchos adolescentes y adultos con TEA, a pesar de las mejoras durante el desarrollo, presentan disfunciones en el FE aplicado a la vida diaria.

Por otra parte, un aspecto clave es la propia heterogeneidad que presenta el funcionamiento ejecutivo en trastornos del neurodesarrollo como el TDAH. Recientemente Roberts, Martel y Nigg, (2017) exploraron posibles subtipos de disfunción ejecutiva en el TDAH, caracterizando tres tipos; con problemas de flexibilidad, déficits de control inhibitorio y un último subtipo con una "relativamente" intacta ejecución de la tarea.

En conclusión, este conocimiento abre el camino hacia la investigación sobre la comorbilidad de los dos trastornos puros; TEA y TDAH.

1.4. Funcionamiento Ejecutivo y Comorbilidad TEA+TDAH

Las funciones ejecutivas se han relacionado con áreas cerebrales como la corteza prefrontal, afectada en el TEA (Goldberg et al., 2005; Lawson et al., 2015; Ozonoff et al., 2004) y en el TDAH (Goldstein & Naglieri, 2013; Rubia, Alegria, & Brinson, 2014). Investigaciones recientes

sobre la condición dual TEA+TDAH sugieren que aspectos clave de las FE están comprometidos en ambos trastornos, y además se han identificado posibles endofenotipos compartidos. Estudios de neuroimagen señalan vínculos fisiopatológicos entre el TEA y TDAH que afectan a los circuitos fronto-estriatales y fronto-parietales implicados en el FE y funciones cognitivas complejas como los procesos atencionales (Rommelse et al., 2011).

A pesar de la evidencia que existe sobre la implicación de las funciones ejecutivas en el TEA y en el TDAH, pocos estudios han explorado el FE en la condición comórbida (Craig et al., 2016). Además, la investigación sobre TEA y los síntomas comórbidos de TDAH se ha centrado principalmente en la infancia (Johnson, Gliga, Jones, & Charman, 2015; Rommelse, Buitelaar, & Hartman, 2017).

Los dominios de las funciones ejecutivas que mayor atención han recibido hasta la fecha sobre el perfil ejecutivo del grupo comórbido han sido los procesos atencionales, el control inhibitorio, la memoria de trabajo (MT), la planificación y la flexibilidad cognitiva. En general todos los trabajos analizados han encontrado más deficiencias de funcionamiento ejecutivo en los grupos comórbidos TEA + TDAH o TDAH + TEA en comparación con los niños con desarrollo típico. Sin embargo, cuando se ha tratado de hallar en el grupo comórbido un perfil específico de funcionamiento ejecutivo, los hallazgos han sido mixtos y poco consistentes (ver Tabla 1).

1.4.1. Procesos atencionales

Gomarus, Wijers, Minderaa y Althaus, (2009) examinaron los procesos de atención selectiva mediante potenciales evocados en niños con TDAH, TEA con o sin síntomas clínicos de hiperactividad y DT. Mientras que los grupos clínicos difirieron entre sí a nivel conductual, no se observó

ninguna distinción en el rendimiento en medidas de atención selectiva. A fin de identificar un posible perfil en atención sostenida en niños TEA+TDAH, Adamo et al. (2014) examinaron la variabilidad en el tiempo de respuesta en niños con TEA (n=46), TEA+ (n=32), TDAH (n=46) y desarrollo típico (n=36), en el SART (test de respuesta de atención sostenida). Los resultados mostraron que los grupos TDAH y TEA+ incrementaban la variabilidad en el tiempo de respuesta en frecuencias rápidas, respecto al grupo TEA puro, apoyando la relación entre los síntomas de TDAH y la variabilidad en el tiempo de respuesta. Las disfunciones en la atención sostenida en los grupos con sintomatología TDAH, sugiere anomalías comunes en los niños con TDAH y TEA+ al compartir déficits en la atención sostenida.

Con un enfoque neurofisiológico Tye et al. (2014) investigaron si las anomalías detectadas en los registros de potenciales evocados (PE) de larga latencia asociadas al TDAH, estaban presentes en el TEA y en el TEA+. Utilizaron pruebas neurofisiológicas como el electroencefalograma (EEG) y electrooculograma y un test de ejecución continua (CPT). Los participantes con TDAH (TDAH/TEA+TDAH) cometieron más errores de omisión y exhibieron un incremento de variabilidad del tiempo de reacción (RT), y reducida amplitud de la onda P3 y NoGo-P3, sugiriendo anomalías en control inhibitorio y memoria de trabajo, en comparación con los participantes con TEA y DT. Asimismo, el grupo TEA mostró una reducida amplitud de la onda N2 en las tareas Go/NoGo, indicando problemas de flexibilidad cognitiva. El grupo TEA+ mostró déficits de ambos trastornos lo cual sugiere que tanto el TEA como el TDAH comparten correlatos neurofisiológicos. Del mismo modo, Lundervold et al. (2016) en una tarea de atención sostenida hallaron que el grupo TEA + TDAH tenía una mayor variabilidad, y un estilo de respuesta más impulsivo que el grupo con TEA puro. Los investigadores concluyeron que los grupos de niños con TDAH y TEA con síntomas de

TDAH comórbidos presentaban un perfil de ejecución similar en procesos atencionales, diferente a los niños con TEA puro.

Por el contrario, Geurts et al. (2008) evidenciaron un patrón de déficits opuesto al medir la variabilidad en el tiempo de respuesta, de manera que los niños con TEA con y sin síntomas de TDAH presentaron mayor variabilidad, mientras que los niños con TDAH y DT no se diferenciaron en ningún índice del tiempo de respuesta.

1.4.2. Control Inhibitorio

Varios estudios no han logrado detectar diferencias estadísticamente significativas en control inhibitorio, utilizando medidas neuropsicológicas, entre los grupos clínicos TEA, TDAH y TEA+TDAH en comparación con el grupo con DT (Sinzig, Bruning, Morsch, & Lehmkuhl, 2008a; Yerys et al., 2009). Sin embargo, en los escasos trabajos en que se ha utilizado un cuestionario para padres y profesores como el Inventario de Funcionamiento Ejecutivo (BRIEF) se ha encontrado una disminución del funcionamiento de la inhibición en niños con TEA y TEA + TDAH en comparación con niños con desarrollo típico (Yerys et al., 2009).

Los síntomas de inatención e hiperactividad e impulsividad, en general inciden negativamente en el control inhibitorio de los niños con TEA. A pesar de que no se apreciaron diferencias significativas entre los grupos clínicos, varios trabajos han observado un mayor déficit en la inhibición en el grupo comórbido (Neely, Green, Sciberras, Hazell, & Anderson, 2016; Pitzianti et al., 2016; Takeuchi et al., 2013).

Bühler, Bachmann, Goyert, Heinzel-Gutenbrunner y Kamp-Becker, (2011) y Sinzig, Morsch, Bruning, Schmidt, y Lehmkuhl, (2008b) evaluaron la inhibición de la respuesta prepotente utilizando la prueba de ejecución

atencional (condición TAP Go / No-Go). Encontraron que el grupo TEA+TDAH estaba más afectado que los otros grupos clínicos. Sinzig et al. (2008a) usando la misma tarea y la misma muestra que Sinzig et al. (2008b) no encontraron diferencias significativas entre los grupos. Aunque, en el grupo comórbido TEA+TDAH se observaron asociaciones significativas entre los síntomas de inatención y el control inhibitorio (Sinzig et al., 2008a).

Resultados similares se han obtenido mediante el uso de imágenes de resonancia magnética funcional (fMRI) comparando diferentes grupos (TEA+TDAH, TDAH, TEA) en una tarea de descuento temporal (Chantiluke et al., 2014). El descuento temporal es la tendencia a devaluar recompensas temporalmente distantes y la tarea requiere por tanto la inhibición de la recompensa inmediata (Basile & Toplak, 2015). Los resultados indicaron que el grupo comórbido tenía la correlación cerebro-comportamiento más fuerte en el lóbulo occipital en relación con todos los demás grupos, lo que indicó anomalías cerebrales en regiones clave de descuento temporal.

1.4.3. Memoria de trabajo

Solo un estudio informó de dificultades significativas en la memoria de trabajo espacial en niños cuyo diagnóstico primario era TDAH y presentaban síntomas comórbidos de TEA al compararlos con el grupo con DT (Van der Meer et al., 2012). En general, los trabajos realizados no han encontrado déficits en niños con TEA y TDAH comórbido (Gomarus et al., 2009; Sinzig et al., 2008b, Takeuchi et al., 2013; Van der Meer et al., 2012; Yerys et al., 2009). Es posible que las demandas de la tarea no hayan sido lo suficientemente sensibles como para captar las diferencias entre los diferentes grupos analizados.

Por otro lado, los trabajos que han explorado la memoria de trabajo verbal comparando los grupos TEA, TDAH, DT con el grupo comórbido han

concluido que existe una mayor afectación en el grupo comórbido en relación con el grupo con DT (Andersen et al., 2013; Neely et al., 2016; Takeuchi et al., 2013; Yerys et al. al., 2009). Del mismo modo parece producirse un efecto aditivo en los niños con TEA+ al presentar un mayor déficit en memoria de trabajo verbal y recuerdo demorado en comparación a los grupos puros TDAH y TEA (Takeuchi et al., 2013).

Recientemente Neely et al. (2016) y Pitzianti et al. (2016) evaluaron la memoria de trabajo verbal utilizando la tarea de dígitos inversos (WISC-IV). Neely et al. (2016) encontraron un perfil de funcionamiento ejecutivo similar entre los grupos TDAH + TEA y TDAH, mientras que Pitzianti et al. (2016) encontraron un perfil de FE parecido entre los grupos TDAH + TEA y TEA. Por su parte, Sinzig et al. (2008b) informaron de similitudes entre el grupo comórbido TEA+TDAH y TDAH puro con respecto al déficit de la memoria de trabajo espacial, utilizando la batería neuropsicológica CANTAB. Los autores sugirieron que los síntomas de TDAH comórbidos no parecen jugar un papel clave en la memoria de trabajo visuoespacial. Es más, Yerys et al. (2009) utilizando la misma tarea no encontraron diferencias significativas entre niños con TEA y DT en memoria de trabajo espacial. Sin embargo, su estudio demostró que el grupo comórbido TEA+ TDAH puntuó significativamente más bajo que los niños con DT, y similar al grupo con TEA.

Los hallazgos sugieren que las diferencias en el diseño de las tareas pueden explicar gran parte de las discrepancias encontradas.

1.4.4. Planificación

La capacidad de planificación del grupo comórbido en relación con los otros dos trastornos TEA y TDAH, ha recibido escasa atención. Hasta la fecha solamente tres estudios han explorado los déficits de planificación

usando la tarea Torre de Londres (ToL) con resultados mixtos. Sinzig et al. (2008b) utilizando una prueba computarizada de planificación espacial basada en la ToL, observó una tendencia hacia tiempos de planificación más largos en los niños con TEA sin TDAH comórbido en comparación con los niños con TDAH solo y el grupo con DT. El grupo TEA + TDAH tuvo una duración de la prueba más prolongada que el grupo con DT (d = 0.6). Sin embargo, no hubo diferencias significativas en ninguna de las medidas utilizadas. Por lo que no se pudo establecer una conclusión sólida, en parte debido a las diferencias en el CI y la edad entre los grupos.

Pitzianti et al. (2016) encontraron una tendencia de mayor dificultad de planificación en el grupo comórbido TDAH + TEA en comparación con los otros grupos clínicos. Específicamente, los resultados indicaron diferencias significativas entre los grupos clínicos y el grupo de control en las puntuaciones totales de ToL y en el tiempo total empleado en la tarea.

Unterrainer et al. (2016) investigaron la planificación en 83 niños con TEA, TDAH, TEA + TDAH, y DT. Los resultados encontraron que los niños con TEA + TDAH estaban más afectados y eran menos precisos a edades tempranas, pero eran comparables con el grupo con DT en edades más avanzadas. Los autores sugieren un retraso en el desarrollo que es más robusto en el grupo TEA + TDAH.

1.4.5. Flexibilidad cognitiva

Los escasos estudios que han evaluado los problemas de flexibilidad (Sinzig et al., 2008b; Van der Meer et al., 2012; Yerys et al., 2009) no han hallado diferencias significativas entre ninguno de los grupos analizados utilizando tareas neuropsicológicas. Aunque el grupo comórbido (TEA+TDAH) cometió más errores y necesitó más tiempo para resolver la tarea en comparación con el grupo TEA y el grupo con DT. Los autores

sugirieron que una de las razones podría ser la naturaleza predecible de la tarea. Por el contrario, Yerys et al. (2009) evidenciaron que el grupo TEA+TDAH estaba más afectado que los grupos TEA y DT según la información de los padres en el inventario de funcionamiento ejecutivo.

Por último, el trabajo de Van der Meer et al. (2012) ha tratado de profundizar en el análisis de la sintomatología del TEA+ desde una perspectiva más global, estudiando tanto el funcionamiento ejecutivo como la cognición social. Estos investigadores compararon diversos grupos de TDAH, TEA+TDAH, TDAH+TEA y desarrollo típico en medidas de inhibición, flexibilidad cognitiva, memoria de trabajo, atención, identificación de emociones faciales, procesamiento centrado en los detalles, así como en estimaciones de los padres de habilidades de comunicación social y funcionamiento ejecutivo en la vida diaria. En todos los grupos clínicos la atención verbal y espacial estaba afectada, lo cual indica que la disfunción atencional se extiende a los trastornos del neurodesarrollo en general. Por el contrario, ningún grupo mostró problemas de inhibición ni de flexibilidad cognitiva. El grupo TDAH+TEA obtuvo peor resultado en la memoria de trabajo visuo-espacial y una deficiencia más pronunciada en la cognición social, centrada en peor identificación de emociones faciales y un estilo de procesamiento focalizado en los detalles. Los resultados sugirieron que los niños con la condición comórbida tenían un perfil "aditivo" en lugar de tener un patrón cualitativamente distinto de déficits.

1.4.6. Perfiles de Funcionamiento ejecutivo

Analizando una amplia gama de dominios de FE, Dajani et al. (2016) identificaron distintos perfiles de FE en niños con TDAH, TEA, TEA + TDAH y DT mediante un análisis de perfil latente con indicadores de FE. Las FE se examinaron utilizando el cuestionario de funcionamiento ejecutivo

BRIEF y varias medidas neuropsicológicas. Los resultados indicaron que el 92% de los niños del grupo TEA+ TDAH se encontraban en la "clase de FE deteriorada". En comparación, solo el 47% de los niños con TEA y el 63% de los niños con TDAH se encontraban en la "clase afectada". Sugiriendo la importancia de tener en cuenta la sintomatología de inatención e hiperactividad en el funcionamiento ejecutivo de los niños con TEA.

Otra de las líneas de investigación que suscita gran interés es el impacto de los síntomas nucleares de ambos trastornos en el funcionamiento ejecutivo de niños con TEA+TDAH. La escasa evidencia existente hasta ahora sugiere que los síntomas de inatención estarían relacionados con los problemas de control inhibitorio y de memoria de trabajo verbal (Neely et al., 2016; Sinzig et al., 2008b; Takeuchi et al., 2013). Además, Sinzig et al., (2008b) hallaron una asociación significativa entre la inatención y la conducta estereotipada y los problemas de flexibilidad.

Tabla 1. Estudios sobre funcionamiento ejecutivo en niños y adolescentes con TEA+TDAH, TDAH+TEA

Referencia	N Participantes (M)	CI	Dominio FE	Principales hallazgos	Conclusiones
Adamo et al. (2014)	46 TDAH (10) 46 TEA; **17 TEA+** (10) 36 DT (10)	106 109 112	Atención	TEA+ similar al TDAH. Comparten anomalías en tiempo de respuesta (RT)	Variabilidad en el RT potencial biomarcador para el TDAH y TEA+
Andersen et al. (2013)	79 TDAH (11.6) **16 TEA+** (12.2) 22 TEA (11.9) 50 DT (11.6)	95.6 91.7 102.9 103.8	Memoria deTrabajo Atención	TEA+ peor en MT. TEA+ y TDAH más dificultades en recuerdo demorado, que TEA y DT	Efectos aditivos en TEA+, TEA+ presentó más problemas atencionales
Bühler et al. (2011)	84 TDAH (9.7) 86 TEA (10.8) **52 TEA+TDAH** (10.1)	97.9 105.4 99.0	Inhibición	TEA + más errores de comisión en Go/NoGo. TEA+ peor inhibición	Los síntomas de TDAH acrecientan las dificultades en TEA
Chantiluke et al. (2014)	18 TDAH (14.3) 15 TEA (14.3) **13 TEA+TDAH** (14) 18 DT (15.2)	110 112 110.8 120	Inhibición	TEA+ mayores deficiencias en asociaciones cerebro-conducta en áreas de descuento temporal	TEA+ no es una simple fenocopia o patología aditiva de dos trastornos puros
Dajani et al. (2016)	93 TDAH (9.79) 30 TEA (9.76) **66 TEA+TDAH** (10.4) 128 DT (10.0)	107.3 106.1 99.9 115.7	BRI-MI Inhibición MT	92% de TEA+ tenían déficits en FE. El grupo con más déficits fue TEA +	Los síntomas de TDAH en el TEA incrementan sintomatología TEA

Referencia	N Participantes (M)	CI	Dominio FE	Principales hallazgos	Conclusiones
Geurts et al. (2008)	53 TDAH (9.1) 25 TEA (9.3) **32 TEA+TDAH** (8.6) 21 TS (10) 85 DT (9.2)	100.8 106.8 99.3 102.1 111.6	Atención	TEA y TEA+ presentaron mayor RT-ISV y ambos grupos fueron más lentos que el grupo con TDAH	La variabilidad en el RT se asocia con comorbilidad y no es específica del TDAH
Gomarus et al. (2009)	15 TDAH (9.8) 15 TEA (10.2) **15 TEA+TDAH** (10.1) 15 DT (10.1)	103.5 108.6 101.9 107.1	Atención selectiva MT	Los grupos clínicos tuvieron similar RT, número de omisiones, y falsas alarmas	Los grupos clínicos no se diferenciaron en MT ni atención selectiva
Lundervold et al. (2016)	38 TDAH (10.0) 9 TEA (10.3) **11 TDAH+TEA** (10.6) 134 DT (9.7)	78.1 92.2 87.1 93.8	Atención	TDAH y TDAH+ peor que DT, TEA en RT, aciertos, variabilidad y consistencia	TDAH+ y TDAH similares. Posible solapamiento fenotípico
Neely et al. (2016)	75 TDAH (7.2) **25 TDAH+TEA** (7.5) 123 DT (7.3)	- - -	MT Inhibición	TDAH+TEA y TDAH similar. Síntomas de TEA o inatención se asociaron con peor inhibición	Niños con TDAH+TEA y TDAH muestran un perfil parecido de FE
Pitzianti et al. (2016)	13 TDAH (10.1) 13 TEA (10.6) **12 TDAH+TEA (**10.2) 13 DT (11.8)	97.4 106 108 106	Planificación MT Inhibición	TDAH+TEA peor en planificación respecto a TEA y TDAH, aunque similar a DT en MT	El grupo comórbido presentó una mayor afectación

Referencia	N Participantes (M)	CI	Dominio FE	Principales hallazgos	Conclusiones
Sinzig et al. (2008a)	30 TDAH (12.9) 20 TEA (14.5) **21 TEA+ TDAH** (10) 30 DT (12.8)	102 112 103 109	Inhibición Atención	No diferencias entre grupos en Inhibición. TEA+ más dificultades en atención dividida y alerta.	No evidencia de un perfil ejecutivo específico de TEA+ respecto a TEA solo
Sinzig et al. (2008b)	20 TDAH (12.2) 20 TEA MA=14.3 **20 TEA+TDAH (**10.9) 20 DT (13.1)	98 112 103 113	Inhibición Flexibilidad Planificación MT	En flexibilidad TEA+TDAH más problemas, asociaciones entre inflexibilidad e inatención y estereotipia	TEA+TDAH presentó similitudes con TDAH en déficits de inhibición, pero no en MT
Takeuchi et al. (2013)	20 TDAH (10.3) 8 TEA (11.2) **16 TEA+TDAH** (9.7) 60 DT (10.1)	98.7 95.0 93.9 -	Inhibición MT	TEA+ y TDAH peor en MT verbal y variabilidad de respuesta. En inhibición no hubo diferencias	TEA+ no es una simple combinación de los trastornos puros en FE
Tye el al. (2014)	18 TDAH (10.4) 19 TEA (11.6) **29 TEA+TDAH** (10.5) 26 DT (10.5)	104.1 115.6 109.7 120.0	Atención Inhibición	Déficits en procesos de inhibición en TEA+ en comparación con TEA	Se sugiere que la comorbilidad TEA+TDAH es una condición distinta
Unterrainer et al. (2016)	42 TDAH (9.83) 18 TEA (10.14) **23 TEA+TDAH** (10.2) 42 DT (9.76)	94.4 97.0 98.8 97.5	Planificación	TEA+ mostró peor ejecución en niños pequeños, pero similar al DT en niños más mayores	TDAH y TEA+ No mostraron déficits en planificación

Referencia	N Participantes (M)	CI	Dominio FE	Principales hallazgos	Conclusiones
Van der Meer et al. (2012)	109 TDAH (9.9) **59 TDAH+TEA (**11.2) **58 TEA+TDAH (**11.5) 418 DT (9.5)	104.2 101.5 104.2 106.2	Atención MT Inhibición Flexibilidad	La atención afectada en todos los grupos clínicos, en MT los grupos con TDAH peor. En inhibición y flexibilidad no diferencias	Diferentes subtipos de comorbilidad TEA+TDAH y diferencias en déficits cognitivos
Yerys et al. (2009)	28 TEA (9.7) **21 TEA+TDAH (**9.6) 21 DT (10.3)	117.3 111.2 116.2	Inhibición Flexibilidad MT, BRI-MI	En medidas ecológicas TEA+TDAH más dificultades que el resto. No en medidas de laboratorio	TEA+TDAH presentó un perfil diferente con efectos aditivos

Nota. CI (Capacidad cognitiva), M Edad (Media), BRI (Indice de regulación comportamental), DT (Desarrollo típico), FE (Funcionamiento ejecutivo), MI (Indice metacognitivo), MT (Memoria de trabajo), RT-ISV (Intravariabilidad individual del tiempo de respuesta), TEA (Trastorno del espectro del autismo), TDAH (Déficit de atención con hiperactividad), TEA+ (Trastorno del espectro del autismo y comorbilidad con déficit de atención con hiperactividad), TS (Síndrome de Tourette)

2. Procesos de Cognición Social en niños con TEA y TDAH

2.1. Procesos de Cognición Social: Reconocimiento de Emociones y Teoría de la Mente

La capacidad que desarrolla el ser humano para relacionarse socialmente con los demás se fundamenta en la cognición social, una habilidad que permite comprender que existen otras personas que pueden pensar, interactuar, y sentir de una manera distinta a la propia. Según Tirapu, Pérez, Erekatxo y Pelegrín (2007) la cognición social es un proceso complejo en el que se integran mecanismos cognitivos basados en la capacidad de procesar la información social y ayudan a percibir, procesar y evaluar los estímulos, que permiten la representación del entorno social. Las dificultades en la cognición social afectan a múltiples dominios que incluyen el reconocimiento de emociones, la teoría de la mente (ToM), el conocimiento social, el estilo atribucional y la percepción social (Green et al., 2008). Dos de los dominios que han sido más investigados son el reconocimiento facial de emociones y la ToM.

El reconocimiento de las emociones (RE) es la capacidad de percibir e identificar las emociones ajenas de diferente naturaleza: emociones básicas (alegría, ira, miedo, sorpresa, asco y tristeza), caracterizadas por ser innatas, y las emociones sociales o morales, (vergüenza, orgullo, culpa, envidia) la cuales van a depender del contexto social y por esa misma razón surgen posteriormente a las emociones básicas. El RE es de vital importancia para el desarrollo social de las personas, debido a que si existen dificultades para identificar emociones en los rostros de los demás, puede resultar más difícil lograr inferir segundas intenciones, comprender miradas, deseos y conductas. La amígdala desempeña una función importante en el reconocimiento de emociones, ya que su principal función es convertir las representaciones perceptuales en cognición y conducta, con el fin de darle el valor emocional y social a los estímulos percibidos (Tirapu, et al., 2007).

La ToM es parte de ese segundo paso o esa segunda intención, la cual surge después del reconocimiento de emociones. Esta permite a grosso modo la comprensión y predicción de la conducta de otras personas, sus conocimientos, sus intenciones y sus creencias (Tirapu, et al. 2007). Las habilidades de ToM se refieren a la capacidad de atribuir estados mentales a los demás y a uno mismo; sentimientos, creencias, intenciones y deseos. Se desarrollan tempranamente en el niño, comenzando con la capacidad para comprender las creencias de los demás acerca de una situación (ToM de primer orden), seguidas de la comprensión de que las personas tienen pensamientos o creencias sobre los pensamientos de otras personas (ToM de segundo orden) y finalmente se desarrollan habilidades mentalistas sociales más complejas (Brent, Rios, Happé & Charman, 2004). Las tareas sobre creencias de primer orden se pueden llevar a cabo con éxito alrededor de los 4 años de edad aproximadamente, mientras que las tareas sobre creencias de segundo orden se logran realizar exitosamente alrededor de los 6 y 7 años de edad, coincidiendo con el uso y comprensión del lenguaje social (Caillies, Bertot, Motte, Raynaud & Abely, 2014).

2.2. Reconocimiento de Emociones y Teoría de la Mente en niños con TEA y niños con TDAH

Los trastornos del neurodesarrollo, como el TDAH y sobre todo el TEA han recibido especial atención en las investigaciones sobre cognición social, que apuntan a la existencia de un déficit a nivel sociocognitivo en comparación con niños con DT.

Las dificultades en las habilidades de ToM se cree que son específicas en el desarrollo del TEA (Baron-Cohen, Leslie, & Frith, 1985). Numerosos estudios han destacado la dificultad que tienen las personas con TEA de

utilizar las habilidades de ToM en situaciones sociales (Baron-Cohen, Tager-Flusberg, & Cohen, 2000; Klin, 2000). Recientemente, Mazza et al. (2017) usando un análisis de mediación demostraron que la ToM juega un rol clave en el desarrollo de las habilidades sociales, y que la carencia de las habilidades de ToM en niños con autismo produce disfunciones en la competencia social. Del mismo modo, Bishop-Fitzpatrick, Mazefsky, Eack, y Minshew (2017), determinaron que el desempeño en tareas de falsa de creencia de primer y de segundo orden se asociaba de forma significativa con un mejor funcionamiento social.

Sin embargo, incluso superando las tareas de ToM, los niños con autismo parecen tener más problemas con la aplicación de las habilidades cotidianas de teoría de la mente que los niños más pequeños con DT (Peterson, Garnett, Kelly, & Attwood, 2009). En contra de lo esperado, niños y adolescentes con TEA de alto funcionamiento pueden realizar igual de bien que sus iguales con DT, tareas avanzadas de ToM, lo cual sugiere que son capaces de entender los fundamentos teóricos de la ToM, pero fallarían en la aplicación de esos principios durante las interacciones sociales diarias, (Scheeren, de Rosnay, Koot, & Begeer, 2013). Tales hallazgos sugerirían que a nivel implícito la ToM mantiene una relación más fuerte con la adaptación social, de manera que resulta plausible, tal y como indican Frith et al. (1994), que algunos niños con TEA aprendan a resolver problemas de ToM explícita en contextos experimentales de forma "no mentalista". De modo que, si bien pueden utilizar estrategias no-sociales que les permiten responder a las preguntas de falsas creencias correctamente, no pueden generalizar las soluciones a situaciones sociales de la vida real. Además, las dificultades de flexibilidad cognitiva agravarían aún más la aplicación de los conocimientos teóricos de la ToM, al exigir el rápido procesamiento de las señales sociales y emocionales cambiantes en los contextos reales. De ahí que en la

investigación que trata de perfilar la naturaleza subyacente de la cognición social en individuos con TEA, es esencial considerar los sistemas implícitos y explícitos de la ToM como dos sistemas separados (Hutchins et al., 2016; Senju, 2013).

La idea principal que se deriva de los trabajos empíricos subraya que el conocimiento de la ToM tiene influencia en las relaciones sociales y en la conducta social de niños con TEA. No obstante, también existen otros factores relevantes, como el funcionamiento ejecutivo o la competencia comunicativa, que podrían estar implicados en el funcionamiento social de niños con autismo. En este sentido, Peterson, Slaughter, Moore, y Wellman, (2016) han demostrado que la asociación de la ToM con la competencia social está mediada significativamente por la capacidad lingüística.

En relación al TDAH, las dificultades de ToM han sido menos estudiadas aunque existe un interés creciente (Buitelaar, Van der Wees, Swaab–Barneveld, & Van der Gaag, 1999; Mary et al., 2016). Es más, la investigación en cognición social, en particular en teoría de la mente (ToM), se ha revelado como una vía valiosa para explorar los problemas en las relaciones sociales de los niños con TDAH. Un meta-análisis de Bora y Pantelis (2016), en el que se incluyeron 44 estudios comparando el rendimiento en tares de cognición social de individuos con TDAH y con desarrollo típico (DT) mostró que en el RE, sobre todo de ira y miedo y en tareas de teoría de la mente, los niños con TDAH obtenían un rendimiento inferior. Sin embargo, en los adultos TDAH no había déficits en la ToM, de manera que los déficits sociocognitivos del TDAH parecían mejorar con la edad.

Por otro lado, una de las cuestiones que estudios recientes han intentado aclarar, se refiere a si los fallos en teoría de la mente tienen un

carácter primario o más bien son la consecuencia del fracaso para expresar las habilidades de la ToM en situaciones que requieren control inhibitorio y otros procesos ejecutivos. Hay estudios que señalan que los niños con TDAH tienen un rendimiento inferior al de niños con DT en tareas de ToM que exigen una inhibición importante (Sodian, Hulsken, & Thoermer, 2003) sugiriendo que los déficits ejecutivos provocan la falta de consideración de los estados mentales en las situaciones sociales.

Tampoco una reciente investigación de Mary et al. (2016) apoya que la disfunción en ToM sea primaria en el TDAH. Estos investigadores compararon a 31 niños diagnosticados de TDAH con 31 niños con DT entre 8 y 12 años de edad e igualados en CI, en tareas neuropsicológicas de control inhibitorio, planificación, flexibilidad y atención, así como en tareas de ToM de primer y segundo orden. Según los resultados, los niños con TDAH obtuvieron un rendimiento inferior en test de FE de inhibición, planificación y atención y en dos tareas de ToM de nivel superior. El dato más sugerente fue que, controlando la inhibición y la atención, el rendimiento de los niños con TDAH se igualó al rendimiento de los niños con DT, mientras que el control de la ejecución de tareas de ToM no normalizó el rendimiento en los tests de inhibición y atención. Por consiguiente, "Esta relación unidireccional sugiere que los deficits en FE y en el dominio atencional son responsables de los déficits en ToM de los niños con TDAH, lo que puede contribuir a sus dificultades socioemocionales" (p. 345).

2.3. Similitudes y diferencias en cognición social en niños con TEA y niños con TDAH

Los estudios que han explorado la cognición social en TEA y TDAH ofrecen resultados poco concluyentes, ya que no está claro si la disfunción característica del TEA, es comparable en severidad al TDAH. No obstante,

la tendencia que cuenta con más apoyo en el análisis comparativo de habilidades mentalistas y de reconocimiento de emociones de niños y adolescentes con TEA, con TDAH y con DT, pone de manifiesto que existen dificultades más acusadas en el grupo con TEA (Bora & Pantelis, 2016; Demopoulos et al., 2013; Demurie, de Core, & Roeyers, 2011; Yang, Zhou, Yao, Su, & Mc Whinnie, 2009).

En un estudio pionero, Buitelaar et al. (1999) compararon la ejecución en tareas de ToM y reconocimiento de emociones en niños con TEA y TDAH. Utilizaron una serie de tareas que valoraban habilidades de ToM tanto de primer orden (como falsa creencia, distinción entre apariencia y realidad) como de segundo orden (atribución de creencias, predecir creencias sobre creencias). Así mismo, llevaron a cabo una prueba de emparejamiento de imágenes que expresaban diferentes emociones básicas. Los hallazgos no permitieron establecer una diferenciación significativa entre los sujetos con TEA y con TDAH, especialmente en el desempeño de habilidades mentales de segundo orden.

Igualmente, Downs y Smith (2004) analizaron varios procesos de cognición social, comparando tres grupos con TEA, TDAH y trastorno oposicionista desafiante y DT. Los resultados indicaron que los niños con TEA presentaban déficits socioemocionales y conductuales en relación al grupo normativo. Por su parte, los niños con TDAH y trastorno oposicionista desafiante mostraron mayor déficit en todas las tareas socioemocionales incluidas las de ToM, al compararlos con los otros grupos.

Es conveniente considerar los tipos de TEA y TDAH por su potencial impacto en las habilidades de ToM. Por ejemplo, cuando se han comparado niños con TDAH con predominio de inatención no se han encontrado dificultades en ToM en ese grupo. Los niños con TEA sin

embargo presentaron más dificultades en ToM (Dyck, Ferguson, & Shochet, 2001). Además, posiblemente el desarrollo de las habilidades de ToM tenga un curso diferente, en el TDAH y en el TEA, marcando una evolución distinta en los déficits, según indica el trabajo de Bühler et al. (2011) en el que examinaron las habilidades de ToM en niños y adolescentes (de 5 a 22 años) con TEA, TDAH y TEA+TDAH. Aplicaron una prueba de atribución de significación social a una serie de secuencias animadas que representaban situaciones sociales concretas, no encontrando diferencias entre los grupos totales en la realización de la tarea ToM. Por el contrario, se observó una diferencia significativa en el reconocimiento facial de emociones entre los grupos de TEA y TDAH más jóvenes (TEA< TDAH), que no se producía entre los grupos más mayores. De ahí que Bühler et al. (2011) concluyeran que los déficits en las habilidades de ToM en el TDAH se producen más tardíamente que en el TEA. En definitiva, parecen depender en gran medida de la estimulación del ambiente familiar primario así como de las interacciones sociales con los iguales.

La investigación en el marco de las neurociencias ha aportado también información relativa al estudio del reconocimiento facial de emociones a través de las respuestas electrofisiológicas. Los hallazgos han evidenciado, que ambos grupos, TEA y TDAH, muestran déficits significativos en el procesamiento de emociones, pero sin que ninguno de los dos grupos presente mayores déficits (Tye et al., 2014).

El meta-análisis previamente mencionado de Bora y Pantelis (2016) recoge una exhaustiva actualización de estudios que abordan la cognición social en individuos con TDAH en comparación con individuos con TEA y DT. Se incluyeron 44 estudios comparando TDAH y DT y 17 comparando TDAH y TEA. Los resultados pusieron de manifiesto que los déficits en la cognición social, sobre todo en ToM, eran significativamente más

pronunciados en los sujetos con TEA en comparación con los sujetos con TDAH. En el reconocimiento emociones, sobre todo de ira y miedo y en tareas de ToM, los niños con TDAH tenían un rendimiento inferior a los grupos con DT, mientras que en adultos con TDAH no había déficits en ToM.

En resumen, se producen trayectorias distintas de los déficits sociocognitivos, de manera que los sujetos con TEA tienen déficits más notables en todas las etapas, si bien la magnitud de las diferencias sugiere que hay un considerable solapamiento entre ambos grupos. Por consiguiente, los déficits en la cognición social no pueden considerarse como específicos del TEA.

Cuando se ha comparado la ejecución de tareas de ToM en niños con TEA y niños con TDAH, el procedimiento de evaluación de habilidades mentalistas que se adopta puede estar modulando los resultados que se obtienen, tal y como queda reflejado en el trabajo de Hutchins et al. (2016). En todas las tareas mentalistas, tanto las que se incluían en la batería que valoraban el conocimiento conceptual de la ToM (conocimiento explícito) como en el inventario de teoría de la mente (ToMI) que recoge situaciones de la vida diaria, el grupo con TEA tuvo una peor ejecución que el resto de grupos. Sin embargo, el grupo TDAH consiguió un nivel de ejecución más alto en las tareas explícitas, es decir de laboratorio. En síntesis, no se encontraron diferencias entre TDAH y el grupo neurotípico en la puntuación compuesta en la batería de tareas de ToM (conocimiento conceptual), mientras que en el inventario ToMI, el grupo con TDAH mostró niveles de ejecución significativamente más bajos que el grupo con desarrollo típico. Los autores sugieren que una explicación plausible podría ser que los procesos “Cool” (fríos) son activados por problemas abstractos (atención,

memoria), mientras que los procesos "Hot" se activan ante problemas que implican la regulación del afecto y de la motivación.

Estudios, como los comentados subrayan la dificultad del procesamiento de la información social en el TEA y en el TDAH, pero evidenciando una mayor disfunción en el TEA. Aunque en general los estudios suelen incluir participantes con un rango amplio de edad y parece oportuno utilizar muestras más homogéneas para evitar posibles sesgos. Otra consideración importante se refiere a la posible heterogeneidad neurocognitiva hallada entre grupos de controles, TDAH y TEA. En general, cuando el nivel cognitivo (capacidad intelectual) es más bajo se aprecian diferencias más acusadas en tareas de cognición social, entre sujetos con TEA y con TDAH.

2.4. Cognición social y comorbilidad TEA+TDAH

Los síntomas de TDAH parecen contribuir al empeoramiento de las dificultades de cognición social en niños con TEA (Van der Meer et al., 2012; Sinzig, Morsch, & Lehmkuhl, 2008; Tye et al., 2013; Tye et al., 2014) (Tabla 2). Por ejemplo, en estudios electrofisiológicos recientes se ha evidenciado un procesamiento atípico de la cara y de la mirada en niños con TEA y con TDAH+TEA / TEA+TDAH, comparados a niños con TDAH y DT. Concretamente, Tye et al. (2014) encontraron que niños con TEA y niños con TDAH mostraron anomalías en las respuestas neurofisiológicas de potenciales evocados a expresiones faciales de emociones. Concretamente, los niños con TEA mostraron déficits específicos en el procesamiento de emociones negativas, mientras que en los niños con TDAH se observaron déficits en el procesamiento de emociones negativas y positivas. Los niños con TEA+TDAH mostraron anomalías en el procesamiento de emociones,

tanto en los componentes tempranos N170, como en los tardíos N400, lo que sugiere efectos aditivos de ambos trastornos.

Resultados similares obtuvieron Tye et al. (2013) utilizando un diseño en el que presentaron fotografías de caras verticales e invertidas a niños con TEA, TDAH, TEA+TDAH y controles con DT para examinar el procesamiento de caras y mirada mediante medidas de PE. Los niños con TEA mostraron menor sensibilidad hacia la orientación y dirección de la mirada reflejada por los componentes de potenciales evocados P1 y N170. Los niños con TDAH presentaron anomalías en las etapas tempranas de atención visual, mostrando déficits específicos de inhibición y procesos atencionales. Con respecto al grupo comórbido se observó una deficiencia más pronunciada en el procesamiento de caras y mirada, en comparación al grupo TDAH, al compartir déficits de ambos trastornos.

Otra investigación que también ha profundizado en las bases neurobiológicas de la comorbilidad entre TEA y TDAH es la de Groom et al. (2017). En su estudio compararon una muestra de 35 participantes entre 8 y 15 años de edad con diferentes trastornos (TEA, TDAH y TDAH+TEA) con 20 controles con DT en correlatos electrofisiológicos del procesamiento de la cara y la mirada. Los resultados revelaron un procesamiento atípico en ambos procesos en niños con TEA y niños con TDAH+TEA al compararlos con los grupos de TDAH y DT. El dato proporciona cierta evidencia sobre mecanismos cerebrales que podrían explicar en parte, la comorbilidad entre el TEA y el TDAH. Además, los hallazgos apoyarían otros trabajos que han sugerido que la comorbilidad entre ambos trastornos no se debe a una simple fenocopia, es decir a que los síntomas de una condición imitan a los de la otra (Rommelse et al., 2011).

Los trabajos anteriormente comentados se sitúan en la línea de un estudio pionero que evaluó el reconocimiento facial del afecto en niños entre 6 y 18 años, con TEA con y sin TDAH comórbido (Sinzig et al., 2008). Se utilizó una tarea computerizada que se usa para la enseñanza del procesamiento de las emociones (Prueba de Frankfurt y entrenamiento de Afecto social -FEFA). Los hallazgos mostraron que la habilidad para reconocer emociones faciales estaba más reducida en niños con TEA+TDAH y TDAH que en niños con TEA y DT. Es más, los problemas de atención sostenida y de control inhibitorio estaban agravando la capacidad de reconocer emociones faciales en los niños con síntomas de TDAH.

Sin embargo, otros estudios, que también han utilizado tareas neuropsicológicas como la Attention Network task (ANT) para el reconocimiento de emociones y la prosodia afectiva, han mostrado una ejecución similar entre niños con TEA y niños con TEA+TDAH y sus hermanos con DT en reconocimiento de emociones faciales (mayor número de errores). Por el contrario, se observaron diferencias en la tarea de prosodia afectiva, donde los niños con TEA+TDAH mostraron una peor ejecución (Oerlemans et al., 2014). En general, el grupo TEA obtuvo peores resultados en el reconocimiento facial de emociones y en la tarea de prosodia afectiva, en comparación con los controles. Por su parte, el grupo TEA+TDAH mostró una ejecución inferior de las dos tareas de cognición social que se aplicaron (aunque sólo en una se diferenció significativamente del grupo TEA). Estos hallazgos, sugieren el mayor riesgo de la condición comórbida TEA+TDAH, de experimentar problemas en el reconocimiento de emociones.

Por su parte, Van der Meer et al. (2012) utilizando la ANT hallaron que los niños con TEA+TDAH fueron significativamente más lentos y tuvieron más errores en tareas de cognición social que los niños con TDAH solo. El grupo de niños con TDAH+TEA se situó en un estadio intermedio

entre los dos grupos mencionados. Una limitación del estudio fue que no contó con un grupo de comparación con TEA solo.

Hasta la fecha, el único trabajo publicado que ha analizado la ToM en el grupo comórbido TEA+TDAH, no encontró diferencias significativas entre niños con TEA, TEA+TDAH y TDAH (Bühler et al., 2011). Aunque, el hallazgo más relevante fue la existencia de diferencias entre los grupos de edad más joven, donde los niños con TEA y TEA+TDAH tuvieron una peor ejecución en la tarea de reconocimiento facial del afecto que los niños con TDAH. Los resultados sugirieron que los niños con TEA carecían de prerrequisitos de ToM y mostraban dificultades desde etapas muy tempranas (Bühler et al., 2011).

Tabla 2. Estudios sobre cognición social en niños y adolescentes con TEA+TDAH y TDAH+TEA

Referencia	N Participantes (M)	CI	Tarea	Principales hallazgos	Conclusiones
Bühler et al. (2011)	84 TDAH (9.7) 86 TEA (10.8) **52 TEA+** (10.1)	97.9 105.4 99.0	Reconocimiento facial (FEM), Tarea de atribución social (SAT)	TEA = TDAH en FEM y ToM; (TEA< TDAH) grupo joven, pero sin diferencias en los mayores	La edad modula los déficits de ToM en los grupos clínicos.
Groom et al. (2017)	12 TDAH (11.9) 10 TEA (12.5) **13 TDAH+ (**12.5) 20 DT (12.5)	97.0 106.0 95.5 111.3	E-prime Procesamiento de caras mediante ERP (RT, N170)	Procesamiento atípico de caras en TEA y TDAH+TEA No hubo diferencias en RT entre los grupos	Mecanismos neurobiológicos comunes entre TDAH y TEA. TEA+ mostró deficiencias aditivas
Oerlemans et al. (2014)	47 TEA (10.7) 79 TEA herm (9.7) **43 TEA+ (**10.5) 139 DT (9.2)	103.1 106.4 103.3 107.4	Reconocimiento facial de emociones Prosodia afectiva ANT	TEA y TEA+ peor en reconocimiento de RE, TEA+ peor que TEA en reconocimiento auditivo de felicidad	La presencia de TDAH (inatención) añade más déficit al reconocimiento facial de emociones
Sinzig et al. (2008)	30 TDAH (12.7) **21 TEA+** (11.6) 19 TEA (13.6) 29 DT (12.8)	100 102 111 109	Reconocimiento facial de emociones (Frankfurt Test)	Niños con TEA+ y TDAH solo mostraron puntuaciones más bajas	Los síntomas de TDAH tienen un impacto negativo en el reconocimiento facial de emociones

Referencia	N Participantes (M)	CI	Tarea	Principales hallazgos	Conclusiones
Tye et al. (2013)	18 TDAH (10.4) 19 TEA (11.6) **29 TEA+** (10.5) 26 DT (10.5)	104.1 115.6 109.7 120.0	Reconocimiento de emociones Potenciales evocados (ERP) P1, N170	(TDAH/TEA+TDAH) exhibieron un reducido efecto de inversión de cara en P1, comparado con DT y TEA	El grupo TEA+TDAH evidenciaron déficits únicos de ambos trastornos
Tye et al. (2014)	18 TDAH (10.4) 19 TEA (11.6) **29 TEA+** (10.5) 26 DT (10.5)	104.1 115.6 109.7 120.0	Reconocimiento de emociones (ERP) N170, N400	TEA/TEA+TDAH mostraron reducida amplitud de N170 TDAH/TEA+TDAH reducida amplitud de N400	Los resultados apoyaron un modelo aditivo de comorbilidad
Van der Meer et al. (2012)	109 TDAH (9.9) **59 TDAH+ (**11.2) **58 TEA+** (11.5) 418 DT (9.5)	104.2 101.5 104.2 106.2	Tarea neuropsicológica de Amsterdam -ANT (Identificación de emociones faciales)	TEA+TDAH fueron más lentos y tuvieron menos aciertos que DT y TDAH TDAH+TEA más lentos que DT	TEA+TDAH mayor déficit en tareas de cognición social

Nota. Herm (Hermanos), CI (Capacidad cognitiva), M (Media), DT (Desarrollo típico), RT (tiempo de respuesta), TEA (Trastorno del espectro del autismo), TDAH (Déficit de atención con hiperactividad), TEA+ (Trastorno del espectro del autismo y comorbilidad con déficit de atención con hiperactividad), TDAH+ (TDAH y TEA)

SEGUNDA PARTE: TRABAJO EMPÍRICO

3. Objetivos e Hipótesis de trabajo

3.1. Objetivo general

El objetivo general de la presente investigación es profundizar en el funcionamiento ejecutivo y en las habilidades de cognición social que contribuyen al funcionamiento social, comportamental y adaptativo de niños con TEA de alto funcionamiento, TDAH y TEA+TDAH a través de los siguientes objetivos específicos:

3.2. Objetivos específicos

1) Analizar el perfil de habilidades de FE, ToM y competencia pragmática de niños con TEA de alto funcionamiento y niños con DT y analizar el papel de mediación que desempeñan estas habilidades en el funcionamiento social (Estudio 1).

2) Analizar el perfil de habilidades de FE y ToM de niños con TDAH y niños con desarrollo típico y determinar a través de análisis de mediación los mecanismos específicos que pueden operar entre síntomas de TDAH, componentes del FE, habilidades de ToM y problemas sociales con compañeros. (Estudio 2).

3) Comparar las habilidades de cognición social de reconocimiento de emociones (RE) y ToM explícita y aplicada, en niños con TEA, TDAH y desarrollo típico, profundizando en la relación que mantienen con el FE en niños con TEA y niños con TDAH. (Estudio 3).

4) Explorar el funcionamiento ejecutivo, las habilidades de cognición social y problemas emocionales y conductuales de niños con TEA, TEA+TDAH, TDAH y DT y analizar la relación entre síntomas de TEA y TDAH con el FE, cognición social y problemas emocionales y conductuales en niños con TEA+TDAH. (Estudio 4).

3.3. Hipótesis

A la luz de la exhaustiva revisión de la literatura anterior sobre los objetivos que se delimitan en la presente Tesis, se plantearon las siguientes hipótesis:

1) Los niños con TEA presentarán un perfil distinto al de sus iguales con DT en habilidades de ToM, FE y competencia pragmática. Los déficits en estos procesos tendrán un impacto negativo en el funcionamiento social de los niños con TEA. Además, las dificultades en ToM y en pragmática mediarán la relación entre síntomas nucleares del TEA y el funcionamiento social.

2) Los niños con TDAH mostrarán una mayor afectación en FE y ToM al compararlos con el grupo con DT, mediando las deficiencias ejecutivas, especialmente el Indice de regulación comportamental (BRI), la relación entre los síntomas del TDAH y los problemas sociales con los compañeros.

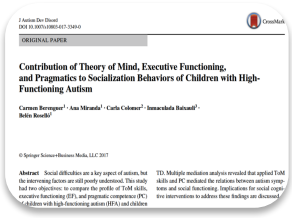
3) Los niños con TEA tendrán peor rendimiento en COS que los niños con DT, mientras que los niños con TDAH presentarán una mayor variabilidad y ocuparán una posición intermedia entre los niños con TEA y DT. Aunque el FE y la ToM se relacionarán significativamente en ambos trastornos, los procesos metacognitivos tendrán mayor importancia en TEA y los componentes del BRI en el TDAH.

4) Los niños con TEA, TDAH, TEA+TDAH mostrarán mayores déficits en las variables analizadas de FE y COS que los niños con desarrollo típico. Además, la presencia de comorbilidad TEA+TDAH producirá mayores dificultades tanto en el FE como en procesos de COS y en el comportamiento y adaptación social.

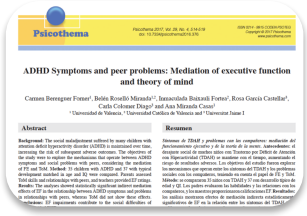
4. Metodología y Resultados

4.1. Organización y publicaciones del compendio

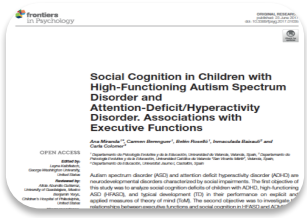
En la siguiente figura se representa en síntesis la organización de los diferentes trabajos que se incluyen en la presente tesis (Figura 2).



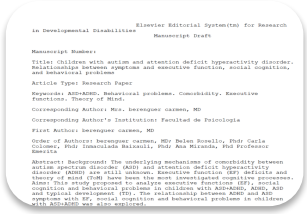
Objetivo 1



Objetivo 2



Objetivo 3



Objetivo 4

Figura 2. Organización de los estudios presentados

Como ya se ha comentado previamente, el primer objetivo específico que se planteó (Objetivo 1) consistió en analizar el perfil de habilidades de FE, ToM y competencia pragmática de niños con TEA de alto funcionamiento y niños con DT y analizar el papel de mediación que desempeñan estas habilidades en el funcionamiento social. Este trabajo se recoge en la publicación con el título: "Contribution of theory of mind,

executive functioning, and pragmatics to socialization behaviors of children with high-functioning autism" (Estudio 1).

Un segundo objetivo fue analizar el perfil de habilidades de FE y ToM de niños con TDAH y niños con desarrollo típico y determinar a través de análisis de mediación los mecanismos específicos que pueden operar entre síntomas de TDAH, componentes del FE, habilidades de ToM y problemas sociales con los compañeros (Objetivo 2). Este trabajo se recoge en la publicación con el título "ADHD Symptoms and peer problems: Mediation of executive function and theory of mind" (Estudio 2).

El tercer objetivo planteó comparar las habilidades de cognición social de reconocimiento de emociones (RE) y ToM explícita y aplicada, en niños con TEA, TDAH y desarrollo típico, así como profundizar en la relación que mantienen con FE en niños con TEA y niños con TDAH (Objetivo 3). Este trabajo se recoge en la publicación con el título: "Social Cognition in Children with High-Functioning Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder. Associations with Executive Functions" (Estudio 3).

Por último, el cuarto objetivo fue explorar el funcionamiento ejecutivo, las habilidades de cognición social y problemas emocionales y conductuales de niños con TEA, TEA+TDAH, TDAH y DT y analizar la relación entre síntomas de TEA y TDAH con el FE, cognición social y problemas emocionales y conductuales en niños con TEA+TDAH (Objetivo 4). Este trabajo se recoge en el estudio con el título: "Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and executive function, social cognition, and behavioral problems" (Estudio 4).

4.2. Resultados de las publicaciones del compendio

Pasaremos a continuación a concretar los resultados de los cuatro estudios que engloban el objetivo general de la presente Tesis

4.2.1. Estudio 1

Berenguer, C., Miranda, A., Colomer, C., Baixauli, I., & Roselló, B. (2017). Contribution of theory of mind, executive functioning, and pragmatics to socialization behaviors of children with high-functioning autism. *Journal of Autism and Developmental Disorders*, 1-12. doi: 10.1007/s10803-017-3349-0

SC Imago Journal Ranking 1.861

ISI. Journal Citation Reports Ranking 13/70

Impact Factor JCR (3.3.21) Quartile 1

Este primer estudio analizó la posible contribución de la ToM, el FE y la competencia pragmática en el funcionamiento social de niños con TEA, así como los potenciales efectos de mediación de la ToM y la competencia pragmática del lenguaje entre los síntomas nucleares del autismo y la socialización. Los hallazgos se sitúan en la línea de otras investigaciones (Bora & Pantelis, 2016; Hutchins et al., 2016), ya que los niños con TEA mostraron un desarrollo inferior a los niños neurotípicos en todas las medidas de ToM que se utilizaron. Además, los niños con TEA presentaron déficits en medidas de cognición social tanto en tareas neuropsicológicas como en cuestionarios para padres que evaluaron habilidades mentalistas de primer orden, así como de segundo orden y de nivel más avanzado. Tal panorámica sugiere la existencia de un déficit profundo y metarrepresentacional en los niños con autismo (Baron-Cohen, 1995; Hughes & Devine, 2015). Sin embargo, conviene matizar que los tamaños parciales del efecto fueron mayores en las tres escalas del inventario ToMI que valora la competencia

de ToM desde el punto de vista de los padres, en comparación a los de la prueba neuropsicológica de ToM de la batería NEPSY-II.

La competencia pragmática de los niños con TEA fue también significativamente inferior a la de los niños con DT, aun controlándose variables como el vocabulario y el sexo. Las dificultades pragmáticas comprendían alteraciones en coherencia, comunicación no verbal, inicios comunicativos inapropiados al contexto, y un lenguaje estereotipado de temática repetitiva y restringida, al igual que muestran otros trabajos (Lam & Yeung, 2012; Orinstein et al., 2015; Volden, Coolican, Garon, White, & Bryson, 2009). Por último, se constataron problemas más acusados de FE en el grupo con TEA que en el grupo de niños con DT, unos resultados que se ajustan a las conclusiones de una revisión exhaustiva sobre el tema (Wallace et al., 2016). Los déficits afectaban tanto a la regulación comportamental, que valora la capacidad para cambiar de estado afectivo y modular las emociones y la conducta, como a la metacognición que refleja la habilidad para manejar tareas cognitivamente y supervisar la ejecución de las mismas.

Por otro lado, se analizaron las relaciones entre el dominio de socialización y la ToM, el FE y la competencia pragmática con el objetivo de determinar el posible papel mediador que juegan estos procesos entre los síntomas de autismo y la socialización de niños con TEA. Los resultados aportaron valores significativos de asociación en la dirección esperada, entre medidas de funcionamiento adaptativo con las dificultades ejecutivas en la vida diaria. Así mismo, la socialización del grupo de niños con TEA se relacionó con la ToM aplicada a la vida diaria en general, es decir las habilidades de ToM, percibidas por los padres, coincidiendo con hallazgos previos (Bishop-Fitzpatrick et al., 2017; Mazza et al., 2017). La misma tendencia se observó en la asociación significativa entre competencia

pragmática y funcionamiento social. Este hallazgo resulta lógico teniendo en cuenta que las habilidades de comunicación pragmática son esenciales para desarrollar una conducta social adaptativa (Tager-Flusberg, 1999). En este caso, habilidades como la iniciación de la comunicación, el uso e interpretación del lenguaje apropiado al contexto o el dominio de la comunicación no verbal se relacionaron claramente con el funcionamiento en situaciones sociales.

Por otra parte, la relación entre el índice metacognitivo y la socialización confirmó la relevancia de los déficits en memoria de trabajo, iniciativa y planificación, en el funcionamiento social de los niños con TEA encontrada en estudios previos (Freeman, Locke, Rotheram-Fuller, & Mandell, 2017; Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Leung et al., 2016). Por el contrario, el BRI no mostró correlaciones significativas con la socialización, probablemente debido a la utilización de una medida de funcionamiento social amplia como es la subescala de socialización de la Vineland. De hecho, otros estudios han encontrado asociaciones significativas entre la regulación comportamental y conductas sociales más concretas como las conductas de cooperación (Li, Zhu, Liu, & Li, 2014). Tampoco se encontraron asociaciones significativas de los diferentes indicadores de la ToM explícita (tarea neuropsicológica), con el dominio de socialización, poniendo de manifiesto la mayor sensibilidad del procedimiento de evaluación vinculado a las pruebas más ecológicas en los resultados obtenidos (Hutchins et al., 2016; Senju, 2012; Senju, Southgate, White, & Frith, 2009).

Finalmente, los análisis de mediación indicaron que tanto las habilidades de ToM aplicadas a la vida diaria como la competencia pragmática del lenguaje tenían una influencia tanto directa como indirecta en la

socialización de niños con TEA. Los hallazgos de Mazza et al. (2017) también han subrayado, la importancia de la ToM en el desarrollo de las habilidades sociales de niños con TEA. En este sentido, otras investigaciones en niños con TEA han demostrado que las habilidades de ToM son significativamente predictivas del lenguaje pragmático (Whyte & Nelson, 2015). Estos resultados subrayan el impacto negativo de las deficiencias en ToM y lenguaje pragmático en el funcionamiento social de niños con TEA.

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ORIGINAL PAPER

Contribution of Theory of Mind, Executive Functioning, and Pragmatics to Socialization Behaviors of Children with High-Functioning Autism

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Abstract Social difficulties are a key aspect of autism, but the intervening factors are still poorly understood. This study had two objectives: to compare the profile of ToM skills, executive functioning (EF), and pragmatic competence (PC) of children with high-functioning autism (HFA) and children with typical development (TD), and analyze their mediator role in social functioning. The participants were 52 children with HFA and 37 children with TD matched on age, intelligence quotient, and expressive vocabulary. Significant differences were found on measures of ToM, both explicit and applied, EF, and PC between children with HFA and TD. Multiple mediation analysis revealed that applied ToM skills and PC mediated the relations between autism symptoms and social functioning. Implications for social cognitive interventions to address these findings are discussed.

Keywords High functioning autism · Theory of mind · Pragmatic competence · Executive functioning · Social domain

All authors have contributed equally to the performance of this work.

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Introduction

A body of empirical studies shows the persistent difficulties in communication and social interaction experienced by children with autism across multiple contexts. These problems are evident from an early age, despite cognitive potential. They cause daily difficulties, become more pronounced with age, and can lead to negative long-term outcomes (Klin et al. 2007). The impairments are expressed in behaviors such as inappropriate affect, social isolation, and failure to initiate interactions with peers, cooperate, share, make friends, express empathy, or provide emotional support (Russell et al. 2012; Schwenck et al. 2012).

The social difficulties of people with autism spectrum disorders (ASD) with cognitive impairment have been extensively studied. However, scant empirical research has been dedicated to the study of socialization impairments in children with high-functioning autism (HFA) and, especially, the variables mediating in these deficits, in spite of their relevance in designing more effective interventions. The present study represents an attempt to advance in this direction by analyzing the role played in the domain of socialization by three cognitive impairments that have been conceptually associated with ASD, and that represent neuralgic centers of psychological research on the disorder. One source of social

communication deficits observed in ASD is an impairment in "Theory of Mind" (ToM). Pragmatic competence (PC) is another cognitive process that has been linked to social problems in ASD. Finally, the third potential source of the social difficulties encountered by individuals with ASD is the deficit in executive functioning (EF).

TOM implies an awareness that others have a mind with mental states, information, and motivations that may differ from one's own, allowing an individual to effectively communicate and interact socially (Baron-Cohen 1995; Baron-Cohen et al. 1985).

Children with ASD obtain significantly worse results on ToM measures than children with typical development (TD) (see meta-analysis by Bora and Pantelis 2016), and research supports the influence of ToM on the social functioning of children with HFA (Kimhi 2014). Mazza et al. (2017), using mediation analysis, showed that ToM plays a key role in the development of social abilities, and that the lack of ToM competences in children with autism impairs their competent social behavior. Bishop-Fitzpatrick et al. (2017) determined that performance on first- and second-order false belief tasks was significantly associated with better social functioning, materialized as higher levels of socially adaptive behavior and lower levels of social problems.

Even successfully completing the ToM tasks, children with autism seem to have more problems with everyday mindreading than younger children with TD (Peterson et al. 2009). Contrary to what would be predicted based on ToM, children and adolescents with HFA can perform advanced ToM tasks as well as their TD peers, and they seem to be able to master the theoretical principles of advanced mental states, but they may still fail to apply these theoretical principles during everyday social interactions (Scheeren et al. 2013). Taken together, the findings emphasize that the implicit applied level maintains a stronger relationship with social adaptation, so that it seems plausible, as Frith et al. (1994) suggested, that some children with HFA learn to resolve explicit ToM problems in experimental contexts in a non-mentalist way. They can use non-social strategies that allow them to respond correctly to false belief questions, but they do not generalize the solutions to real life, which also requires the flexible processing of changing emotional and social signals. Thus, measures of explicit/conceptual ToM competence and measures of applied ToM competence expressed in real world must be considered in research that tries to describe the relationships between the ToM and adaptive social behavior (Hutchins et al. 2016). Results are enhanced when both explicit social cognition performance and implicit social cognition performance in terms of spontaneous perspective taking are included (Callenmark et al. 2014).

Children with HFA generally present deficits also in spontaneous language and conversational skills. Compared to their peers with TD, children with HFA use fewer facial expressions and gestures, have difficulty taking turns in conversation, and can insist on topics in which they are especially interested. These pragmatic deficits affect their social relations and tend to persist in adolescence and adulthood. Using an observational methodology, Bauminger et al. (2003) analyzed the communication and social interaction patterns developed by individuals with HFA during school recess and snack times. They showed a lower level of participation in peer interactions and fewer combined and complex social behaviors. These social abilities have been related to structural expressive language and pragmatics, which have contributed with significant unique variance to the prediction of social behavior in children with ASD (Volden et al. 2009). More recently, Orinstein et al. (2015) compared youth with HFA, optimal outcome (OO), and TD. The group with HFA obtained the lowest scores on the structured evaluation of pragmatics and the estimation of these skills in everyday situations. Likewise, the results of the correlations showed that the children and adolescents with HFA with more social symptoms of autism presented lower performance on pragmatic competence measures, but this relationship was not present in TD participants.

Empirical studies show a close link between mentalist and communicative abilities, so that understanding of false belief seems to be the most powerful predictor of changes in the children's development of communicative competence (Resches and Pérez-Pereira 2007). Given the significance of theory of mind abilities for communication, it is not surprising that the ToM deficit is the cognitive phenomenon most frequently researched in association with pragmatic language in autism. In fact, a significant correlation has been found in children with autism—but not in a group with developmental delay—between the performance on ToM tasks and the capacity to respond to a conversational partner with new and relevant contingent information (Capps et al. 1998). In another pioneer study (Tager-Flusberg and Sullivan 1995), theory of mind performance was significantly correlated with a number of different narrative measures only for the group with autism. In addition, the individuals with autism gave significantly fewer appropriate explanations for the emotional states of the story characters, which is linked to the capacity to understand other minds. Indeed, the tendency of people with autism to interpret speech literally might suggest that they do not understand the mind of the speaker. An overview of research documenting problems in figurative language in individuals with ASD highlighted that individuals in the autistic spectrum fail to integrate a situation model that integrates the speaker's intent and the rest of the context in which all this must be used (Vulchanova et al. 2015).

However, as the classic review by Tager-Flusberg (1999) has already concluded, although it should not be minimized

the significance of ToM hypothesis in the interpretation of core deficits in both the social and language domains of autism, not all aspects of the syndrome can be interpreted within this framework. Many symptoms are not reflections of an underlying deficit in interpreting people from a mentalistic perspective. Other factors related to social development, such as executive functioning, should also be considered.

The "executive functions" encompass a broad spectrum of interrelated processes that are in charge of "guiding, directing, and controlling cognitive, emotional, and behavioral functions, especially during the active solution of novel problems" (Gioia et al. 2000). The role of the executive profile in autism requires more thorough investigation, but various reviews have suggested a specific pattern of executive dysfunction in components such as planning and flexibility that distinguishes autism from other disorders (Hill 2004; Miranda-Casas et al. 2013; Wallace et al. 2016).

One relevant issue that has hardly been explored has to do with demonstrating the relationship between EF deficits and the everyday behavioral difficulties that may originate from them. Although more empirical research is needed, negative relationships have been found between the Initiate and Working Memory subdomains of the Behavior Rating Inventory of Executive Function (BRIEF) and most of the adaptive behavior domains of the Vineland Adaptive Behavior Scales (Gilotty et al. 2002). Poorer EF is associated with increased playground isolation and less engagement with peers (Freeman et al. 2017). In fact, significant associations and longitudinal predictive power have been found between subdomains of the BRIEF and adaptive functioning on the Vineland Adaptive Behavior Scales, with executive problems significantly contributing to less adaptive behavior across domains (Pugliese et al. 2015). In addition, the executive functions have demonstrated to predict both emotional and behavioral school engagement, and more specifically, emotion regulation can predict prosocial peer engagement (Jahromy et al. 2013).

Studies have also shown that the pattern of associations between adaptive social behaviors and the EF is different in ASD (Leung et al. 2016) compared to TD. Thus, the executive processes of behavioral regulation, including inhibition, emotional regulation and shift, predict social functioning in children with ASD and TD. However, the metacognitive executive processes of initiation, working memory, monitoring, planning, and organization are predictors of social adaptation only in children with ASD.

In the past few years, a growing body of research has focused on abilities other than ToM that underlie social competences. Although only a few studies have examined the value of specific cognitive abilities, they suggest that characteristic deficits in various domains such as EF and PC may predict functional outcomes in HFA. ToM can be a necessary condition, but not sufficient, for the development of adaptive social behaviors. Therefore, the present study has proposed two objectives: on the one hand, to compare the profile of ToM skills, EF, and PC of children with HFA and children with TD; and on the other, to analyze the relationships between ToM, EF, and PC and the socialization domain within the HFA group and, using a mediator model, determine their possible mediator role between symptoms of the disorder and functioning in the social domain. The children with HFA are expected to present a clearly differentiated profile, compared to their peers with TD, on ToM skills, EF, and PC. In the same way, the deficits in ToM, EF, and PC are expected to have a negative association with the social functioning of children with HFA. Along with theory of mind deficits, the executive and pragmatic dysfunctions identified in children with ASD are expected to mediate between the symptoms and the social problems they experience.

Methods

Participants

Participants in the study were 89 children between 7 and 11 years old with an intellectual quotient (IQ) within the limits of normality, measured with the K-BIT (Kaufman and Kaufman 2000). They were distributed in two groups: a group containing 52 children with high-functioning autism spectrum disorder (HFA) and 37 children with typical development (TD), matched on age and IQ (see Table 1). Regarding gender, 79.7% of the participants were boys, and 20.3% were girls. Language was evaluated with the vocabulary subtest from the WISC-IV (Wechsler 2003), which is closely related to overall language (Snow et al. 1989) (see Table 1).

Table 1 Demographic characteristics of the participants in each group

	TD (n = 37) Mean (SD)	HFA (n = 52) Mean (SD)	$F_{1,87}$	χ^2	p
Age (years)	8.54 (1.26)	8.59 (1.38)	.02	–	.880
IQ	102.11 (8.91)	101.42 (12.65)	.08	–	.778
Vocabulary	12.91 (2.75)	11.51 (3.34)	4.36	–	.040*
Parental education	3.27 (.95)	3.05 (1.09)	2.06	–	.154
Gender (% male)	62.1%	92.3%	–	12.17	.000*
Medication (% yes)	0.0%	32.7%	–	14.95	.000*

Parental education measured as highest level of mother or father (0 = elementary school, 1 = compulsory secondary school, 2 = medium level vocational training, 3 = upper secondary education (Bachiller) or superior level vocational training, 4 = university degree)

*$p < .05$

The participants with HFA had received a clinical diagnosis of ASD in the Psychiatry and Neuropediatric services of hospitals and medical centers in the Valencian community. In order to confirm the ASD diagnosis, strict cut-off points were applied, as recommended on the Social Communication Questionnaire (SCQ; Rutter et al. 2003a) and on the Autism Diagnostic Interview-revised (ADI-R; Rutter et al. 2003b). The diagnostic measures were administered by a psychologist from the research team who was accredited in their application.

Regarding schooling, 38.46% of the children with ASD were enrolled in specific Language and Communication Classrooms, and 61.54% were enrolled in ordinary classrooms and attended therapeutic support rooms part-time every day in the same school where they were enrolled.

The children with TD were enrolled in ordinary classrooms in the same schools that the children diagnosed with HFA attended. They had no history of psychopathology or referral to pediatric mental health units (USMI), according to the information found in the school records, and they did not meet DSM 5 criteria for ASD on the screening carried out before beginning the evaluation.

The exclusion criteria for the children who participated in this study were evaluated through an extensive anamnesis carried out with the families. They included neurological or genetic diseases, brain lesions, sensory, auditory, or motor deficits, and an IQ below 80. The administration of psychomedications was only an exclusion criterion for the children in the TD group, whereas 32.7% of the children with ASD were taking antipsychotic medications (mostly risperidone) for behavioral problems and symptoms of irritability.

Measures

Theory of Mind

To carry out this study, the theory of mind measures of explicit knowledge and applied knowledge were selected.

Explicit ToM knowledge: NEPSY-II: A developmental neuropsychological assessment (Korkman et al. 2007). This test is designed to evaluate the capacity to understand mental functions such as beliefs, intentions, deception, and emotions, among others. Therefore, the objective is to rate the ability to understand that others have thoughts and feelings that can be different from one's own. In addition, it is designed to measure the capacity to understand the relationship between the emotions and the social context and identify the appropriate emotion in certain social contexts. It consists of two tasks, the verbal task, which combines questions about first- and second-order beliefs, and the contextual task, which shows some images of children in different social contexts in order to identify the one that best represents the feelings of the target character shown in the images. The internal reliability coefficients for the test are high ($r \geq 0.80$) (Brooks et al. 2009).

Applied ToM Knowledge: Theory of Mind Inventory (ToMI; Hutchins et al. 2014; Spanish adaptation by; Pujals et al. 2016). To evaluate the application of the ToM skills, the ToMI inventory was completed by parents. It is composed of 42 items. Each item is an indicator of a specific dimension of Theory of Mind, in order to approach the breadth and complexity of the mentalist skills. The items are grouped in three subscales, and they offer a general average score. The early subscale rates skills that begin to develop in the first stages of childhood, such as social reference or understanding emotions. The basic subscale includes typical ToM characteristics of children starting school, such as basic meta-representations or the distinction between physical and mental. Finally, the advanced subscale evaluates more mature aspects of theory of mind, such as second-order inferences or making complex social judgments. Each item is evaluated from 0 to 20, "Definitely not" to "Definitely", with an intermediate score of "Undecided", and high scores indicate the perception of good ToM competence.

The ToMI has been widely validated and has good test–retest reliability, internal consistency, and criterion validity for samples with typical development and with ASD. It has shown excellent sensitivity (.9) and specificity (.9) when used to examine children with ASD, although its purpose is not to make a differential diagnosis (Hutchins et al. 2012).

Communicative Competence

The extent of general communication behavior exhibited by the children was measured using The Children's Communication Checklist Second Edition (CCC-2; Bishop 2003) filled out by the parents. The CCC-2 contains 70 items grouped in 10 subscales that measures different aspects of communication: the structure of language (speech, syntax, semantics, coherence), pragmatics (inappropriate initiation, stereotyped language, use of context, and non-verbal communication), and behaviors that are found to be impaired in children with ASD (social relationships and interests).

The frequency of the behaviors described in each item are rated on a 4-point scale; a high score indicates more communication problems.

This study used the pragmatic composite index (PCI), which is obtained by adding together the scale scores on the coherence, inappropriate initiation, stereotyped language, use of context, and non-verbal communication subscales. This specific grouping, although not contemplated in the CCC-2, has been used in other studies (Geurts and Embrechts 2008; Helland 2014).

The CCC-2 presents good internal consistency, with alphas values ranging from 0.73 to 0.89, and test–retest reliability ranging from 0.44 to 0.76 (Helland et al. 2009). It has proven to be a highly sensitive tool for identifying pragmatic language impairment in high-functioning speakers with ASD who also have structural language and nonverbal cognitive scores within typical limits (Volden and Phillips 2010).

Executive Functioning

The teachers' version of the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al. 2000) was filled out by the teachers. It consists of 86 items that rate the child's executive functions through the observation of his/her behavior in the school context. The items are scored on a Likert-type scale with three levels (never, sometimes, often), and they are grouped in eight scales that make up the two general indexes included in our analyses. The behavioral regulation index (BRI) rates the child's capacity to change his/her affective state and modulate his/her emotions and behavior using appropriate self-control. It contains the inhibit, shift, and emotional control subscales. The metacognitive index includes the subscales of initiate, working memory, plan/organize, organization of materials, and monitor. It reflects the child's ability to handle tasks cognitively and supervise his/her own performance.

The direct scores can be transformed into T scores, with higher scores indicating worse executive functioning. Thus, T scores equal to or greater than 65 are considered to have clinical significance. The test–retest reliability of the Spanish adaptation of the teacher version of the BRIEF ranged between 0.86 and 0.92 (Maldonado Belmonte 2016). These values are similar to those obtained on the original version of the test (Gioia et al. 2000).

Socialization Domain

The socialization domain was evaluated with the Vineland Adaptive Behavior Scales (VABS-II ed; Sparrow et al. 2005). The Vineland scale is a semi-structured interview for parents to evaluate their child's social competence and adaptation through four areas of behavior: communication, daily life skills, socialization, and motor skills. This study used the scores on the socialization domain, which has three sub-domains: the Interpersonal Relationships subdomain, with 13 items (e.g. "Shows interest in children the same age, other than brothers or sisters, for example, watches them, smiles at them, etc…"); the Play and Leisure Time subdomain, with 13 items (e.g. "Plays with others with minimal supervision"); and the Coping skills subdomain, with 11 items (e.g. "Follows through with arrangements, for example, if promises to meet someone, meets that person"). The Vineland scale has been widely used in people with ASD to evaluate social maturity. It has solid psychometric properties, with high test–retest reliability (α= .98) (Sparrow et al. 2005).

Clinical Symptoms of ASD

For the dimensional evaluation of the autism symptoms, a clinical psychologist held an interview with the parents, who reported on the diagnostic criteria of the Autism Spectrum Disorder included in the DSM-5 (American Psychiatric Association 2013). The first block referred to persistent deficiencies in social communication and social interaction in various contexts, and it contained three items (e.g. "Do you now or have you ever noted in your child an abnormal social approach or some problem in normal conversation?"). The second block referred to restrictive and repetitive patterns of behavior, interests, or activities, and it contained four items (e.g. "Do you now or have you ever observed stereotyped or repetitive movements, use of objects, or speech in your child?").

The parents evaluated the severity of each criterion from 0 to 3, where 0 represents "almost never", 1 "sometimes", 2 "often", and 3 "many times".

Procedure

The study was approved by the Ethics Committee of the University of Valencia (Declaration of Helsinki in the European Council Agreement, 1964). Likewise, it had authorization from the Board of Education of the Valencian Government to access the schools and locate the participants. The evaluation was carried out in the schools where the children were enrolled. The informed oral and written consent of the parents of all the participants was also obtained after informing them about the research proposals.

The evaluation was carried out in specially prepared spaces in the schools that met the optimal conditions for psychoeducational assessment. Parents and children were evaluated during school hours, without interfering with the basic curricular activities. The tests were applied by experienced professionals who were familiar with the different instruments. The teachers' information was collected in each collaborating school.

Data Analysis

The statistical analyses were performed with the software Statistical Package for the Social Science (SPSS), version 22.00 (SPSS Inc., Chicago, IL USA). To analyze the differences between the ASD and TD groups in the socialization domain, explicit and applied ToM skills, EF, and PCI, a multivariate analysis of covariance (MANCOVA) was

carried out using gender and vocabulary as covariates. The differences on the entire test were verified through additional covariate analyses of variance (ANCOVAs).

For the additional ANCOVAs, the level of significance was set at $p < .005$, after applying the Bonferroni correction, and the value of η^2_p was calculated to test the strength of the association.

Partial correlation analyses were also performed in the ASD group, including gender and vocabulary as covariates, in order to study the relationships between the ASD symptomatology, explicit and applied ToM competence, the BRI and metacognitive index (MI), the pragmatic competence, and the socialization domain. A multiple regression analysis was also carried out to study the impact of the variables on the socialization domain.

Finally, a multiple mediation analysis was carried out using the PROCESS program of mediation, moderation, and conditional analysis (Hayes 2013), in order to examine the possible mediation of the variables that showed statistical significance with the socialization domain, that is, applied ToM knowledge and the PCI. To do so, the ASD Symptoms variable was used as the independent variable, the score on the socialization domain was the dependent variable, and applied ToM knowledge and the PCI were used as mediator variables. To control the possible influence of other variables in the mediation model, gender, due to its relationship with the socialization domain, and vocabulary were included as covariates in the Process macro. Based on Baron and Kenny (1986), for the mediation model to be acceptable, four requirements have to be met: (a) the predictor variable has to be related to the dependent variable, (b) the predictor variable has to be related to the mediator variable, and (c) the mediator variable has to be related to the dependent variable, after controlling for the effect of the predictor variable. The final condition is that the effect of the predictor variable on the dependent variable, controlling the effect of the mediator variables, must not be statistically significant.

When the effect of the predictor is reduced until reaching non-significant levels, the mediation effect is considered full. When its effect is reduced but remains significant, the mediation is considered partial.

The present study used the bootstrapping procedure with 10,000 repetitions to verify the mediator effect of the aforementioned variables with a confidence interval of 95%. When the indirect effect of the mediators is significantly different from zero, this indirect effect is considered significant.

We analyzed the distribution of the variables and their fit to the normal distribution curve by applying the Kolmogorov–Smirnov test, transforming only the variables that showed an anomalous distribution using square root procedures. In relation to the bootstrapping method, because the sample size was not very large, we followed the recommendations of MacKinnon et al. (2004), and we used the non-parametric bootstrapping procedure. This method has been specifically designed to obtain reliable and valid conclusions in studies where the sample sizes are not large and, therefore, where the assumption of multivariate normality can not be assumed (Preacher and Hayes 2004).

Results

Comparison of children with ASD and TD on the socialization domain, explicit and applied ToM measures, EF, and CP.

The MANCOVA performed to evaluate the main effect of group on the indicators of socialization domain, explicit and applied ToM competence, EF, and PCI, controlling for gender and vocabulary, was statistically significant [Wilk's Lambda (Λ) = .16, $F_{(11,75)} = 35.59$, $p < .001$, $\eta^2_p = .83$]. The confirmatory ANCOVAs yielded the following results (see Table 2): on the socialization domain significant differences were found, $F_{1,85} = 53.02$ $p < .001$, $\eta^2_p = .38$; on the NEPSY battery tasks, significant differences were observed; on Verbal ToM, $F_{1,85} = 21.69$, $p < .001$, $\eta^2_p = .20$, and on the total ToM-NEPSY score, $F_{1,85} = 25.68$, $p < .001$, $\eta^2_p = .23$; on the applied knowledge task (ToMI) significant differences were observed on Early ToMI, $F_{1,85} = 51.03$, $p < .001$, $\eta^2_p = .38$; Basic ToMI, $F_{1,85} = 90.10$, $p < .001$, $\eta^2_p = .52$; Advanced ToMI, $F_{1,85} = 209.05$, $p < .001$, $\eta^2_p = .71$, and on the total score on the ToMI $F_{1,85} = 148.68$, $p < .001$, $\eta^2_p = .64$. The confirmatory ANCOVAs also revealed statistically significant differences between the groups on the BRI, $F_{1,85} = 34.17$, $p < .001$, $\eta^2_p = .28$, the Meta-cognition Index—MI, $F_{1,85} = 53.97$, $p < .001$, $\eta^2_p = .38$, and the Pragmatic Competence, $F_{1,85} = 227.29$, $p < .001$, $\eta^2_p = .72$.

Relationships between the socialization domain and theory of mind measures (explicit and applied), EF, and PCI in children with HFA.

The results of the correlation analyses, using the covariates of gender and vocabulary (Table 3), revealed the existence of significant associations between the socialization domain and the ASD symptoms from the DSM 5 ($p < .001$), as well as the applied ToM competence at the three levels, early ToMI ($p < .001$), basic ToMI ($p < .001$), and total ToMI ($p < .001$). In addition, the analyses revealed significant correlations between the socialization domain and the MI ($p = .007$) and PCI ($p < .001$). No significant associations were found between the socialization domain and the explicit ToM competence test, the advanced TOMI subscale, or between the socialization domain and the BRI.

Multiple regression analysis was carried out in the ASD group in order to evaluate the relationships among the dependent variable of the socialization domain and the MI, the total applied ToMI, and PCI, as explanatory variables. The results of the regression analysis indicated

Table 2 Differences between the groups of children with HFA and TD on the socialization domain, explicit and applied ToM competence, EF and PCI

	TD (n = 37)		HFA (n = 52)		$F_{(1,85)}$	η^2_p
	M	SD	M	SD		
Socialization D.	93.28	9.40	75.48	9.87	53.02*	.38
ToM verbal	17.49	2.05	14.02	3.64	21.69*	.20
ToM contextual	4.89	0.99	3.95	1.58	6.83	.07
ToM total	22.38	2.43	17.96	4.15	25.68*	.23
ToMI early	18.99	1.14	14.52	3.39	51.03*	.38
ToMI basic	19.04	1.13	12.92	3.35	90.10*	.52
ToMI advanced	17.25	2.36	8.02	3.01	209.05*	.71
ToMI total	18.38	1.42	11.51	2.88	148.68*	.64
BRI	49.65	6.49	64.40	14.05	34.17*	.28
MI	47.78	6.60	62.73	10.37	53.97*	.38
PCI	51.59	9.75	18.83	8.59	227.29*	.72

Socialization D. socialization domain, *ToM* theory of mind-NEPSY, *ToMI* theory of mind inventory, *BRI* behavioral regulation index, *MI* metacognition index, *PCI* pragmatic composite index

*p< .005 (Bonferroni correction)

Table 3 Partial correlations between the socialization domain, ASD symptoms, explicit and applied ToM competence, EF, and PCI in the HFA group, controlling for vocabulary and gender

	1	2	3	4	5	6	7	8	9	10	11
1. Socialization	–										
2. Symptoms	−.45**	–									
3. ToM verbal	.19	−.32*	–								
4. ToM contex	.13	−.20	.14	–							
5.ToM total	.22	−.35*	.92**	.51**	–						
6. ToMI early	.66**	−.48**	.12	.28*	.21	–					
7. ToMI basic	.59**	−.53**	.42**	.09	.41**	.69**	–				
8. ToMI adva	.24	−.31*	.23	.10	.24	.52**	.41**	–			
9. ToMI total	.62**	−.55**	.33*	.17	.35*	.86**	.87**	.74**	–		
10. BRI	−.19	−.12	.30*	.11	.31*	.06	.12	.10	.11	–	
11. MI	−.37*	.16	.14	.03	.13	−.30*	−.25	−.22	−.30*	.64**	–
12. PCI	.64**	−.60**	.28*	.24	.34*	.59**	.60**	.47**	.67**	−.03	−.35*

Socialization D. socialization domain, *Symptoms* autism symptoms-DSM, *ToM* theory of mind-NEPSY, *ToMI* theory of mind inventory, *BRI* behavioral regulation index, *MI* metacognition index, *PCI* pragmatic composite index)

*p< .05, **p < .01

that the significant predictors that explained the greatest percentage of variance in the socialization domain were the total applied ToM (β = .32, p = .027) and PCI (β = .37, p = .012) (Table 4).

The results of the correlations and regression analyses supported the viability of the mediation analysis.

Therefore, a multiple mediation model was carried out, in which the applied ToM and PCI mediated the relationship between the ASD symptoms and the socialization domain. As Fig. 1 shows, when the direct effect of Group on the socialization domain was evaluated, controlling for the mediator variables, the *path* c′ was not statistically significant (p = .910). In addition, the ASD symptoms had a

Table 4 Multiple regression analysis of MI, ToMI and PCI predicting socialization domain in HFA group

	B	*SE*	β	p
Socialization D	$F_{(3,48)} = 15.7^*; R^2 = .46$			
MI	−.15	.10	−.16	.145
ToMI	1.11	.48	.32	.027*
PCI	.42	.16	.37	.012*

MI metacognition index, ToMI theory of mind inventory, *PCI* pragmatic composite index

*p< .05

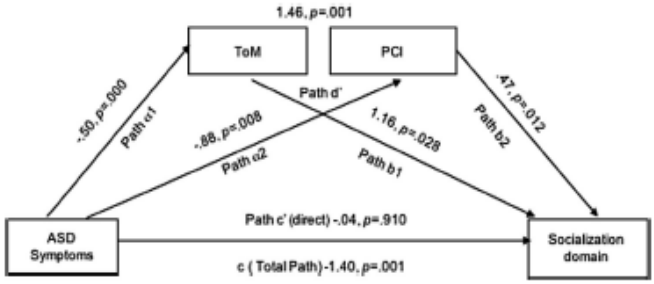

Fig. 1 Multiple mediation analysis of the applied ToM competence and the pragmatic composite index on the relationship between the ASD symptoms and the socialization domain

significant direct effect on $a1 = -.50$, p = .000 y $a2 = -.88$, p = .008.

The indirect effect obtained with the mediator of applied ToM, using *bootstrapping* procedure for a sample of 10,000 and a confidence interval (CI) of 95%, was statistically significant on the *path* between the ASD symptoms and the socialization domain, CI [− 1.48, − .034]. Similar results were found with PCI as the mediator in the relationship between ASD symptoms and the socialization domain CI [− 1.06, − .02]. As zero was not found in this confidence interval, the findings suggest that the indirect effects were significant (p < .05).

The analysis of the covariates indicated that neither sex (β = 2.08, p = .66), nor vocabulary (β = .25, p = .51) had a significant role.

Discussion

The purpose of the present study was to achieve more in-depth knowledge about the socialization domain deficits of children with HFA. Previous empirical studies have focused the analysis on the ToM, but this study broadens the perspective to include cognitive and linguistic factors that could be influencing the social functioning of children with HFA.

A first objective was to compare the ToM skills, EF, and PCI of children with HFA and children with TD. As expected, the results of the group of children with HFA were clearly lower on explicit and applied ToM skills, the main EF indexes, and PCI. Specifically, and coinciding with the results of a recent meta-analysis (Bora and Pantelis 2016), the children with HFA showed more impairment than the children with TD on the ToM measures used. Moreover, the findings are added to those obtained by Hutchins et al. (2016), providing support for deficits of individuals with HFA on the two ToM systems, explicit and applied, at the early (comprehension of basic emotions), basic (basic meta-representations and distinction between physical and mental) and advanced (second-order inferences and more complex social judgements) levels. This situation suggests the existence of a profound meta-representational impairment in children with autism (Baron-Cohen 1995; Hughes and Devine 2015). However, it is important to note that the partial effect sizes were greater for the three ToMI inventory scales that evaluate applied competence than those for the ToM tests from the NEPSY-II battery, which assess explicit competence.

The pragmatic competence of children with HFA was also significantly lower than that of the children with TD, even controlling for variables such as vocabulary and sex. The pragmatic difficulties included alterations in coherence, non-verbal communication, communicative initiations inappropriate for the context, and stereotyped language on repetitive and restricted topics, as other studies have shown (Lam and Yeung 2012; Orinstein et al. 2015; Volden et al. 2009). Finally, greater EF deficits were found in the group with HFA than in the group with TD, and these results coincide with the conclusions of an exhaustive review on the topic (Wallace et al. 2016). The deficits affected both behavioral regulation, which rates the capacity to change the affective state and modulate emotions and behavior, and meta-cognition, which reflects the ability to manage tasks cognitively and supervise their execution.

The second objective of the present study was to analyze the relationships between the socialization domain and ToM, EF, and PC, and determine the possible mediator role of these processes between autism symptoms and the socialization domain in children with HFA.

The results of the partial correlations yielded significant association values in the expected direction, pointing out links between outcome-based measures of adaptive functioning and executive difficulties in real life. Thus, the socialization domain of the *Vineland Adaptive Behavior Scales* in the HFA group was related to the ToM applied to daily life in general and, more specifically, to the early and basic levels, coinciding with previous findings (Bishop-Fitzpatrick et al. 2017; Mazza et al. 2017).

The same tendency was observed in the significant association between PC and social functioning. This finding is logical, taking into account that social communication and competence are in some ways inextricably linked to each other (Tager-Flusberg 1999), with pragmatic skills being essential in developing successful social interactions. In this case, skills such as initiation of communication, the use and interpretation of language appropriate to the context, or the command of non-verbal communication are clearly related to functioning in social situations. In spite of the close relationship between pragmatics and socialization, to the best of our knowledge, few studies have linked the two constructs, at least in the ASD population, although data from studies on this association in typical development or other neurodevelopmental disorders point in the same direction (Baixauli-Fortea et al. 2015; Leonard et al. 2011). Similarly, the relationship between the metacognitive index and the socialization domain from the Vineland confirmed the relevance of the deficits in working memory, initiative, and planning in the social functioning of children with HFA, as found in previous studies (Freeman et al. 2017; Gilotty et al. 2002; Leung et al. 2016). By contrast, the BRI did not show significant correlations with the socialization domain, probably due to the use of a broad social functioning measure, such as the socialization subscale of the Vineland. In fact, other studies have found significant associations between behavioral regulation and more specific social behaviors such as cooperative behaviors (Li et al. 2014). No significant associations were found either between the different indicators of explicit ToM (verbal and contextual) and the socialization domain, revealing the greater sensitivity of the evaluation procedure linked to the applied ToM system in our results (Hutchins et al. 2016; Senju 2012; Senju et al. 2009).

The regression analysis indicated that ToM skills can account for a portion of the social impairments of children with HFA, so that the applied ToM competence along with pragmatic language skills are able to explain the social functioning of children with HFA. The metacognitive index of EF did not reach a significant value in the regression model. This finding is inconsistent with Leung et al. (2016) who found that the metacognitive index of EF was a significant predictor of Social Responsiveness Scale (SRS) total score in the ASD group. This discrepancy may be due to methodological differences, such as the smaller number of participants, and also the use of different instruments to measure a widely concept as social competence. However, MI had a high and significant correlation with the socialization domain, which suggests that planning, self-monitoring and working memory could play a role, at least in part, in the social results of ASD children (Freeman et al. 2017; Jahromy et al. 2013; Pugliese et al. 2015).

Finally, the mediation analyses indicated that both the ToM skills applied to everyday life and pragmatic language competence had both a direct and indirect influence on the socialization of children with HFA. The findings of Mazza et al. (2017), using a mediation analysis, also highlighted the importance of the ToM in the development of social skills in children with ASD; however, in addition, the present study confirmed the association between the ToM and the capacity to communicate in social contexts. Thus, studies that have followed a cross-sectional trajectory methodology in children with ASD have shown that ToM abilities significantly predict pragmatic language (Whyte and Nelson 2015). Likewise, as expected, the direct effect of ASD symptoms on socialization tended to disappear when taking into account the mediator influence of the ToM and PC in the relationship between ASD symptoms and socialization. The results showed the negative impact of deficits in ToM and pragmatic language on the social functioning of children with HFA. They provided evidence about the relationship between applied ToM skills and PC, and about the joint mediator role played by these two phenomena between ASD symptoms and social functioning outcomes.

Limitations

The present study is the first to investigate the contribution of the ToM, EF, and PC to the social functioning of children with HFA, and determine the mediation effects between autistic symptoms and socialization, using a mediation model. However, in spite of its interest, this study has some limitations. One of them is the low number of participants, who, in addition, had an exclusively HFA profile, which could affect the generalization of the results. Another limitation has to do with the measure used to rate the socialization of the children with HFA. In the present study, we used parent information to evaluate the children's socialization problems through the Vineland Adaptive Behavior Scales. This type of interview has been used in previous studies, and it has good psychometric properties, but the multidimensional nature of the socialization construct should be analyzed taking into account specific aspects of the construct, such as relationships with peers, prosocial behavior, or social information processing. Furthermore, the complexity of social functioning requires multiple informants (e.g., teachers) and the use of more naturalistic measures such as sociometrics or observational techniques. In fact, other studies that have used teacher questionnaires did not find mediation effects between the ToM and social functioning (Peterson et al. 2016). Moreover, testing vocabulary alone to eliminate the impact of this covariate is important but insufficient when studying pragmatic development of individuals with ASD. The optimal procedure would be to use other structural language measures (e.g., grammar and syntax)

that are more advanced than vocabulary test to control for general language comprehension.

In addition, longitudinal designs would be necessary to determine the directionality of the causal relationship between the variables analyzed in our study. The lack of longitudinal studies reveals the need to more closely examine the social information processing of children with HFA.

In spite of their preliminary character, these results reveal relevant information about the link between symptoms of ASD and general social functioning through mediation of pragmatic and ToM abilities, including also aspects of metacognition. They have especial interest for parents, teachers, and other social agents involved in optimizing the development of children and adolescents con HFA and promote evidence-based interventions that minimize the isolation and improve social functioning.

Although much more work is needed in this area, our contribution highlights the need to go beyond techniques based on applied behavior analysis to adopt multicomponent programs that take these aspects into account. In this direction, there are positive data on the efficacy of cognitive-behavioral-ecological CB-E interventions (Bauminger 2007). This approach appears to promote social perception and problem-solving capabilities, promoting a more advanced ability to define and recognize emotions in social situations. Specifically, it has proved to be effective in enhancing the capabilities for group peer interaction and for improving awareness of others and social cognition among children with HFA.

The implementation of a school-based, teacher-facilitated social skills intervention known as Program for the Education and Enrichment of Relational Skills (PEERS) has also shown significant improvements in responsiveness and social cognition in children with autism (Laugeson et al. 2014). The participants demonstrated overall improvement in social responsiveness, particularly in the areas of social motivation, social awareness, social communication, and decreased autistic mannerisms. The results of PEERS on the importance of active participation of the child and teachers as significant mediators of the program effect are in line with the conclusion of a recent meta-analyses underlining the valuable role of the parents in pragmatic language interventions (Parsons et al. 2017).

In addition to consider the natural contexts in the interventions of children with autism, it should not be forgotten that the association with positive emotional experiences may be able to promote spontaneous orientation toward social communication, increase socialization opportunities, and facilitate the learning and practice of mentalist and pragmatic skills (Chevallier et al. 2012).

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Author Contributions CB conceived the study, participated in its design, and coordination, interpretation of results and drafted the manuscript; AM conceived the study, participated in the design, coordination of the study, interpretation of the data and manuscript revisions; CC participated in the design and coordination of the study, and data collection; IB participated in the coordination of the study and data collection; BR participated in data analysis and interpretation of results. All authors read and approved the final manuscript.

Compliance with Ethical Standards

Conflict of interest Authors declare no conflict of interest.

Ethical Approval The study was approved by the Ethics Committee of the University of Valencia (Declaration of Helsinki in the European Council Agreement, 1964).

References

American Psychiatric Association (APA) (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Baixauli-Fortea, I., Roselló-Miranda, B., & Colomer-Diago, C. (2015). Relationships between language disorders and socio-emotional competence. *Revista de Neurología, 60*, 51–56.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychology research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Baron-Cohen, S. (1995). *Mindblindness*. Cambridge, MA: MIT Press.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*, 37–46.

Bauminger, N. (2007). Brief report: Individual social-multi-modal intervention for HFASD. *Journal of Autism and Developmental Disorders, 37*, 1593–1604.

Bauminger, N., Shulman, C., & Agam, G. (2003). Peer interaction and loneliness in high-functioning children with autism. *Journal of Autism and Developmental Disorders, 33*, 489–507.

Bishop, D. V. (2003). *The children's communication checklist: CCC-2*. London: Harcourt Assessment.

Bishop-Fitzpatrick, L., Mazefsky, C. A., Eack, S. M., & Minshew, N. J. (2017). Correlates of social functioning in autism spectrum disorder: The role of social cognition. *Research in Autism Spectrum Disorders, 35*, 25–34.

Bora, E., & Pantelis, C. (2016). Meta-analysis of social cognition in attention-deficit/hyperactivity disorder (ADHD): Comparison with healthy controls and autistic spectrum disorder. *Psychological Medicine, 46*, 699–716.

Brooks, B. L., Sherman, E. M., & Strauss, E. (2009). NEPSY-II: A developmental neuropsychological assessment. *Child Neuropsychology, 16*, 80–101.

Callenmark, B., Kjellin, L., Rönnqvist, L., & Bölte, S. (2014). Explicit versus implicit social cognition testing in autism spectrum disorder. *Autism: The International Journal of Research and Practice, 18*, 684–693.

Capps, L., Kehres, J., & Sigman, M. (1998). Conversational abilities among children with autism and children with developmental delays. *Autism: The International Journal of Research and Practice, 2*, 325–344.

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E. S., & Schultz, R. T. (2012). The social motivation theory of autism. *Trends in Cognitive Science, 16*, 231–239.

Freeman, L. M., Locke, J., Rotheram-Fuller, E., & Mandell, D. (2017). Brief report: Examining executive and social functioning in elementary-aged children with autism. *Journal of Autism and Developmental Disorders*. doi:10.1007/s10803-017-3079-3.

Frith, U., Happé, F., & Siddons, F. (1994). Autism and theory of mind in everyday life. *Social Development, 3*, 108–124.

Geurts, M., & Embrechts, M. (2008). Language profiles in ASD, SLI and ADHD. *Journal of Autism and Developmental Disorders, 38*, 1931–1943.

Gilotty, L., Kenworthy, L., Sirian, L., Black, D. O., & Wagner, A. E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropyschology, 8*, 241–248.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test review behavior rating inventory of executive function. *Child Neuropsychology, 6*, 235–238.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: The Guilford Press.

Helland, W. A. (2014). Differentiating children with specific language impairment and children with Asperger syndrome using parental reports. *Annals of Psychiatry and Mental Health, 2*, 1013.

Helland, W. A., Biringer, E., Helland, T., & Heimann, M. (2009). The usability of a norwegian adaptation of the children's communication checklist second edition (CCC-2) in differentiating between language impaired and non-language impaired 6-to 12-year-olds. *Scandinavian Journal of Psychology, 50*, 287–292.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences, 8*, 26–32.

Hughes, C., & Devine, R. T. (2015). A social perspective on theory of mind. In M. E. Lamb (Ed.), *Handbook of child psychology and developmental science: Socioemotional processes* (pp. 564–609). Hoboken, NJ: Wiley.

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2012). Psychometric evaluation of the theory of mind Inventory (ToMI): A study of typically developing children and children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*, 327–341.

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2014). *Technical manual for the theory of mind inventory and theory of mind task battery*. Unpublished copyrighted manuscript. http://www.theoryofmindinventory.com.

Hutchins, T. L., Prelock, P. A., Morris, H., Benner, J., LaVigne, T., & Hoza, B. (2016). Explicit vs applied theory of mind competence: A comparison of typically developing males, males with ASD, and males with ADHD. *Research in Autism Spectrum Disorder, 21*, 94–108.

Jahromy, L. B., Bryce, C. I., & Swanson, J. (2013). The importance of self-regulation for the school and peer engagement of children with high-functioning autism. *Research in Autism Spectrum Disorders, 7*, 235–246.

Kaufman, A. S., & Kaufman, N. I. (2000). *K-BIT, Test breve de inteligencia de Kauffman [Kaufman brief intelligence test]*. Madrid: Pearson.

Kimhi, Y. (2014). TOM abilities and deficits in autism spectrum disorders. *Topics in Language Disorders, 34*, 329–343.

Klin, A., Saulnier, C. A., Sparrow, S. S., Cicchetti, D. V., Volkmar, F. R., & Lord, C. (2007). Social communication abilities and disabilities in higher functioning individuals with autism spectrum disorders: The Vineland and the ADOS. *Journal of Autism and Developmental Disorders, 37*, 748–759.

Korkman, M., Kirk, U., & Kemp, S. (2007). *NEPSY-II: A developmental neuropsychological assessment*. San Antonio, TX: The Psychological Corporation.

Lam, Y. G., & Yeung, S. S. (2012). Towards a convergent account of pragmatic language deficits in children with high-functioning autism: Depicting the phenotype using the pragmatic rating scale. *Research in Autism Spectrum Disorders, 6*, 792–797.

Laugeson, E., Ellingsen, R., Sanderson, J., Tucci, L., & Bates, S. (2014). The ABC's of teaching social skills to adolescents with autism spectrum disorder in the classrooen: The UCLA PEERS (©) Program. *Journal of Autism and Developmental Disorders, 44*, 2244–2256.

Leonard, M. A., Milich, R., & Lorch, E. P. (2011). The role of pragmatic language use in mediating the relation between hyperactivity and inattention and social skills problems. *Journal of Speech, Language and Hearing Research, 54*, 567–579.

Leung, R. C., Vogan, V. M., Powell, T. L., Anagnostou, E., & Taylor, M. J. (2016). The role of executive functions in social impairment in autism spectrum disorder. *Child Neuropsychology, 22*, 336–344.

Li, J., Zhu, L., Liu, J., & Li, X. (2014). Social and non-social deficits in children with high-functioning autism and their cooperative behaviors. *Research in Autism Spectrum Disorders, 8*, 1657–1671.

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*, 99–128.

Maldonado Belmonte, M. J. (2016). *Adaptation of the behavior rating inventory of executive function (BRIEF) to the spanish population and its usefulness for the diagnosis of attention deficit hyperactivity disorder inattentive and combined subtypes*. Doctoral dissertation, Universidad Complutense de Madrid, Spain.

Mazza, M., Mariano, M., Peretti, S., Masedu, F., Pino, M. C., & Valenti, M. (2017). The role of theory of mind on social information processing in children with autism spectrum disorders: A mediation analysis. *Journal of Autism and Developmental Disorders, 47*, 1369–1379.

Miranda-Casas, A., Baixauli-Fortea, I., Colomer-Diago, C., & Roselló-Miranda, B. (2013). Autismo y trastorno por déficit de atención con hiperactividad. Convergencias y divergencias en funcionamiento ejecutivo y teoría de la mente [Autism and attention deficit hyperactivity disorder: Similarities and differences in executive functioning and theory of mind]. *Revista de Neurología, 57*, 177–184.

Orinstein, A. J., Suh, J., Porter, K., De Yoe, K. A., Tyson, K. E., Troyb, E., et al. (2015). Social function and communication in optimal outcome children and adolescents with an autism history on structured test measures. *Journal of Autism and Developmental Disorders, 45*, 2443–2463.

Parsons, L., Cordier, R., Munro, N., Joosten, A., & Speyer, R. (2017). A systematic review of pragmatic language interventions for children with autism spectrum disorder. *PLoS ONE, 12*(4), e0172242.

Peterson, C., Garnett, M., Kelly, A., & Attwood, T. (2009). Everyday social and conversation applications of theory-of-mind understanding by children with autism-spectrum disorders or typical development. *European Child and Adolescent Psychiatry, 18*, 105–115.

Peterson, C., Slaughter, V., Moore, C., & Wellman, H. M. (2016). Peer social skills and theory of mind in children with autism, deafness, or typical development. *Developmental Psychology, 52*, 46–57.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments & Computers, 36*, 717–731.

Pugliese, C. E., Anthony, L., Strang, J. F., Dudley, K., Wallace, G. L., & Kenworthy, L. (2015). Increasing adaptive behavior skill deficits from childhood to adolescence in autism spectrum disorder: Role of executive function. *Journal of Autism and Developmental Disorders, 45*, 1579–1587.

Pujals, E., Batlle, S., Camprodon, E., Pujals, S., Estrada, X., Aceña, M., et al. (2016). Brief report: Translation and adaptation of the

theory of mind inventory to spanish. *Journal of Autism and Developmental Disorders, 46*, 685–690.
Resches, M., & Pérez-Pereira, M. (2007). Referential communication abilities and Theory of Mind development in preschool children. *Journal of Child Language, 34*, 21–52.
Russell, G., Golding, J., Norwich, B., Emond, A., Ford, T., & Steer, C. (2012). Social and behavioural outcomes in children diagnosed with autism spectrum disorders: A longitudinal cohort study. *Journal of Child Psychology and Psychiatry, 53*, 735–744.
Rutter, M., Bailey, A., & Lord, C. (2003a). *Social communication questionnaire*. Los Angeles: Western Psychological Services.
Rutter, M., Le Couteur, A., & Lord, C. (2003b). *ADI-R. Autism diagnostic interview revised. Manual*. Los Angeles: Western Psychological Services.
Scheeren, A. M., de Rosnay, M., Koot, H. M., & Begeer, S. (2013). Rethinking theory of mind in high-functioning autism spectrum disorder. *Journal of Child Psychology and Psychiatry, 54*, 628–635.
Schwenck, C., Mergenthaler, J., Keller, K., Zech, J., Salehi, S., Taurines, R., et al. (2012). Empathy in children with autism and conduct disorder: Group-specific profiles and developmental aspects. *Journal of Child Psychology and Psychiatry, 53*, 651–659.
Senju, A. (2012). Spontaneous theory of mind and its absence in autism spectrum disorder. *The Neuroscientist, 18*, 108–113.
Senju, A., Southgate, V., White, S., & Frith, U. (2009). Mindblind eyes: An absence of spontaneous theory of mind in asperger syndrome. *Science, 325*, 883–885.
Snow, C., Cancino, H., Gonzalez, P., & Shriberg, E. (1989). Giving formal definitions: An oral language correlate of school literacy. In D. Bloome (Ed.), *Classrooms and literacy* (pp. 233–249). Norwood, NJ: Ablex.
Sparrow, S. S., Cicchetti, D. V., & Balla, D. (2005). *The vineland II adaptive behavior scales*. Circle Pines, MN: American Guidance Service.
Tager-Flusberg, H. (1999). A psychological approach to understanding the social and language impairments in autism. *International Review of Psychiatry, 11*, 325–334.
Tager-Flusberg, H., & Sullivan, K. (1995). Attributing mental states to story characters: A comparison of narratives produced by autistic and mentally retarded individuals. *Applied Psycholinguistics, 16*, 241–256.
Volden, J., Coolican, J., Garon, N., White, J., & Bryson, S. (2009). Brief report: Pragmatic language in autism spectrum disorder: Relationships to measures of ability and disability. *Journal of Autism and Developmental Disorders, 39*, 388–393.
Volden, J., & Phillips, L. (2010). Measuring pragmatic language in speakers with autism spectrum disorders: Comparing the Children's Communication Checklist—2 and the Test of Pragmatic Language. *American Journal of Speech-Language Pathology, 19*, 204–212.
Vulchanova, M., Saldaña, D., Chahboun, S., & Vulchanov, V. (2015). Figurative language processing in atypical populations: The ASD perspective. *Frontiers in Human Neuroscience, 9*, 1–11.
Wallace, G. L., Yerys, B. E., Peng, C., Dlugi, E., Anthony, L. G., & Kenworthy, L. (2016). Chapter three-assessment and treatment of executive function impairments in autism spectrum disorder: An update. *International Review of Research in Developmental Disabilities, 51*, 85–122.
Wechsler, D. (2003). *Wechsler intelligence scale for children, fourth edition (WISC-IV)*. San Antonio, TX: The Psychological Corporation.
Whyte, E., & Nelson, K. (2015). Trajectories of pragmatic and nonliteral language development in children with autism spectrum disorders. *Journal of Communication Disorders, 54*, 2–14.

4.2.2. Estudio 2

Berenguer, C., Roselló, B., Baixauli, I., García, R., Colomer, C., & Miranda, A. (2017). ADHD Symptoms and peer problems: Mediation of executive function and theory of mind. *Psicothema*, *29*, 514-519. doi: 10.7334/psicothema2016.376

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El segundo estudio abordó los síntomas del TDAH y los problemas sociales analizando los posibles efectos del FE y la ToM. Los niños con TDAH mostraron un desarrollo peor que los niños con DT en todos los dominios de FE evaluados, incluida su capacidad para inhibir el comportamiento, pasar de una situación a otra, modular respuestas emocionales, iniciar tareas o actividades, organizar materiales de aprendizaje y monitorear el esfuerzo así como la memoria de trabajo y planificación. Los hallazgos se suman a la literatura que respalda las deficiencias en FE en personas con TDAH (Schoemaker, Mulder, Dekovic, & Matthys, 2013; Willcutt, et al., 2005).

Acorde con el metanálisis de Bora y Pantelis, (2016), este estudio mostró un peor desarrollo en niños con TDAH en los tres aspectos de las habilidades de ToM aplicadas a situaciones cotidianas de la vida real: nivel temprano (referencia social, comprensión de emociones básicas), nivel básico (metarrepresentaciones básicas o distinción entre físico y mental) y nivel avanzado (inferencias de segundo orden y realización de juicios sociales complejos).

Por otro lado, se encontró una asociación entre los síntomas del TDAH dificultades en las relaciones con los compañeros y baja aceptación social, coincidiendo con otros hallazgos (Kim et al., 2015; Tseng, Kawabata, Gau, & Crick, 2014). El BRI también se asoció significativamente con problemas con los compañeros, lo cual respalda el argumento de que la inhibición de la respuesta es el déficit primario en el TDAH (Barkley, 2005). El BRI también se correlacionó con las habilidades de la ToM, señalando la importancia de la regulación del comportamiento en la aplicación práctica de las habilidades mentalistas en situaciones cotidianas de la vida. Por el contrario, los procesos metacognitivos no mostraron ninguna correlación estadísticamente significativa con las variables de estudio. Tampoco hubo asociaciones significativas entre los diferentes indicadores de ToM (temprano, básico, avanzado y total) y los síntomas del TDAH o problemas con los compañeros.

Finalmente, los resultados de los análisis de mediación indicaron que el BRI tenía una influencia directa e indirecta sobre los problemas sociales con los compañeros. Estos datos podrían indicar el papel negativo desempeñado por los problemas inhibitorios de los niños con TDAH en las interacciones sociales con los iguales.

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ADHD Symptoms and peer problems: Mediation of executive function and theory of mind

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Abstract

Background: The social maladjustment suffered by many children with attention deficit hyperactivity disorder (ADHD) is maintained over time, increasing the risk of subsequent adverse outcomes. The objectives of the study were to explore the mechanisms that operate between ADHD symptoms and social problems with peers, considering the mediation of FE and ToM. **Method:** 35 children with ADHD and 37 with typical development matched in age and IQ were compared. Parents assessed ToM skills and relationships with peers, and teachers provided EF ratings. **Results:** The analyses showed statistically significant indirect mediation effects of EF in the relationship between ADHD symptoms and problems in relationships with peers, whereas ToM did not show these effects. **Conclusions:** EF impairments contribute to the social difficulties of children with ADHD.

Keywords: ADHD symptoms, executive functioning, problems with peers, theory of Mind.

Resumen

Síntomas de TDAH y problemas con los compañeros: mediación del funcionamiento ejecutivo y de la teoría de la mente. **Antecedentes:** el desajuste social de muchos niños con Trastorno por Déficit de Atención con Hiperactividad (TDAH) se mantiene con el tiempo, aumentando el riesgo de resultados adversos. Los objetivos del estudio fueron explorar los mecanismos que operan entre los síntomas del TDAH y los problemas sociales con los compañeros, teniendo en cuenta el papel de FE y ToM. **Método:** se compararon 35 niños con TDAH y 37 con desarrollo típico de edad y QI. Los padres evaluaron las habilidades y las relaciones con los compañeros, y los maestros proporcionaron calificaciones EF. **Resultados:** los análisis mostraron efectos de mediación indirecta estadísticamente significativos de EF en la relación entre los síntomas del TDAH y los problemas en las relaciones con los compañeros, mientras que ToM no mostró estos efectos. **Conclusiones:** los déficits en EF contribuyen a las dificultades sociales de los niños con TDAH.

Palabras clave: síntomas del ADHD, funcionamiento ejecutivo, problemas con los compañeros, teoría de la Mente.

Children with ADHD show low social acceptance, which becomes more evident in the circle of peers. Negative interactions between children with ADHD and their peers take place early, so that the rejection occurs in days and even in hours. Consequently, more than 50% experience social rejection, and they can have up to 500,000 negative interactions every year (Hoza et al., 2005). They have poorer quality relationships, they spend less time on direct or telephone contact with their friends outside of school, and their social interaction is not characterized by reciprocity or empathic behaviors, such as consoling, sharing, supporting, seeing things from the other person's point of view, or negotiating (Normand et al., 2011).

The social problems persist over time, they interfere with the correct development of social skills and self-regulation, and they increase the risk of cigarette smoking, depression, and overall maladjustment in adolescence (Mrug et al., 2012). In addition, and even more worrisome, the efficacy of intensive interventions in this area is rather limited (McQuade & Hoza, 2008). Therefore, it is important to perform an in-depth analysis of the possible factors involved in problems with peers in order to improve intervention outcomes.

The symptoms of ADHD according with *the Diagnostic and statistical manual of mental disorders-text revision- 5th edition* [DSM-V] (American Psychiatric Association [APA], 2013), have been considered a primary contributor to dysfunctions experienced by children with ADHD in establishing enduring social relationships. In both the hyperactivity/impulsivity and inattention domains, symptom severity is related to the deterioration in interpersonal relationships, low acceptance by classmates (Kim et al., 2015; Tseng, Kawabata, Gau, & Crick, 2014), and problems in family relationships (Miranda, Berenguer, Colomer, & Roselló, 2014). Moreover, in recent years, researchers have shown increasing interest in the study of the relationship between social problems and executive functioning deficits (see review by Roselló-Miranda, Berenguer- Forner, Baixauli-Fortea, & Miranda-Casas, 2016).

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Various studies have shown the relationship between executive impairments and social problems in ADHD in childhood and adolescence. A significant effect of omission and commission errors in a continuous performance test was found on acceptance by classmates (Miller & Hinshaw, 2010), as well as associations between planning and spatial working memory deficits in people with ADHD and problems in relations with peers (Tseng & Gau, 2013). Impairments in EF persist over time, predicting worse social functioning in adolescence, according to the results of a follow-up study (Rinsky & Hinshaw, 2011). Finally, executive impairments on cognitive flexibility, working memory and attention are accompanied by biases or "positive illusions" in the social terrain (McQuade et al., 2011).

Research on theory of mind (ToM), has been revealed too as a valuable way to explore the problems of children with ADHD in social relationships. A meta-analysis by Bora & Pantelis (2016) compared the performance of individuals with ADHD and typical development (TD) on social cognition tasks, showing that, in the recognition of emotions and on theory of mind tasks, the children with ADHD showed worse performance.

There is little information about the relationships between FE and TOM problems in children with ADHD, but the literature supports the associations between EF and ToM in typical development (Carlson, Moses, & Claxton, 2004; Hughes & Ensor, 2007). One of the questions that recent studies have tried to clarify is whether ToM failures have a primary nature, or whether they are the consequence of failing to express ToM skills in situations that require inhibitory control and other executive processes. Some studies point out that children with ADHD show worse performance than children with TD on ToM tasks that require considerable inhibition (Sodian, Hulsken, & Thoermer, 2003; Yang, Zhou, Yao, Su, & McWhinnie, 2009), suggesting that executive impairments produce a lack of consideration of mental states in social situations and could interfere the suppression of irrelevant stimuli, finally affecting the consideration of alternative perspectives of the world.

The evidence also indicates that the inhibitory problems and emotional control of children with ADHD impede the application of ToM skills in contexts of daily life (Papadopoulos, Panayiotou, Spanoudis, & Natsopoulos, 2005; Soltani, Kazemi, Maleki, & Soltani, 2013). In fact, a recent study by Mary et al. (2016) does not find ToM dysfunction to be a primary factor in ADHD either. According to their results, controlling inhibition and attention, the performance of the children with ADHD matched the performance of the children with TD. However, when the performance on the ToM tasks was controlled, the performance on the inhibition and attention tests was not normalized. Therefore, "This unidirectional relationship suggests that impairments in EF and the attentional domain are responsible for the ToM deficits in children with ADHD, which can contribute to their socioemotional difficulties" (p. 345).

In summary, accumulated evidence has shown the contribution of ADHD symptoms and EF impairments to the social problems of children with ADHD, whereas the role of ToM, and especially its relationships with the other domains, has hardly been explored (Papadopoulos et al., 2005; Soltani et al., 2013). As far as we know, only the study by Mary et al. (2016) provides indirect support for the important role of the negative impact of EF on ToM in the social problems of children with ADHD. Furthermore, there is a lack of studies that deepen in the interrelation between the different domains adopting a naturalistic evaluation approach that represents with more fidelity the behavior in the real life than the laboratory tests.

Taking an ecological assessment approach, the aims of the present study were first to examine differences between children with ADHD and children with TD on executive functioning, ToM components and peer problems. The second aim was to analyze the relationship between the symptoms of ADHD, FE, TOM and peer problems in order to investigate possible mechanisms of mediation between ADHD symptoms and peer problems. It is expected to find significant differences between the two groups in the analyzed variables and secondly it is hypothesized that EF impairments (especially the index of behavioral regulation-BRI), as the primary deficit in ADHD, as opposed to ToM deficits, would act as a mediator variable in the relationship between ADHD symptoms and problems with peers.

Method

Participants

In this study participated 72 children aged between 7 and 11 years, distributed in two groups, one group with ADHD (n=35) and one group with typical development (n=37). Mean age of children with ADHD, M= 9.14 SD= 1.41; children with TD, M=8.54, SD= 1.26. All the participants had an overall intelligence coefficient (IQ) equal to or above 80, measured with the K-BIT (Kaufman & Kaufman, 2000): children with ADHD, M= 99.03, SD= 9,87; children with TD, M=102.11, SD= 8.9. The two groups were matched on age t (70) = -1.89, p = .062 on IQ t (70) = 1.43, p = .155, but the majority of the children with ADHD were boys (91.42%) compared to 67.56% of the group with TD (χ^2 (1, N=72) = 6.20, p = .013).

School psychologists identified 42 children with ADHD. They had received a clinical diagnosis in psychiatry and neuropsychiatry services of hospitals and medical centers in the Valencian Community. In order to confirm the diagnosis, the parents and teachers filled out the list of 18 criteria for ADHD according to the DSM-5 (APA, 2013) assessing the severity of each item from 0 to 3. The presence of at least six inattention symptoms and/or six other hyperactivity/impulsivity symptoms, persistence of the symptoms for at least one year, and clear interference in their daily life functioning were the criteria adopted to confirm the diagnosis. Considering the agreement between parents and teachers, 77.14% of the participants showed a combined presentation and 22.86% had an ADHD inattentive presentation. The Kappa-Cohen test value was $\varkappa$ = 0.97. Seven of 42 children were finally eliminated because they did not meet the ADHD criteria in the evaluation. In addition, 71.4% of participants with ADHD were taking psychostimulants and 40% of them had behavioral problems.

The children with typical development (TD) were selected in the same schools where the clinical sample was obtained. They did not present a record of psychopathologies, according to information facilitated by the school and the parents, and they did not meet the DSM-5 (APA, 2013) criteria for ADHD.

Instruments

Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000).

This questionnaire rates the child's EF through the teachers' observation of his/her behavior in the school context. It consists of 86 items scored on a Likert-type scale with three response options (never, sometimes, often). The items are grouped in 8 scales that make up two indexes, which were chosen for this study. The behavioral regulation index (BRI) includes the emotional control, change, and inhibition subscales. The metacognition index (MI) includes the subscales of initiative, working memory, planning/organization, organization of materials, and monitoring. Psychometric characteristics of the BRIEF have been studied in the Spanish population the main indexes (BRI and MI) and the GEC, the Cronbach alpha coefficients of the BRIEF-E were high, around .90 (García Fernández, González-Pienda, Rodríguez-Pérez, Álvarez García, & Álvarez Pérez, 2014). In this study, the Cronbach's alpha was .99 for the teachers' version.

Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997).

This scale, completed by parentes, contains 25 items directed toward children from 4 to 16 years old, and is concentrated in 5 subscales: emotional symptoms, behavioural problems, hyperactivity /inattention, peer problems and prosocial behavior. The peer problems subscale, which includes items that ask about behaviors that show maladaptation in the group of peers ("He is pretty solitary and would rather play alone", or "The other children pick on him/her") was selected as criterion of social development. We also used the other subscales to identify associated problems. The items are scored on a Likert-type scale ranging from 1 (not true) to 3 (certainly true). The SDQ has adequate statistical and psychometric properties (.73) measured with Chronbach's alpha (Goodman, 2001), and in the Spanish population also has good reliability (.76) (Rodríguez et al., 2012).

Theory of Mind Inventory (ToMI; Hutchins, Prelock, & Bonazinga, 2012; Spanish adaptation by Pujals et al., 2016).

This inventory for parents contains 42 items and addresses the wide range of mentalist skills. The items are grouped in 3 subscales and offer a general average score. The early subscale rates skills typical of the first stages of childhood, such as social reference and comprehension of basic emotions; the basic subscale rates ToM characteristics typical of children starting to attend school, such as basic meta-representations and the distinction between physical and mental; the advanced subscale evaluates more mature aspects of theory of mind, such as second-order inferences or making complex social judgments. Finally, the scores of TOMI total includes the sum of the previous three scales. Each item is assessed on a scale ranging from 0 to 20, from "Definitely not" to "Definitely", with a mid-point of "Undecided". High scores show the perception of good ToM competence.

The ToMI has been sufficiently validated and has good test-retest reliability and excellent sensitivity (.90) and specificity (.90), (Hutchins et al., 2012).

Procedure

The present study was approved by the Ethics Committee of the University of Valencia (Declaration of Helsinki in the Convention of the European Council, 1964). Authorization was also obtained from the Board of Education of the Valencian Government to locate children in Schools who had received a previous diagnosis of ADHD by childhood mental health specialists, as well as children with typical development. The objectives of the study were communicated to the parents and principals of the schools, and written consent was obtained from the parents and schools that agreed to participate in the study. The evaluation was carried out by trained psychologists in classrooms set up for this purpose in the different schools.

Data analysis

The statistical analyses were performed with the software *Statistical Package for the Social Science* (SPSS), version 22.00. In this study a cross-sectional design with two comparison groups was performed. Analyses of covariance (ANCOVA) were carried out to test the differences between the ADHD and TD groups on the two EF indexes (BRI and MI), the three levels of theory of mind from the ToMI, and peer relationship problems (SDQ). Sex and age were used as covariables. In addition, partial correlation analyses were carried out to study the associations among the variables being studied. Next, simple mediation analyses, were conducted using the PROCESS program for mediation, moderation, and conditional analysis (Hayes, 2013), which makes it possible to determine whether the relationship between two variables (independent= X and criterion=Y) is maintained when a third variable (mediator=M) is proposed as accounting for the relationship between them. Moreover, a bootstrap non-parametric resampling procedure was applied to try to compensate for the limitations of statistical methods that assume standard distribution in small sample sizes.

Results

The analyses of covariance (ANCOVAs) comparing the teachers' ratings on the two EF indexes showed significant differences between the ADHD and TD groups. Likewise, the results revealed significant differences between the two groups on problems with peers (Table 1). In addition, in the after controlling for sex and age, with the ToMI variables, significant differences

Table 1
Differences between children with ADHD and TD in FE main components and peer problems, with sex and age as covariables (ANCOVAs)

	ADHD (n = 35)		TD (n = 37)				
	M	SD	M	SD	$F_{1,68}$	p	η^2_p
BRI	60.45	10.86	37.81	6.78	90.46	.000*	.57
MI	104.22	15.98	59.48	11.5	166.69	.000*	.71
Peer problems	2.88	1.90	0.46	.95	39.29	.000*	.36

*$p<.05$

were obtained on the three levels and on the ToMI total, ToMI Early, ToMI Basic and ToMI Advanced, with significantly lower scores for the ADHD group in all cases (Table 2).

Table 3 shows the partial correlations, controlling for sex and age, among the study variables in the ADHD group. Statistically significant values were found for the correlations between the ADHD symptoms and BRI (p=.007) and problems with peers (p=.032) in the theoretically expected direction. The BRI correlated with problems with peers (p=.022) and the theory of mind early (p=.022) and basic (p=.027) ToMI. The other EF measure, the MI index, did not reach a statistically significant association with any of the study variables. Furthermore, although the three levels of ToM, early, basic, and advanced, coherently presented significant associations with each other, they did not maintain significant associations with ADHD symptoms or problems in relationships with peers.

Figure 1 provides a summary of three mediational analyses to explore whether the EF (BRI, MI) or TOMI total scale are mediating the relationship between inattention/hyperactivity symptoms and peer relationship problems.

Thus, in figure 1A, we analyze if BRI mediates the relationship between hyperactivity/inattention and peer relationship problems. As expected, ADHD symptoms significantly predicted the BRI (Path A, R^2=.20, $F_{(1,33)=}$ 8.38, p = .006). The second regression analysis showed that the BRI was significantly associated with worse functioning in peer relationships, controlling for ADHD symptoms (R^2=.18, $F_{(2,32)=}$ 3.63, p = .037). Likewise, the total effect of ADHD symptoms significantly predicted all the social peer problems (R^2 = .11; $F_{(1,33)}$ = 4.19, p = .048).

In the final step to determine mediation (Path C'), ADHD symptoms did not predict problems with peers above and beyond what was accounted for by BRI (p = .271). The indirect effect obtained using the bootstrapping procedure for a sample of 10.000 and a confidence interval (CI) de 95% was statistically significant, with a confidence interval that not include the zero value b= .13, SE = .07, 95% CI [.026, .334]. By dividing the b of the indirect effect by the b of the total effect (Mackinnon & Dwyer, 1993), BRI was found to account for 39% of the path from ADHD manifestations to peer problems. Thus, BRI is a partial mediator in this relationship (with full mediation defined as accounting for 100% of the variance).

As Figure 1B illustrates the standardized indirect effect between ADHD symptoms and peer problems, controlling for MI index was not statistically significant b= .03, SE = .05, 95% CI [-.021, .206]. Likewise, the standardized indirect effect between ADHD symptoms and peer problems, controlling for ToM was not statistically significant b= .01, SE = .05, 95% CI [-.037, .210] (figure 1C).

Discussion

The first aim of the present study was to analyze the differences between children with ADHD and children with TD on Executive functioning, ToM components and peer problems. The children with ADHD showed worse development than children with TD on all the EF components assessed, including their ability to inhibit behavior, shift from one situation to another, modulate emotional responses, initiate tasks or activities, organize learning materials, and monitor work effort, as well as their working memory and planning. The findings contribute to the literature supporting impairments in EF in people with ADHD (Schoemaker, Mulder, Dekovic, & Matthys, 2013; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), and they also support the value of reports of children's day-to-day EF in the "school context". Along the same lines, and in agreement with the conclusions of a recent

Table 2
Differences between children with ADHD and TD in ToMI Inventory, with sex and age as covariables (ANCOVAs)

	ADHD (n = 35)		TD (n = 37)		$F_{1,68}$	p	η^2_p
	M	SD	M	SD			
ToMI Total	15.87	2.13	18.38	1.42	35.82	.000*	.34
ToMI Early	17.22	1.83	18.98	8.23	22.68	.000*	.25
ToMI Basic	16.68	2.14	19.03	1.12	31.95	.000*	.32
ToMI Advanced	14.13	3.05	17.24	2.36	26.47	.000*	.28

*p<.05

Table 3
Partial correlations between executive functioning variables, theory of mind, ADHD symptoms, and peer problems; ADHD Group

	1	2	3	4	5	6	7
1. Behavioural Regulation Index							
2. Metacognition Index	.31						
3. ToMI Total	-.32	-.20					
4. ToMI Early	-.39*	-.29	.70**				
5. ToMI Basic	-.38*	-.20	.87**	.68**			
6. ToMI Advanced	-.17	-.08	.89**	.45**	.59**		
7. Peer problems	.39*	.32	-.15	-.20	-.24	-.03	
8. ADHD Symptoms	.46**	.10	-.01	-.15	-.07	-.04	.37*

Note: ToMI (Theory of mind)
*p < .05; **p < .001

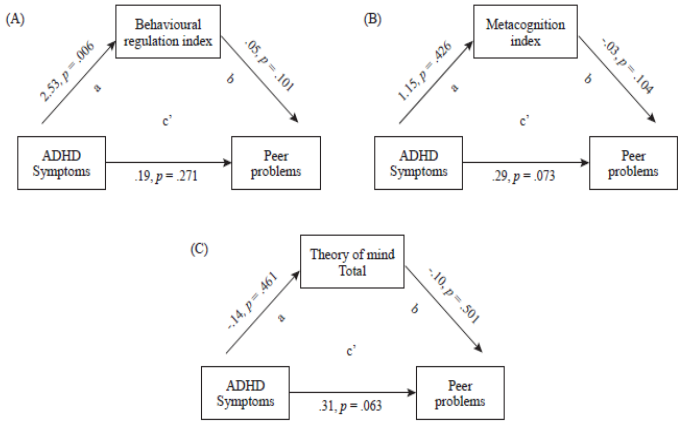

Figure 1. Simple mediation analysis of the effect of: BRI on the relationship between ADHD symptoms and peer problems (1A), MI on the relationship between ADHD symptoms and peer problems (1B), and ToM on the relationship between ADHD symptoms and peer problems (1C)

meta-analysis (Bora & Pantelis, 2016), this study showed worse development in children with ADHD in the three aspects of ToM skills applied to everyday real-life situations: early level (social reference, understanding basic emotions), basic level (basic meta-representations or distinction between physical and mental), and advanced level (second-order inferences and making complex social judgments).

The second aim showed that yielded significant association values between different variables, generally in the expected direction. The ADHD symptoms were related to difficulties in relationships with peers and low social acceptance, coinciding with previous findings (Kim et al., 2015; Tseng et al., 2014). The BRI was also significantly associated with problems with peers, which supports the argument that response inhibition is the primary deficit in ADHD (Barkley, 2005). The BRI also correlated with theory of mind skills, pointing to the importance of behavioral regulation in the practical application of ToM skills in everyday situations in life. By contrast, the MI did not show any statistically significant correlation with the study variables. Nor were there significant associations between the different ToM indicators (early, basic, advanced, and total) and ADHD symptoms or problems with peers.

Finally, the results of the mediational analyses indicated that the BRI had both a direct and indirect influence on problems with peers. As expected, the direct effect of ADHD symptoms on difficulties in social relations with peers tended to disappear when taking into account the mediator role of the BRI, which acts, therefore, as a partial mediator in the relationship between ADHD symptoms and problems with peers. In other words, mediation was defined as a generative mechanism in which the effect of ADHD symptoms on problems with peers was partially transmitted by the BRI. These data could indicate the negative role played by inhibitory problems of children with ADHD (Mary et al., 2016). However, ToM skills and MI do not meet the conditions to be considered a possible mediator.

Although to the best of our knowledge the present research is the first study to explore the potential mediating effects of EF and ToM in the relationship between ADHD symptoms and social problems, it has various limitations. The sample included a small number of participants, so that the results have to be considered preliminary, and replication studies are needed. Moreover, the majority were boys and had a combined presentation, which restricts the possible generalization to these cases. As well as the methodological limitations, since there is no contrast test and the results may be mediated by overestimation. Another limitation refers to the measure used to rate social conduct. In the present study, we used information from parents to measure social problems with peers by combining items from the SDQ. Although this ad hoc measure showed good psychometric properties, social behavior is a multidimensional construct, and so future analyses should incorporate different facets of it, such as leadership capacity, cooperation, or social skills (Huang-Pollock, Mikami, Pfiffner, & McBurnett, 2009). In addition, although our data provide evidence for a mediational model, the transversal design does not allow us to determine the directionality of a causal relationship between the variables. Longitudinal or experimental studies would help to verify the causal relationships glimpsed in this study. The lack of studies in this area calls for more research to gain a clearer understanding of the significance of EF components, especially in relation to the broader social impairment that is characteristic of ADHD.

In spite of their preliminary nature, the results of this study warn of the need for early implementation of programs in the family and school that emphasize teaching EF strategies in order to optimize social and personal development. The EF are essential for successfully dealing with relationships with peers. Specifically, the relevance of behavioral regulation components, including inhibition and emotional control, should be underlined when designing early intervention programs for the socioemotional development of children with ADHD.

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References

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders*. Washington, DC: American Psychiatric Association.

Barkley, R. A. (2005). *ADHD and the nature of self-control*. New York: Guilford.

Bora, E., & Pantelis, C. (2016). Meta-analysis of social cognition in attention-deficit/hyperactivity disorder (ADHD): Comparison with healthy controls and autistic spectrum disorder. *Psychological Medicine, 46*, 699-716.

Carlson, S. M., Moses, L. J., & Claxton, L. J. (2004). Individual differences in executive functioning and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology, 87*, 299-319.

García Fernández, T., González-Pienda, J., Rodríguez-Pérez, C., Álvarez García, D., & Álvarez Pérez, L. (2014). Psychometric characteristics of the BRIEF scale for the assessment of executive functions in Spanish clinical population. *Psicothema, 26*, 47-54.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Behaviour rating inventory of executive function. *Child Neuropsychology, 6*, 235-238.

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry, 38*, 581-586.

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*, 1337-1345.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: The Guilford Press.

Hoza, B., Mrug, S., Gerdes, A., Hinshaw, S. P., Bukowski, W. M., Gold, J. A., & Kraemer, H. C. (2005). Aspects of peer relationships are impaired in children with attention deficit/Hyperactivity disorder? *Journal of Consulting and Clinical Psychology, 73*, 411-423.

Huang-Pollock, C., Mikami, A.Y., Pfiffner, L., & McBurnett, K. (2009). Can executive functions explain the relationship between attention deficit hyperactivity disorder and social adjustment? *Journal of Abnormal Child Psychology, 39*, 679-691.

Hughes, C., & Ensor, R. (2007). Executive function and theory of mind. Predictive relations from ages 2 to 4. *Development and Psychopathology, 43*, 1447-1459.

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2012). Psychometric evaluation of the Theory of Mind Inventory (ToMI): A study of typically developing children and children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*, 327-341.

Kaufman, A.S., & Kaufman, N.I. (2000). *K-BIT, Test breve de inteligencia de Kauffman* [Kaufman brief intelligence test]. Madrid: Pearson.

Kim, J.W., Kim, B-N., Kim, J.I., Lee, Y.S., Min, K.J., Kim, H-J., & Lee, J. (2015). Social network analysis reveals the negative effects of attention-deficit/hyperactivity disorder (ADHD) symptoms on friend-based student networks. *PloS one, 10*, 1-14.

Mackinnon, D.P., & Dwyer, J.H. (1993). Estimating mediated effects in prevention studies. *Evaluation Review, 17*, 144-158.

Mary, A., Slama, H., Mousty, P., Massat, I., Capiau, T., Drabs, V., & Peigneux, P. (2016). Executive and attentional contributions to Theory of Mind deficit in attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology, 22*, 345-365.

McQuade, J.D., & Hoza, B. (2008). Peer problems in attention deficit hyperactivity disorder: Current status and future directions. *Developmental Disabilities Research Review, 14*, 320-324.

McQuade, J.D., Tomb, M., Hoza, B., Waschbusch, D.A., Hurt, EA., & Vaughn, A.J. (2011). Cognitive deficits and positively biased self perceptions in children with ADHD. *Journal of Abnormal Child Psychology, 39*, 307-319.

Miller, M., & Hinshaw, S. (2010). Does childhood executive function predict adolescent functional outcomes in girls with ADHD? *Journal of Abnormal Child Psychology, 38*, 315-326.

Miranda, A., Berenguer, C., Colomer, C., & Roselló, R. (2014). Influence of the symptoms of attention deficit hyperactivity disorder (ADHD) and comorbid disorders on functioning in adulthood. *Psicothema, 26*, 471-476.

Mrug, S., Molina, B. G., Hoza, B., Gerdes, A., Hinshaw, S., Hechtman, L., & Arnold, L. E. (2012). Peer rejection and friendships in children with attention-deficit/hyperactivity disorder: Contributions to long-term outcomes. *Journal of Abnormal Child Psychology, 40*, 1013-1026.

Normand, S., Schneider, B., Lee, M., Maisonneuve, M., Kuehn, S., & Robaey, P. (2011). How do children with ADHD (mis) manage their real-life dyadic friendships? A multi-method investigation. *Journal of Abnormal Child Psychology, 39*, 293-305.

Papadopoulos, T.C., Panayiotou, G., Spanoudis, G., & Natsopoulos. D. (2005). Evidence of poor planning in children with attention deficits. *Journal of Abnormal Child Psychology, 33*, 611-623.

Pujals, E., Batlle, S., Camprodon, E., Pujals, S., Estrada, X., Aceña, M., …, Pérez, V. (2016). Brief report: Translation and adaptation of the theory of mind inventory to Spanish. *Journal of Autism and Developmental Disorders, 46*, 685-690.

Rinsky, J.R., & Hinshaw, S.P. (2011). Linkages between childhood executive functioning and adolescent social functioning and psychopathology in girls with ADHD. *Child Neuropsychology, 17*, 368-390.

Rodríguez, P.J., Betancort, M., Ramírez, G.M., García, R., Sanz, E.J., & De las Cuevas, C. (2012). Psychometric properties of the parent and teacher versions of the strength and difficulties questionnaire (SDQ) in a Spanish sample. *International Journal of Clinical Health and Psychology, 12*, 265-279.

Roselló-Miranda, B., Berenguer- Forner, C., Baixauli-Fortea, I., & Miranda-Casas, A. (2016). Modelo integrador de la adaptación social de niños con trastorno por déficit de atención/hiperactividad [Integrating model of social adaptation of children with attention deficit / hyperactivity disorder]. *Revista de Neurología, 62*, 85-91.

Schoemaker, K., Mulder, H., Dekovic, M., & Matthys, W. (2013). Executive Functions in preschool children with externalizing behavior problems: A meta-analysis. *Journal of Abnormal Child Psychology, 41*, 457-471.

Sodian, B., Hulsken, C., & Thoermer, C. (2003). The self and action in theory of mind research. *Consciousness and Cognition, 12*, 777-782.

Soltani, S., Kazemi, F., Maleki, N., & Soltani, Z. (2013). Deficits in theory of mind and executive function in children with attention deficit hyperactivity disorder. *Applied Science, 2*, 449-455.

Tseng, W.L., & Gau, S.S. (2013). Executive function as a mediator in the link between attention-deficit/hyperactivity disorder and social problems. *Journal of Child Psychology and Psychiatry, 54*, 996-1004.

Tseng, W. L., Kawabata, Y., Gau, S. S. F., & Crick, N. R. (2014). Symptoms of attention-deficit/hyperactivity disorder and peer functioning: A transactional model of development. *Journal of Abnormal Child Psychology, 42*, 1353-1365.

Willcutt, E.G., Doyle, A.E., Nigg, J.T., Faraone, S.V., & Pennington, B.F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry, 57*, 1336-1346.

Yang, J. Zhou, S., Yao, S., Su, L., & McWhinnie, C. (2009). The relationship between theory of mind and executive function in a sample of children from Mainland China. *Child Psychiatry and Human Development, 40*, 169-182.

4.2.3. Estudio 3

Miranda, A., Berenguer, C., Roselló, B., Baixauli, I., & Colomer, C. (2017). Social Cognition in Children with High-Functioning Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder. Associations with Executive Functions. *Frontiers in Ppsychology*, *8*, 1035. doi.org/10.3389/fpsyg.2017.01035

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El tercer estudio evaluó las posibles similitudes y diferencias en procesos de cognición social en niños con TEA y niños con TDAH. Así como, la interacción entre las habilidades de cognición social y el FE en niños con TEA y niños con TDAH. Los resultados revelaron que los niños con TEA y los niños con TDAH, en comparación con un grupo control con DT, mostraron deficiencias en todas las medidas de cognición social, como han señalado otras investigaciones (Downs & Smith, 2004; Sinzig et al., 2008; Demurie et al., 2011; Demopoulos et al., 2013; Baribeau et al., 2015).

El uso de medidas de ToM con diferentes niveles de complejidad, es decir, tareas de laboratorio de conocimiento explícito y habilidades aplicadas en contextos de la vida cotidiana, añadió matices específicos a los hallazgos. Primero, al comparar la capacidad de reconocer emociones básicas tales como felicidad, tristeza, miedo, ira y furia, el rendimiento de niños con TEA y niños con TDAH no se diferenció significativamente. Sin embargo, se observó un patrón diferente en las habilidades de ToM aplicadas, donde los padres percibieron que el grupo con TEA tenía más dificultad que los otros

dos grupos en la comprensión básica de las emociones. Además, el grupo con TDAH se encontró en una posición intermedia entre los grupos con DT y TEA en la aplicación práctica de las habilidades de ToM. Los resultados, coincidentes con la tendencia general encontrada en anteriores trabajos (Demurie et al., 2011; Demopoulos et al., 2013; Baribeau et al., 2015), sugieren que las situaciones de la vida diaria requieran más recursos que las tareas ejecutivas de laboratorio.

Por otro lado, en el grupo de niños con TDAH, los procesos de regulación comportamental se asociaron significativamente con los procesos de cognición social. Este dato demuestra una asociación estrecha entre inhibición y medidas de ToM y se ajusta al modelo de Barkley (1997), explicando cómo el control inhibitorio afecta a una amplia gama de comportamientos vinculados al procesamiento de la información social.

En el grupo con TEA se evidenció una situación diferente, de manera que fueron los componentes del procesamiento metacognitivo los que se relacionaron significativamente con las habilidades de ToM. Estudios previos han demostrado un vínculo entre ToM y FE en niños y adolescentes con TEA, específicamente en habilidades de flexibilidad cognitiva (Joseph & Tager–Flusberg, 2004; Pellicano, 2007) y en subdominios metacognitivos relacionados con la capacidad de resolver problemas en una variedad de contextos (Leung et al., 2016; Freeman et al., 2017). Nuestros hallazgos se suman al conocimiento existente y aportan nuevas evidencias sobre los déficits de niños con TDAH y TEA en RE y ToM. Consideramos, no obstante, que las deficiencias sociales de estos dos trastornos del neurodesarrollo no pueden explicarse únicamente por los déficits en COS o en FE. Como subraya un reciente meta-análisis (Imuta, Henry, Slaughter, Selcuk, & Ruffman, 2016) será imprescindible explorar posibles factores explicativos adicionales como los procesos de crianza, las variables

sociodemográficas, características familiares, la escuela, el sistema de aprendizaje y la estructura social donde se desarrolla el individuo.

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Social Cognition in Children with High-Functioning Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder. Associations with Executive Functions

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Autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) are neurodevelopmental disorders characterized by social impairments. The first objective of this study was to analyze social cognition deficits of children with ADHD, high-functioning ASD (HFASD), and typical development (TD) in their performance on explicit and applied measures of theory of mind (ToM). The second objective was to investigate the relationships between executive functions and social cognition in HFASD and ADHD. One hundred and twenty-six 7- to 11-year old children, 52 with HFASD, 35 with ADHD, and 39 with TD, performed the NEPSY-II social perception subtests. Parents estimated their children's ToM skills using the Theory of Mind Inventory (ToMI). Teacher-reported data from the Behavior Rating Inventory of Executive Function (BRIEF) were also obtained. The HFASD and ADHD groups showed worse performance on the verbal ToM task than the TD group, and only the performance of the HFASD group was significantly lower than the TD group on the contextual ToM task. Parents also estimated that the HFASD group had more difficulties on the applied ToM than the ADHD and TD groups. Furthermore, there is a different executive function-theory of mind link in the HFASD and ADHD groups: behavioral regulation processes such as inhibition and emotional control are more associated with social cognition in children with ADHD, whereas metacognitive processes such as initiation and planning have a strong association with social cognition in children with HFASD. These findings have implications for understanding social perception deficits in neurodevelopmental disorders, highlighting the need for early intervention.

Keywords: ADHD, ASD, facial affect recognition, theory of mind, executive functions

INTRODUCTION

Autism spectrum disorders (ASD) and attention deficit hyperactivity disorder (ADHD) are two disorders that stem from a disruption in the development of the brain and share the same genetic etiology, which largely explains the complexity of the impairments that characterize them (Ghirardi et al., 2017). Further evidence for common neurobiological substrates is based on the identification of similarities in the cognitive endophenotypes in individuals with these two disorders (Rommelse et al., 2011). The comparison and combination of the findings on overlapping and contrasting areas in the clinical manifestations and their possible interrelationships can help to clarify the nature of these two neurodevelopmental disorders. Two of the possible candidates for research on the cognitive profiles of ASD and ADHD are executive functioning (EF) and social cognition (Theory of Mind and affect recognition). Other possibilities such as weak central coherence or delay aversion are not appropriate for this line of research because each is related to only one of the two disorders, ASD and ADHD, respectively.

Research on social cognition is particularly valuable in understanding individual differences in social ability and exploring the social interaction impairments commonly found in both disorders. The study of the typical social cognition impairments in ASD has extended to ADHD in an attempt to identify possible similarities and divergences between the two disorders. Social cognition (SC) refers to the mental operations that underlie social interactions and involve interpersonal sensitivity in real social settings. It is a broad, complex, and multifaceted construct that reflects a wide variety of psychological processes, highlighting affect recognition (AR) and theory of mind (ToM). On the one hand, AR consists of identifying emotionally salient information in the environment, including verbal (lexical-semantic) and nonverbal (intonation, facial, visual, and body movement) cues about other people's emotions (Phillips, 2003). On the other hand, ToM is defined as the cognitive ability to attribute mental states such as thoughts, beliefs, and intentions to other people. It implies an awareness that others have minds with mental states, information, and motivations that may differ from one's own, allowing an individual to explain, manipulate, and predict behavior (Korkmaz, 2011).

The analysis of the 11 studies that have compared children and adolescents with ASD and ADHD (see **Table 1**) shows that these two disorders share difficulties in social cognition, both on different levels of ToM tasks and on tests of emotion recognition (Buitelaar et al., 1999; Adachi et al., 2004; Downs and Smith, 2004; Sinzig et al., 2008; Yang et al., 2009; Bühler et al., 2011; Demurie et al., 2011; Demopoulos et al., 2013; Baribeau et al., 2015; Hutchins et al., 2016) or empathic capacity (Dyck et al., 2001).

With regard to the severity of the dysfunction in ToM and AR abilities, the studies indicate that the differences between ASD and ADHD are generally more quantitative than qualitative. People with ASD are affected more severely, producing a symptomatological continuity where ADHD holds an intermediate position between TD and ASD (Demurie et al., 2011; Demopoulos et al., 2013; Baribeau et al., 2015). In fact, individuals with ADHD, compared to ASD, seem to perform similarly to the TD group on appearance-reality tasks (Yang et al., 2009). However, some studies diverge from the general tendency, revealing that children with ADHD could not be differentiated from children with high-functioning autism on their performance on ToM tasks, especially on second-order mentalizing skills (Buitelaar et al., 1999).

In addition, some findings have shown a negative effect on AR when ADHD symptoms are associated with ASD. When comparing the facial AR skills of groups of children and adolescents with ASD, ADHD, ASD+ADHD, and TD, the findings showed that the groups with ADHD symptoms had more AR difficulties than the groups with only ASD or TD (Sinzig et al., 2008). Likewise, when ADHD is accompanied by oppositional-defiant disorder (ODD), there is an additional impairment in ToM development, so that the ADHD/ODD group showed more socio-emotional and behavioral impairment than the ASD group, which exhibited cooperation and ToM skills (Downs and Smith, 2004). Along with comorbidity, the types of ASD and ADHD are factors that should also be taken into account when evaluating the results. For example, one study that included only children with ADHD with a predominance of inattention did not find ToM impairments in the ADHD group, although this group showed less empathic ability. The children with severe ASD experienced pronounced deficits in ToM skills and the capacity for empathy. By contrast, the group with high-functioning autism (with Asperger's syndrome) showed a similar profile to the group with no psychopathologies (Dyck et al., 2001).

The developmental stage is another aspect to consider in ToM skills because the development of mentalizing skills seems to follow a different course in ASD and ADHD. Although, there is a lack of studies with a longitudinal design, using a cross-sectional design (Bühler et al., 2011), a significant difference in facial emotion recognition was observed between the youngest ASD and ADHD groups (ASD<ADHD), and this difference did not occur in the older groups. Therefore, social cognition impairments occur later in ADHD than in ASD, probably depending on experiences in the family circle and with classmates.

There is a noteworthy influence of the procedure used to measure the mentalist skills on the results, as reflected in the study by Hutchins et al. (2016). On all the measures, both on the battery that rated explicit ToM knowledge and on the TOMI inventory, focused on applying ToM to daily life situations, the ASD group had worse performance than the other groups. However, the ADHD group achieved higher performance on the explicit tasks, that is, on the laboratory measures. In fact, no differences were found between the ADHD and neurotypical groups on the composite score on the ToM battery (explicit knowledge), whereas on the TOMI inventory scores, the ADHD group showed significantly lower performance levels than the TD group. The authors argue that this result may be due to the fact that the application of ToM skills in daily life requires a greater number of executive functioning (EF) resources (inhibition, working memory, attention). Another possible explanation is

TABLE 1 | Previous studies that compare social cognition skills in children and adolescents with ADHD and high-functioning ASD ($N = 11$).

References	Participant: (N)	Total IQ	Theory of mind tasks	Results	Conclusions
Adachi et al., 2004	29 ADHD MA = 9.6 54 ASD MA = 9.8 199 TD MA = 10.0	96.7 96.1 –	Box of Marbles' task Metaphoric and Sarcastic Scenario test	ADHD: Success on ToM tasks = 84.6%. ASD: Success on ToM task = 69.2% Relationship between ToM and sarcasm	Both ADHD and ASD show impairments in metaphor comprehension. ADHD: Adequate comprehension of sarcastic situations. ASD: Specific incapacity to understand sarcasm
Baribeau et al., 2015	71 ADHD MA = 9.3 118 ASD MA = 11.6 42 ODD MA = 13.7 34 TD MA = 12.5	100.6 91.4 108.8 113.1	Reading the mind in the eyes Test child version (RMET) Social communication Questionnaire (SWAN)	Differences between ASD and ADHD in RMET Serious impairment in ASD and medium in ADHD Both groups performed worse on RMET items with a positive valence	ADHD presented a moderate alteration in social information processing, between ASD and TD. In ASD, social impairment is central. Social communication deficits and H/I traits are associated with impaired social perception abilities
Bühler et al., 2011	84 ADHD MA = 9.7 86 ASD MA = 10.8 52 ASD+ADHD MA = 10.1	97.9 105.4 99.0	Facial emotion matching Social attribution task Battery for attention Inhibition Go/NoGo	Differences in inhibitory control (ADHD<ASD) and in the ToM performance among younger (ASD < ADHD) but not older children	Age modulates the ToM deficits in the clinical groups. Children with ASD lack ToM prerequisites and show impairments very early on, whereas children with ADHD display difficulties over the course of their development
Buitelaar et al., 1999	20 PC (9 ADHD MA = 12.3) 20 ASD MA = 12.5 20 PDD MA =10.1 20 TD MA = 10.5	99.8 102.1 98.7 –	6 First-order ToM tasks 4 Second-order ToM tasks Emotion recognition tasks	The two ASD groups are not distinguished on socio-cognitive performance, nor are they differentiated from the ADHD group. Other disorders showed no differences from TD	Impairments in mentalizing and emotion recognition skills are not specific to autism disorder. Individuals with ASD hardly differ from other disorders (such as ADHD) on their social comprehension in testing situations
Demopoulos et al., 2013	436 ADHD MA = 10.3 137 ASD MA = 10.5	98.2 88.3	Social solving problems Affect recognition Social judgment test	ADHD and ASD performance was inferior to TD performance on all the measures, although the ASD group was worse than the ADHD	Children with ADHD display similar socio-cognitive impairments to those of children with ASD, although with less severity. The differences are more quantitative than qualitative
Demurie et al., 2011	13 ADHD MA = 13.7 13 ASD MA = 14.3 18 TD MA = 13.8	102.9 101.5 Averege	Interpersonal reactivity index Reading the mind in the eyes Empathic accuracy task	ASD presented impairments in perspective taking abilities. ADHD adolescents' performance was between ASD and TD adolescents	ToM problems are not specific to ASD. On all the measures, ASD < ADHD < TD, which would indicate a certain symptomatological *continuum*
Downs and Smith, 2004	16 ADHD/ODD MA = 8.3 10 ASD MA = 7.1 10 TD MA = 7.7	103.3 106.6 108.9	Cooperative Behavior (CB):Prisoner's dilemma test Emotional understanding-EU Behavioral development	ASD and TD outperformed ADHD/ODD on CB and EU. ASD showed worse emotion recognition and more active/odd behavior	ADHD/ODD group showed more socio-emotional and behavioral impairments than the ASD group. High-functioning ASD can develop cooperation and ToM, but experience deficits in identifying emotions and appropriate behaviors.
Dyck et al., 2001	35 ADHD 48 ASD 48 Other disorders 36 TD MA = 12.09	–	4 emotion recognition scales (Empathic abilities, EA) ToM. Strange stories test Wechsler intelligence scale	Autism groups presented alterations in ToM and empathic abilities ADHD group showed deficits in empathy, but not in ToM	Deficits in empathic capacity are not specific to the autism spectrum. Empathy is not independent from intelligence, so that both dimensions are necessary to discriminate ASD from other disorders

(Continued)

TABLE 1 | Continued

References	Participant: (N)	Total IQ	Theory of mind tasks	Results	Conclusions
Hutchins et al., 2016	29 ADHD MA = 9 67 ASD MA = 9.7 49 TD MA = 8.8	Average IQ range	9 Measures of explicit ToM TOMI Inventory (measure of applied ToM competence)	ASD: Worse performance than children with ADHD and TD on all measures ADHD: Equal performance to TD on explicit ToM, but lower on TOMI	Complexity in assessment is critical to distinguish the groups. ADHD fail to apply ToM abilities in the real world. ASD presented global ToM difficulties that seem attributable to a deeper meta-representational deficit
Sinzig et al., 2008	30 ADHD MA = 12.7 21 ASD+ADHD 19 ASD MA = 12.6 29 TD MA = 12.8	100 102 111 109	Facial affect recognition (Frankfurt Test). Inhibition Attention, Set-Shifting	ADHD groups performed significantly worse than the control group on Affect Recognition	The facial affect recognition ability is reduced in children suffering from ADHD symptoms, both in autistic and pure ADHD children
Yang et al., 2009	26 ADHD MA = 8.2	109.9	ToM 1. Appearance-reality	Children with ASD performed worse than ADHD and TD children on ToM tasks	Significant relationship between ToM and inhibitory control after partialling out IQ. ToM deficit with intact EF is unlikely
	20 ASD MA = 8.0 30 TD MA = 8.1	96.6 118.2	ToM 2. Unexpected location	ADHD performed similarly to the TD group EF: Stroop, Wisconsin Test	

MA, Mean age; ADHD, Attention deficit hyperactivity disorder; ASD, Autism spectrum disorder; TD, Typical development; ODD, Oppositional defiant disorder; PDD, Pervasive developmental disorder; PC, Psychiatric control group; EF, Executive functions.

related to the quality of the EF resources, as the applied ToM would imply a greater involvement of the "Hot" EF, which are activated to address problems that require affect and motivation regulation. This circumstance would also justify the intermediate performance of the ADHD group on the Early and Basic Subscales and their impaired performance on the Advanced subscale of the ToMI: "It may be that the Early, Basic, and Advanced Subscales require variable thresholds of EF for success" (Hutchins et al., 2016, p. 104).

The concept of EF refers to skills that make it possible to maintain an adequate response pattern to reach a future goal and dynamically self-regulate one's behavior (Goldstein et al., 2013). It includes a broad spectrum of higher mental processes that are grounded in prefrontal and thalamic-reticular areas of the brain. Their function is to direct the thoughts, actions, and emotions, and, therefore, they play a decisive role in socio-personal adaptation (Barkley, 2011; Diamond, 2013).

Poor executive functions are an established deficit of two of the most common neurodevelopmental disorders, ADHD (Barkley, 1997) and ASD (Lai et al., 2017). "ase provide the city name for"). In fact, EF deficits are the neuropsychological traits common to both disorders that have received the most support in the literature (Rommelse et al., 2011), although findings related to the specific subdomains of the deficit are not completely consistent. On the one hand, some studies suggest that the EF differences between ASD and ADHD are more quantitative than qualitative, so that it is difficult to use executive measures to differentiate the specific domains affected in each of these disorders. On the other hand, a large number of studies have provided evidence for the dissociation of the EF deficits in ADHD and ASD. Children with ASD would mostly show an alteration in planning, whereas the deficits of children with ADHD would affect inhibition and verbal working memory (Gargaro et al., 2011; Miranda-Casas et al., 2013; Craig et al., 2016).

Problems in inhibition, information recall, flexibility, and the ability to monitor, plan, and initiate socially appropriate responses—all aspects of EF—may contribute to the social impairments experienced by children with ADHD and children with ASD. A large body of evidence supports the associations between the EF and ToM in typical development (Carlson et al., 2004; Hughes and Ensor, 2007). However, few studies have examined the interesting interplay between EF and social cognition in children with neurodevelopmental disorders such as ASD and ADHD. In the case of ADHD, the findings point out that the inhibitory problems of children with ADHD impede the representation of mental states and ToM skills. In other words, ToM itself remains intact, but there is a failure to express this ability (Papadopoulos et al., 2005; Sodian and Hulsken, 2005). Supporting this view, Mary et al. (2016) hypothesize that ToM dysfunctions in children with ADHD could be due to attentional or executive deficits. They found that children with ADHD performed worse than neurotypical children on all the EF tests (inhibition, planning, attention) and two higher-order ToM tasks. The most interesting result was that, controlling inhibition and attention, the performance of children with ADHD was similar to that of children with typical development. By contrast, controlling the ToM scores did not normalize their performance

on inhibition and attention tasks, indicating that EF and attention deficits were determining the ToM failures in children with ADHD.

The literature also supports the critical role of EF in the ToM skills of children with ASD. Specifically, cognitive flexibility and shifting skills have shown a significant correlation with ToM tasks that require children to change from their own perspective to that of others (Zelazo et al., 2002; Pellicano, 2007). Furthermore, cognitive shifting predicts ASD preschoolers' capacity to shift between their own beliefs and a false belief presented (Kimhi et al., 2014). Likewise, in a longitudinal study conducted over a 3-year period, early EF and central coherence skills predicted developmental changes in ToM skills, regardless of age, language, and nonverbal intelligence (Pellicano, 2010). An important and unexplored question is related to the functional link between ToM and EF in ASD and ADHD. To the best of our knowledge, in the only study that analyzed this question, carried out by Yang et al. (2009), the data from the correlational analyses showed that only inhibition was significantly related to ToM performance after partialling out non-verbal intelligence. Yang et al. (2009) applied laboratory neuropsychological tasks to measure EF. However, given the differences between the demands of a structured evaluation scenario and those of the real world, it is essential to collect the ratings of a set of metacognitive, behavioral, and emotional abilities in daily life by informants who know the subject well. Two recent studies have provided interesting findings. On one hand, it has been found that metacognitive executive processes (i.e., initiation, working memory, planning, organization, and monitoring) predicted social function only in children with ASD and not in TD children (Leung et al., 2016). On the other hand, teachers' ratings of poor initiation, working memory, and planning and organizational skills have been related to more time engaged in solitary play, suggesting that metacognitive skills such as initiation, working memory, and planning and organization are associated with social functioning in children with autism (Freeman et al., 2017).

In summary, a growing body of research supports the existence of social cognition impairments in children with ASD and children with ADHD and, to a lesser extent, differential patterns across these disorders, with more significant social perception deficits in ASD and milder deficits in ADHD. However, other findings provide relatively mixed evidence, possibly due to factors such as the broad age range of the participants, the developmental stage, the nature of the ToM measurement procedure itself (explicit or applied), group differences in intelligence, and the diagnosis of the type of presentation of the ADHD participants. Thus, one important area for future research is the continued investigation of these two neurodevelopmental disorders. This study builds on the previous one, focusing on the analysis of similarities and differences between the implicit and explicit ToM systems and possible links between ToM and EF in children with HFASD and children with ADHD. In order to obtain reliable conclusions, critical factors have been controlled, specifically the intelligence level (IQ) and verbal ability, given the degree of overlap between IQ and EF and the relationships between verbal ability and the capacity to represent mental states (Happé, 1995).

Considering the significance of these findings about similarities and differences between ASD and ADHD in the conceptualization of these two disorders, the first objective of this study is to compare the AR and ToM abilities, both explicit (laboratory tasks) and applied (parent ratings in real life—ToMI), in children with HFASD, ADHD, and TD, matched on chronological age, mental age, and vocabulary. Children with HFASD are expected to have worse performance on all the measures of social cognition than the children with TD. Children with ADHD are expected to show a more variable performance, depending on the type of measure, and occupy an intermediate position between the children with HFASD and the children with TD.

The second objective consists of exploring in the two clinical groups, children with HFASD and children with ADHD, the interplay between AR and ToM skills and "everyday" components of EF measured by the BRIEF. Based on the limited literature examining the relationship between executive and social functioning in children with ASD and children with ADHD, we predict that the EF components that have a significant relationship with the ToM in both disorders will differ. Specifically, we expect that EF behavioral regulation index subdomains, a characteristic deficiency seen in individuals with ADHD (Barkley, 1997; Mary et al., 2016), will maintain a more significant relationship with AR, ToM tasks, and ToMI total scores in this group. We also expect that the EF metacognitive index subdomains in the group with ASD will show a higher relationship with the overall indicators of AR, ToM tasks, and the ToMI performance (Leung et al., 2016; Freeman et al., 2017).

MATERIALS AND METHODS

Participants

Participants in this study were 126 children from 7- to 11-years old, distributed in three groups: a group with HFASD (n = 52), a group with ADHD (n = 35), and a group with TD (n = 39). Mean age of children with HFASD, M = 8.59, SD = 1.38; children with ADHD, M = 9.14 SD = 1.41; children with TD, M = 8.46, SD = 1.27. The decision on the age range was motivated by developmental reasons (coinciding with the phase of the development of concrete operational stage) and due to the importance of Primary Education in the Spanish education system that coincides with this developmental period. All the participants had an overall IQ equal to or above 80, measured with the K-BIT (Kaufman and Kaufman, 2000): Children with HFASD, M = 101.42, SD = 12.65; children with ADHD, M = 99.03, SD = 9.87; children with TD, M = 102.21, SD = 8.70. The three groups were balanced on age, $F_{(2, 123)} = 2.61$, $p = 0.078$, total IQ, $F_{(2, 123)} = 0.865$, $p = 0.423$ and semantic language level, assessed with the vocabulary subtest of the WISC-IV (Wechsler, 2003) $F_{(2, 123)} = 1.03$, $p = 0.350$. In addition, 91.42% of the HFASD group and 94.3% of the ADHD group were male.

The children in the two clinical groups had received a diagnosis of HFASD or ADHD in the Child Neurology and Child Psychiatry Services of hospitals and medical centers in

the provinces of Valencia and Castellón (Valencian Community, Spain). The clinical diagnoses of HFASD and ADHD were confirmed before applying the battery of tests selected for the present study. Specifically, to confirm the HFASD diagnosis, strict cut-off points recommended for the Social Communication Questionnaire (SCQ; Rutter et al., 2003) and the revised Autism Diagnostic Interview (ADI-R; Rutter et al., 2006) were applied. These two instruments were administered to the parents by a clinical psychologist from the research team who had been accredited for their application.

The ADHD diagnosis was also confirmed through interviews with parents and teachers, who provided information about the 18 ADHD criteria from the DSM-5 (American Psychiatric Association, 2013), rating the severity of each item from 0 to 3. The requirements were the presence of at least six inattention symptoms and/or another six hyperactivity/impulsivity symptoms, persistence of the symptoms for at least 1 year, and their clear interference in the subject's daily functioning. Another requirement was a T score equal to or greater than 63 on the scales related to the ADHD diagnosis on Conners' Rating Scales—Revised, parents version (CPRS-R:L; Conners, 2001). The majority of the subjects in this group, 77.14%, showed a combined ADHD presentation, whereas 22.86% met the criteria for a presentation with a predominance of inattention. As would be expected, the rate of behavior problems (identified with the Strengths and Difficulties Questionnaire, SDQ, filled out by the parents; Goodman, 1997) in our ADHD sample was 40%.

Regarding the school modality, three children with HFASD (5.8%) and two children with ADHD (5.7%) were attending school in regular classrooms full time; 29 children with HFASD (55.7%) and 33 with ADHD (94.3%) attended regular classrooms but received educational support for their specific needs in the school; and finally, 20 children with HFASD (38.5%) were placed in the Communication and Language classrooms modality.

Participants with TD were all attending school in regular classrooms in the same schools where the children with ADHD and HFASD attended. They had no history of psychopathology or referral to children's mental health units (USMI), according to the information from the school records, and they did not meet the DSM 5 criteria for ADHD or HFASD on the screening carried out by SCQ before beginning the evaluation.

The exclusion criteria for the children who participated in the study were evaluated through an extensive prior anamnesis carried out with the families. They included severe or genetic neurological diseases, brain lesions, psychosis, visual, auditory, motor, or sensorial deficits, and an intelligence coefficient <80. The administration of psycho-drugs was only an exclusion criterion for the TD group. By contrast, 32.7% of the children in the HFASD sample were taking antipsychotics (mainly Risperidone), and 71.4% of the children in the ADHD sample were receiving psychostimulants, generally time-released (mainly Methylphenidate).

Procedure

The study was approved by the Ethics Committee of the University of Valencia (Declaration of Helsinki in the Convention of the Council of Europe, 1964). It obtained the approval of the Consellería de Educación de la Generalitat Valenciana to locate children who had received a previous diagnosis of HFASD or ADHD by professionals in specialized childhood mental health services. The families were personally told about the aims of our research and asked for their informed consent. Oral permission from the children and written informed consent from their parents were obtained before beginning the evaluation, which took place in the schools in which they were enrolled.

The intelligence test and the two tests from the social perception domain were administered to all the children individually by trained examiners in prepared classrooms in the different schools. The parents provided information about their children's ToM skills in daily life contexts, and the teachers-tutors filled out the questionnaire selected to assess the EF.

Measures

Affect Recognition-AR

The subtest from the social perception domain of the NEPSY-II battery (A Developmental Neuropsychological Assessment Battery, Korkman et al., 2007) was applied.

It consists of four different tasks, and its purpose is to assess the ability to recognize the six basic emotions: happiness, sadness, fear, anger, disgust, and neutral, in photographs of children's faces. On the first and second tasks, the child is shown three photographs and asked to select two photographs of faces that express the same emotion. On the third task, the child must select one of the four faces that show the same emotion as the photograph that appears in the upper part. On the final task, the child is shown a face for 5 s and immediately asked to point to the two photographs, out of six, that show the same emotion as the face shown previously. The total score ranges between 1 and 25 in children aged 6 or younger and between 1 and 36 in children aged 7 or older, with higher scores reflecting a greater ability to match the same emotions.

Theory of Mind Abilities (ToM)

In our evaluation of the ToM, we accept the distinction made by Hutchins et al. (2016) between explicit ToM competence, defined as conceptual, operative, and logical knowledge, and applied knowledge, which involves the capacity to display ToM knowledge when facing everyday real-life dilemmas.

Explicit ToM knowledge

To evaluate explicit ToM knowledge, we used the Theory of Mind subtest included in the social perception domain of the NEPSY-II battery (A Developmental Neuropsychological Assessment Battery, Korkman et al., 2007). This test was designed to evaluate the capacity to comprehend mental functions such as beliefs, intentions, deception, and emotions, among others. The purpose, therefore, is to assess the capacity to understand that others have thoughts and feelings that might be different from one's own. Likewise, it aims to measure the capacity to understand the relationship between the emotions and the social context, and identify the appropriate emotion in specific social contexts. It consists of two tasks. The verbal tasks consist of showing the child

an image and describing a situation related to that image. Next, the child is asked a question that requires him/her to comprehend another person's point of view. The tasks combine first- and second-order false belief questions, double deception tasks, and comprehension of figurative language.

The verbal tasks also include questions based on verbal scenarios with no pictorial support. An example for children from 7 to 11 years old would be the following: "the children in the class of Judith, their teacher, were decorating Christmas cards. Since it was almost time for recess, Judith said: "children hurry up!" What did she mean? There are also two items that measure verbal imitation and gesture skills, which are considered a basic ToM factor. The contextual task measures the child's capacity to relate an emotion to the social context. It is composed of 6 items that show images of a girl in different social contexts. From four photographs of the girl's face with different emotions, the child is asked to identify the one that has the same emotion as the girl in the picture. The child can respond by pointing to the photographs, and no verbal responses are necessary.

Applied ToM Knowledge

Theory of Mind Inventory (ToMI, Hutchins et al., 2014. Spanish adaptation: Pujals et al., 2016). The ToMI inventory for parents or caregivers is composed of 42 items, and its objective is to address the breadth and complexity of mentalist skills. The items are grouped in 3 subscales, and they offer a general average score. The early subscale (ToMI-E) is composed of 7 items and assesses ToM skills that begin to develop in the first stages of childhood, such as social references and understanding basic emotions (e.g., "my child understands that when I show fear, the situation is unsafe or dangerous," or "my child recognizes when others are happy"). The basic subscale (ToMI-B) includes 19 items that encompass ToM characteristics typical of children beginning the educational stage, such as the basic meta-representations and the distinction between physical and mental representations [e.g., "If I showed my child a cereal box filled with cookies and asked him/her "What would someone who has not looked inside think is in the box?" My child would say that another person would think there was cereal in the box" (false belief)]. Finally, the advanced subscale (ToMI-A) is composed of 16 items that assess more mature aspects of the ToM that develop between 5 and 8 years old, such as second-order inferences and making complex social judgments (e.g., "My child understands the difference between a friend teasing in a nice way and a bully making fun of someone in a mean way"). Each item is rated from 0 to 20, from "Definitely not" to "Definitely," with a mid-point of "Undecided." Responses are made with a vertical mark on a continuous line, indicating the score that best reflects the degree of agreement with each statement presented. High scores show the perception of good ToM competence.

The ToMI inventory has been extensively validated, and it has shown test-retest reliability, internal consistency, and criterion validity for samples with typical development and ASD. It has also shown excellent sensitivity (0.9) and specificity (0.9) when used to examine children with ASD, although its purpose is not to perform a differential diagnosis (Hutchins et al., 2012).

Executive Functioning

Behavior rating inventory of executive function; (BRIEF, Gioia et al., 2000)

The teacher version of the questionnaire was applied to assess the child's EF through the teacher's observation of his/her behavior in the school context. It consists of 86 items rated on a Likert-type scale with three levels (never, sometimes, often). The items are grouped in 8 scales: Inhibit ("Interrupts others"); Shift ("Becomes upset with new situations"); Emotional control ("Overreacts to small problems"); Initiate ("Is not a self-starter"); Working Memory ("Has a short attention span"); Plan/Organize (does not finish long-term projects); Organization of materials ("Leaves playroom a mess"); and Monitor ("Does not check work for mistakes").

The scales make up two indexes. The Behavioral Regulation Index (BRI) is composed of the Inhibit, Shift, and Emotional Control scales, assessing the child's capacity to make cognitive changes and adjust his/her emotions and behavior through appropriate inhibitory control. The Metacognition Index (MI) is composed of the Initiate, Working Memory, Plan/Organize, Organization of materials, and Monitor scales. This index reflects the child's ability to initiate, plan, organize, self-monitor, and maintain working memory. It could be interpreted as the ability to self-manage cognitive tasks and supervise their performance. This index is related to the capacity to actively solve problems in a variety of contexts.

The direct scores can be transformed into T-scores, with higher scores indicating worse EF. The questionnaire's reliability and validity have been adequately demonstrated (Gioia et al., 2002; García Fernández et al., 2014).

RESULTS

Statistical Analyses

Statistical analyses were performed using the software Statistical Package for the Social Sciences (SPSS), version 22.00 (SPSS Inc., Chicago, IL USA). Multivariate Analysis of Variance (MANOVA) was conducted to analyze differences between the HFASD, ADHD, and TD groups on the AF and ToM (explicit knowledge) subscales of the NEPSY-II and the ToMI inventory (applied knowledge). For the additional ANOVAs, the level of significance was set at $p < 0.006$ after applying the Bonferroni correction, and η^2_p was calculated to assess the strength of association. Pearson correlation analyses were also conducted in each clinical group to study the relationships between different EF domains and AR and explicit and applied competence in ToM. Because the age differences were close to statistical significance, analyses were performed, introducing age as covariable in the MANCOVA and conducting partial correlations; however, essentially the same results emerged when the analyses were conducted with the covariate.

Comparison between Children with HFASD, ADHD, and TD in Social Cognition

The MANOVA conducted to assess the main group effect on the conceptual knowledge (NEPSY subscales) and applied knowledge (ToMI) indicators was statistically significant [Wilk's Lambda

(Λ) = 0.26, $F_{(16, 232)} = 13.76$, $p < 0.001$, $\eta^2_p = 0.48$]. ANOVAs showed significant differences in the NEPSY subscales: Affect recognition, $F_{(2, 123)} = 18.57$, $p < 0.001$, $\eta^2_p = 0.23$; Verbal-ToM, $F_{(2, 123)} = 13.91$, $p < 0.001$, $\eta^2_p = 0.18$; Contextual-ToM, $F_{(2, 123)} = 5.84$, $p = 0.004$, $\eta^2_p = 0.08$, and Total-ToM score, $F_{(2, 123)} = 17.28$, $p < 0.001$, $\eta^2_p = 0.22$. Statistically significant differences were also shown in the applied knowledge task (TOMI): Early-ToMI, $F_{(2, 123)} = 35.65$, $p < 0.001$, $\eta^2_p = 0.36$; Basic-ToMI, $F_{(2, 123)} = 64.25$, $p < 0.001$, $\eta^2_p = 0.51$; Advanced-ToMI, $F_{(2, 123)} = 116.04$, $p < 0.001$, $\eta^2_p = 0.65$ and in the ToMI total score [$F_{(2, 123)} = 96.42$, $p < 0.001$, $\eta^2_p = 0.61$].

Bonferroni *post-hoc* analyses showed statistically significant differences between the TD group and both clinical groups on AR, Verbal-ToM, and Total-ToM ($p < 0.001$), with no significant differences between clinical groups. On the contextual task, the HFASD group showed significantly worse performance than the TD group ($p < 0.001$), and performance of the ADHD and TD groups was similar. However, there were no significant differences between clinical groups on this task. A different pattern was observed for ToM applied knowledge, where there were statistically significant differences among the three groups, HFASD, ADHD, and TD, on the three subscales of the ToMI and on the Total score ($p < 0.001$). The HFASD group had the lowest score, whereas the TD group had the highest, according to parent estimations. See **Table 2**.

Relations between EF and Social Cognition in HFASD and ADHD Groups

In the ADHD group, AR significantly correlated with Inhibit ($p < 0.001$), Shift ($p < 0.001$), Emotional control ($p = 0.012$), and the BRI ($p < 0.001$). There were also significant correlations between AR and Monitor ($p = 0.016$). There were no significant correlations between AR and EF in the HFASD group, as **Table 3** shows. In the HFASD group, there were significant correlations between the metacognitive component of Initiate and Verbal-ToM ($p = 0.009$) and Total-ToM ($p = 0.020$), both from the NEPSY-II battery. Similarly, there were significant correlations between Initiate and Basic-ToMI ($p = 0.033$), Advanced-ToMI ($p = 0.046$), and Total-ToMI ($p = 0.040$). There were also significant correlations between Organization of materials and Basic-ToMI ($p = 0.033$), advanced-ToMI ($p = 0.030$), and Total-ToMI ($p = 0.016$), and between MI and advanced-ToMI ($p = 0.043$) and Total-ToMI ($p = 0.026$).

Correlation analyses in the ADHD group did not show significant associations between ToM tasks on the NEPSY-II and BRIEF subscales. However, there were significant negative correlations between inhibit and Early-ToMI ($p = 0.034$), Basic-ToMI ($p < 0.001$), and total-ToMI ($p = 0.027$), as well as between emotional control and Early-ToMI ($p = 0.045$). The same pattern was observed between the BRI and the Early-ToMI ($p = 0.014$), Basic-ToMI ($p = 0.013$), and Total-ToMI ($p = 0.049$). Regarding the metacognitive processes, there were statistically significant correlations between Organization of materials and Early-ToMI ($p = 0.026$), Basic-ToMI ($p = 0.012$), and Total-ToMI ($p = 0.049$), as well as between Monitor and Early-ToMI ($p = 0.018$), Basic-ToMI ($p = 0.013$), and Total-ToMI ($p = 0.022$).

DISCUSSION

Research on poor social functioning in children with ASD and ADHD has increased exponentially, suggesting a significant clinical overlap between these two disorders in terms of impairments in social skills. Although, the consequences of social impairment in the trajectory of both disorders is no longer disputed, only a small body of research has examined social cognition deficits comparing groups of children with ASD, ADHD, and TD. The literature review on this area of study reveals two important issues. First, there is a lack of consistency in the findings related to the profile of ToM skills in individuals with ASD and ADHD. Second, another question that remains unresolved is related to the possible functional link between ToM and EF in ASD and ADHD.

Therefore, the first objective of this study was to analyze two fundamental social cognition abilities, affect recognition and ToM, in children with HFASD, ADHD, and typical development, matched on age, IQ, and semantic knowledge. Children with HFASD were expected to have worse performance on all the social cognition measures than children with TD and children with ADHD. The analysis revealed that children with HFASD and children with ADHD, compared to a group of typically developing peers, showed impairments on all the social cognition measures. In addition, consistency is observed in the results, regardless of the ToM assessment methodology employed, that is, performance tasks or parent estimates of daily life behavior. This finding, which is consistent with the initial hypothesis, supports the idea that children with these two disorders experience deficits in AR (Downs and Smith, 2004; Sinzig et al., 2008; Demurie et al., 2011; Demopoulos et al., 2013; Baribeau et al., 2015) and attribution of mental states, such as feelings, beliefs, intentions, and desires (Buitelaar et al., 1999; Adachi et al., 2004; Demurie et al., 2011; Demopoulos et al., 2013; Hutchins et al., 2016).

The use of ToM measures with different levels of complexity, i.e., laboratory tasks of explicit knowledge and applied abilities in everyday life contexts, adds specific nuances to the findings. First, when comparing the ability to recognize basic emotions such as happiness, sadness, fear, anger, and disgust, the performance of children with HFASD and children with ADHD is not significantly different. The ease of distinguishing between different faces is based on holistic processing, that is, the perception of faces as more than the sum of their parts. It is likely that failures of individuals with ASD and ADHD in understanding and interpreting facial emotions are due to the use of predominantly non-holistic, chaotic, and disorganized strategies. They focus attention on some minor facial feature that keeps them from fully understanding someone else's emotional expression. In fact, Berggren et al. (2016) demonstrated that attention had a significant influence on AR in individuals with ADHD and ASD. Furthermore, according with the Weak Coherence Account (Happé and Frith, 2006), individuals with ASD have a perceptual bias for local, rather than global, stimulus features. However, according to a study by Booth and Happé (2010), individuals with ADHD, in spite of their inhibitory deficits, do not have central coherence problems. Consequently, impaired visual processing related to attentional

TABLE 2 | Differences between children with ASD, ADHD, and TD on ToM tasks and ToMI Inventory (ANOVAs).

	TD ($n = 39$)		ASD ($n = 52$)		ADHD ($n = 35$)				
	M	*SD*	*M*	*SD*	*M*	*SD*	$F_{(2, 123)}$	η^2p	Group differences
AR	28.36	2.69	23.75	4.09	24.11	4.38	18.57*	0.23	ASD, ADHD<TD
ToM V	17.35	2.07	14.01	3.63	15.22	2.79	13.91*	0.18	ASD, ADHD<TD
ToM C	4.89	0.96	3.95	1.57	4.34	1.18	5.84*	0.08	ASD<TD
ToM Tot	22.25	2.42	17.96	4.15	19.57	3.27	17.28*	0.22	ASD, ADHD<TD
ToMI E	18.87	1.22	14.52	3.38	17.22	1.83	35.65*	0.36	ASD<ADHD<TD
ToMI B	18.87	1.30	12.92	3.34	16.68	2.14	64.25*	0.51	ASD<ADHD<TD
ToMI A	17.00	2.51	8.02	3.01	14.13	3.05	116.04*	0.65	ASD<ADHD<TD
ToMI Tot	18.20	1.58	11.50	2.88	15.87	2.13	96.42*	0.61	ASD<ADHD<TD

*AR, Affect recognition; ToM V, Theory of mind-Verbal; ToM C, Theory of mind- Contextual; ToM Tot, Theory of mind- Total; ToMI E, ToMI-Early; ToMI B, ToMI Basic; ToMI A, ToMI Advanced. *p < 0.006 (Bonferroni correction).*

TABLE 3 | Pearson correlation coefficients between executive functions and social cognition measures in ASD and ADHD groups.

		AR	ToMV	ToMC	ToMTot	ToMIE	ToMIB	ToMIA	ToMITot
ASD	Inhibit	0.04	0.17	−0.01	0.20	0.04	0.08	−0.01	−0.04
	Shift	0.10	0.18	0.15	0.20	0.11	0.15	0.06	0.13
	Emotional control	0.05	0.24	−0.01	0.26	0.14	0.16	0.17	0.19
	BRI	0.08	0.23	0.05	0.26	0.11	0.14	0.08	0.13
	Initiate	−0.10	−0.36**	−0.01	−0.32*	−0.15	−0.30*	−0.28*	−0.29*
	Working memory	−0.15	0.04	−0.14	0.03	−0.14	−0.15	−0.16	−0.16
	Plan	−0.09	0.07	0.01	0.06	−0.25	−0.18	−0.26	−0.24
	O. Materials	−0.13	−0.05	−0.11	−0.06	−0.26	−0.30*	−0.30*	−0.33*
	Monitor	0.05	−0.02	−0.02	0.01	−0.19	0.18	−0.17	−0.21
	MI	−0.10	−0.05	−0.07	−0.04	−0.26	−0.26	−0.28*	−0.31*
ADHD	Inhibit	−0.57**	0.07	−0.05	0.03	−0.36*	−0.51**	−0.17	−0.37*
	Shift	−0.47**	0.08	0.11	0.15	−0.27	−0.16	−0.07	−0.13
	Emotional control	−0.42*	−0.07	−0.03	−0.08	−0.34*	−0.29	−0.18	−0.27
	BRI	−0.61**	0.03	0.01	0.03	−0.41*	−0.42*	−0.18	−0.34*
	Initiate	−0.06	0.02	0.08	0.15	−0.33	−0.08	−0.19	−0.17
	Working memory	−0.04	−0.03	−0.16	0.01	−0.06	−0.02	−0.03	−0.06
	Plan	0.10	0.25	0.11	0.32	−0.11	0.07	0.11	0.06
	O. Materials	−0.25	0.11	0.01	0.15	−0.38*	−0.42*	−0.10	−0.34*
	Monitor	−0.40*	0.03	0.12	0.08	−0.40*	−0.41*	−0.26	−0.39*
	MI	−0.15	0.09	0.02	0.17	−0.30	−0.21	−0.09	−0.21

*AR, Affect recognition; ToM V, Theory of mind-Verbal; ToM C, Theory of mind-Contextual; ToM Tot, Theory of mind-Total; ToMI E, ToMI-Early; ToMI B, ToMI Basic; ToMI A, ToMI Advanced; O. Materials, Organization of Materials; BRI, Behavioral Regulation Index; MI, Metacognition Index. *p < 0.05; **p < 0.01.*

or monitoring strategy deficits might contribute more to the emotion recognition problems observed in the ADHD group than weak central coherence. However, our study cannot provide an answer to this question, which remains open to future research.

On the NEPSY-II ToM verbal subtest, both the HFASD and ADHD groups differed from TD, but not from each other. Both clinical groups were equally affected in their ability to understand first- and second-order false beliefs, double deception, and figurative language, all aspects assessed on the ToM verbal subtest. The HFASD group also presented difficulties on the contextual task, obtaining significantly worse results than the TD group. By contrast, the ADHD group's performance was similar to that of the TD group, suggesting that children with ADHD do not have problems with inferring feelings or mental states of other children based on the visual or physical social context. ADHD children seem to frame emotions based on context clues with greater ease than children with ASD. These results might be related to the "context blindness" hypothesis (Vermeulen, 2014), which states that individuals with ASD experience impairments in the spontaneous use of context in information processing, in this case, of a social and emotional nature.

A different pattern was observed in the applied ToM skills, distinguishing children with HFASD, ADHD, and typically developing peers. Statistically significant differences among the three groups were found on all three ToMI subscales (Early, Basic, and Advanced): Parents perceived that the ASD group had more difficulty than the other two groups in understanding basic emotions, distinguishing between physical and mental, making second-order inferences, or making complex social judgments. In addition, there appeared to be a symptomatic continuity, such that the ADHD group was found in an intermediate position between TD and ASD in the practical application of ToM abilities. The results agree with the trend found in previous work (Demurie et al., 2011; Demopoulos et al., 2013; Baribeau et al., 2015). It is possible that daily life situations estimated by parents require more resources than laboratory executive tasks. In other words, the individuals would be less likely to efficaciously apply their conceptual capacity in real life interactions due to difficulties in parallel processing and in selecting appropriate strategies for the context. However, in any case, real-world, everyday ToM impairments observed by parents or teachers would not reduce the importance of neuropsychological tasks. Instead, they could contribute to a broader understanding of structured performance-based TOM deficits found in the clinical or laboratory setting.

When the achievement levels of children with HFASD and ADHD are compared on the two types of ToM tasks, explicit and applied, the results are not fully consistent with the work of Hutchins et al. (2016). In the only study that applied both types of measures, Hutchins et al. (2016) found "impaired explicit and applied ToM in children with ASD, but intact explicit and impaired applied ToM competence in children with ADHD" (p. 103). Our work coincides with this generalized profile of the ASD group's deficits in mental abilities, regardless of their explicit or applied nature. However, the group with ADHD, in our case, showed deficits on the verbal task of explicit knowledge. One reason the performance of children with ADHD on this task would be equal to that of children with ASD could be a high rate of comorbid learning disabilities. In fact, although we have no objective data, more than 90% of the children with ADHD were receiving educational support for their specific needs at school.

Our results suggest the existence of more severe impairments in social cognition in the HFASD group compared to the ADHD group, although both neurodevelopmental disorders involve difficulties in processing social information. Furthermore, deficits are found on the AR task, which requires perceptual skills, as the children do not have any other information apart from what is contained in the facial expressions, and on the ToM tasks, which require higher thought processes such as logical skills, pragmatic language, and the recognition that one's mind is different from the minds of others. Deficits are also shown in both structured ToM test situations and multidimensional real-life situations, which require more complex and sophisticated skills. Moreover, the worse performance of the group with HFASD on ToM abilities, compared to the group with ADHD, does not seem to be due to language limitations, considering that the two groups were matched on expressive vocabulary. HFASD difficulties may be linked to a more severe meta-representational deficit, an idea that future research will have to verify.

The second objective of this study was to explore the interplay between AR and ToM abilities and "every day" EF in children with HFASD and children with ADHD to find out whether ToM deficits are related to different EF subdomains in these children. A first analysis showed that, in both groups, significant relationships were found on scales measuring the application of ToM skills in the real world. Social interactions in daily life where we must respond spontaneously to a variety of events require more EF resources than laboratory tasks performed in contexts with greater control and stimuli isolation. Hence, it is important to complement the evaluation of ToM performance tasks by measuring how children cope with real-world social interactions that can result in success or failure and have emotional consequences.

As expected, the interrelationships between EF and ToM abilities presented a different profile in ASD and ADHD. In children with ADHD, Inhibit, Shift, Emotional control, and the Behavioral regulation index presented high and significant correlations with AR and Early TOMI. Inhibitory control and the Behavioral regulation index also correlated significantly with the Basic TOMI. Finally, Monitor presented correlations with AR and Early and Basic TOMI scales, underlining the ongoing control that the integration of emotional cues requires in the constantly changing social environment. The findings coincide with previous literature (Yang et al., 2009; Mary et al., 2016) demonstrating a close association in ADHD between inhibition and ToM measures that require ignoring the knowledge we have about a situation and responding from another person's perspective. The overall pattern fits Barkley model (1997), which explains how the involvement of inhibitory control in different EF components (e.g., affect regulation and motivation) affects a wide range of behaviors linked to social information processing.

The correlations in the ASD group show a quantitatively and qualitatively different situation. This group shows a somewhat worse profile that focuses on the EF of Initiate. A poor decisive attitude, or difficulty in thinking of alternatives to solve problems, correlated negatively with performance on the verbal ToM task and, especially, with two scales that assess the application of ToM abilities in the context of everyday life, that is, Basic and Advanced TOMI. Organization of materials was significantly associated with the Basic TOMI, whereas the Metacognitive index was associated with the Advanced TOMI. Previous studies have demonstrated a link between ToM and EF in children and adolescents with ASD, specifically on set-shifting skills (Joseph and Tager–Flusberg, 2004; Pellicano, 2007). Likewise, measures of divided attention and semantic fluency have been significantly associated with social and communication autism symptoms (Kenworthy et al., 2009). In our study, the initiate behavior skills in ASD focus the relationship between EF and ToM on metacognitive subdomains related to the ability to actively solve problems in a variety of contexts. As in previous studies (Leung et al., 2016; Freeman et al., 2017), we found significant associations between metacognitive executive function and social cognition measures in ASD.

Our findings add to existing knowledge about deficits of children with ADHD and HFASD in AR and understanding others' mental states, which reflects a certain symptomatological continuum where HFASD shows greater severity. However, the social impairments of these two neurodevelopmental disorders cannot be explained solely on the basis of ToM failures. According to a recent meta-analysis (Imuta et al., 2016), although performance on ToM tasks is associated with different subtypes of prosocial behavior (helping, cooperating, comforting), the magnitude of the association is relatively weak, and it is still necessary to explore additional paths. Social cognition development is dependent on the maturing of several brain systems, and it is urgent to develop new research to study emotional dysfunctions in ADHD, using not only behavioral measures, but also cerebral activity measures (Albert et al., 2008). Fronto-striatal system dysfunction, an etiology shared by ASD and ADHD (Gargaro et al., 2011), could be an explanatory factor in social cognition and executive problems. However, the brain's organization is shaped by parenting (attachment type, discipline style, parenting stress, coping strategies, sociodemographic family characteristics, parents' mental health), school (learning environments, instructional methodology, teacher cognitive schemes), and the social macrosystem that determines social norms. This exemplifies the complex interactions that occur between brain development and the (social) environment.

The present study has several methodological limitations. Sample size and the fact that most of the children in the ADHD group have a combined presentation may affect the generalizability of the results. Moreover, the low number of females and the recruitment of participants from families with middle-class income levels may not adequately represent the general population. A high percentage of children with ADHD were medicated. Another limitation is related to the ToM measures used. Although, an effort was made to integrate measures of a different nature, it would have been desirable to also incorporate measures based on direct observation protocols. In addition, the present study relied only on teachers' reports of EF, without including supplemental laboratory performance measures. Future work should combine laboratory and informant-based measures for a more in-depth investigation. In particular, the unexpected lack of significant relationships between working memory and ToM in both the HFASD and ADHD groups may be due, at least in part, to the measurement methodology used. It would have been advisable to use other memory indicators such as performance tests. Furthermore, the results of the correlation analyses have an exploratory nature, due to the many variables that intervene in the analyses. However, the application of the Bonferroni correction in this situation would involve a greater possibility of committing a Type II error and rejecting relationships that may exist. Finally, the cross-sectional design does not allow us to conclude whether the interrelationships between mental abilities and EF follow a different course in ASD and ADHD. A longitudinal research design would make it possible to test the directionality of the influence.

Despite these limitations, this study provides evidence about deficits in social cognition processes in children with ASD and ADHD and the differential role of EF. It supports the importance of incorporating EF measures in the evaluation and treatment of children with these two neurodevelopmental disorders. A better understanding of the individual differences in this interdependence will lead to greater possibilities of carrying out successful interventions. Inhibition and behavioral regulation deficits need special treatment that might differ from interventions for metacognitive deficits. Above all, interventions on social problems will be more successful if they are developed from the point of view of performance, the family, and the school, and introducing multimodal components of EF and ToM, given the relationships between these skills.

AUTHOR CONTRIBUTIONS

AM, CB, BR, IB, and CC each made substantial contributions to the conception and design of the work, to the acquisition, analysis, or interpretation of data for the work, drafting the work or revising it critically for important intellectual content, final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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REFERENCES

Adachi, T., Koeda, T., Hirabayashi, S., Maeoka,. Y., Shiota, M., Wright, E. C., et al. (2004). The metaphor and sarcasm scenario test: a new instrument to help differentiate high functioning pervasive developmental disorder from attention deficit/hyperactivity disorder. *Brain Dev.* 26, 301–306. doi: 10.1016/S0387-7604(03)00170-0

Albert, J., López-Martín, S., Fernández-Jaen, A., and Carretié. L. (2008). Alteraciones emocionales en el trastorno por déficit de atención/hiperactividad: datos existentes y cuestiones abiertas. *Rev. Neurol.* 47, 39–45. doi: 10.1016/S0387-7604(03)00170-0

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders*. Washinton, DC: American Psychiatric Association.

Baribeau, D. A., Doyle-Thomas, K. A., Dupuis, A., Iaboni, A., Crosbie, J., McGinn, H., et al. (2015). Examining and comparing social perception abilities across childhood-onset neurodevelopmental disorders. *J. Am. Acad. Child Adolesc. Psychiatry* 54, 479–486. doi: 10.1016/j.jaac.2015.03.016

Barkley, R. A. (1997). Behavioral inhibition, sustained attention and executive functions: constructing a unifying theory of ADHD. *Psychol. Bull.* 121, 65–94. doi: 10.1037/0033-2909.121.1.65

Barkley, R. A. (2011). *Executive Functioning and Self-Regulation. Integration, Extended Phenotype and Clinical Implications*. New York, NY: Guilford Press.

Berggren, S., Engström, A. C., and Bölte, S. (2016). Facial affect recognition in autism, ADHD and typical development. *Cogn. Neuropsychiatry* 21, 213–227. doi: 10.1080/13546805.2016.1171205

Booth, R., and Happé, F. (2010). "Hunting with a knife and ... fork": examining central coherence in autism, attention deficit/hyperactivity disorder, and typical development with a linguistic task. *J. Exp. Child Psychol.* 107, 377–393.doi: 10.1016/j.jecp.2010.06.003

Bühler, E., Bachmann, C., Goyert, H., Heinzel-Gutenbrunner, M., and Kamp-Becker, I. (2011). Differential diagnosis of autism spectrum disorder and attention deficit hyperactivity disorder by means of inhibitory control and 'theory of mind'. *J. Autism Dev. Disord.* 41, 1718–1726. doi: 10.1007/s10803-011-1205-1

Buitelaar, J. K., Van der Wess, M., Swaab-Barneveld, H., and Van der Gaag, R. J. (1999). Theory of mind and emotion-recognition in autism spectrum disorders and in psychiatric control and normal children. *Dev. Psychopathol.* 11, 39–58. doi: 10.1017/S0954579499001947

Carlson, S. M., Moses, L. J., and Claxton, L. J. (2004). Individual differences in executive functioning and theory of mind: an investigation of inhibitory control and planning ability. *J. Exp. Child Psychol.* 87, 299–319. doi: 10.1016/j.jecp.2004.01.002

Conners, C. K. (2001). *Conners' Parent Rating Scale-Revised: Long Version (CPRS-R:L).* North Tonawanda, NY: Multi-Health Systems, Inc.

Craig, F., Margari, F., Letrottaglier, A. R., Palumbi, R., Giambattista, C., and Margari, L. (2016). A review of executive function deficits in autism spectrum disorder and attention-deficit/hyperactivity disorder. *Neuropsychiatr. Dis. Treat.* 12, 1191–1202. doi: 10.2147/NDT.S104620

Demopoulos, C., Hopkins, J., and Davis, A. (2013). A comparison of social cognitive profiles in children with autism spectrum disorders and attention-deficit/ hyperactivity disorder: a matter of quantitative but not qualitative difference? *J. Autism Dev. Disord.* 43, 1157–1170. doi: 10.1007/s10803-012-1657-y

Demurie, E., deCorel, M., and Roeyers, H. (2011). Empathic accuracy in adolescents with autism spectrum disorders and adolescents with attention deficit/ hyperactivity disorder. *Res. Autism Spectr. Disord.* 5, 126–134. doi: 10.1016/j.rasd.2010.03.002

Diamond, A. (2013). Executive functions. *Annu. Rev. Psychol.* 64, 135–168. doi: 10.1146/annurev-psych-113011-143750

Downs, A., and Smith, T. (2004). Emotional understanding, cooperation, and social behavior in high-functioning children with autism. *J. Autism Dev. Disord.* 34, 625–635. doi: 10.1007/s10803-004-5284-0

Dyck, M. J., Ferguson, K., and Shochet, I. M. (2001). Do autism spectrum disorders differ from each other and from non-spectrum disorders on emotion recognition tests? *Eur. Child Adolesc. Psychiatry* 10, 105–116. doi: 10.1007/s007870170033

Freeman, L. M., Locke, J., Rotheram-Fuller, E., and Mandell, D. (2017). Brief report: examining executive and social functioning in elementary-aged children with autism. *J. Autism Dev. Disord.* 47, 1890–1895. doi: 10.1007/s10803-017-3079-3

García Fernández, T., González-Pienda, J. A., Rodríguez Pérez, C., Álvarez García, D., and Álvarez Pérez, L. (2014). Psychometric characteristics of the BRIEF scale for the assessment of executive functions in Spanish clinical population. *Psicothema* 26, 47–52. doi: 10.7334/psicothema2013.149

Gargaro, B. A., Rinehart, N. J., Bradshaw, J. L., Tonge, B. J., and Sheppard, D. M. (2011). Autism and ADHD: how far have we come in the comorbidity debate. *Neurosci. Biobehav. Rev.* 35, 1081–1088. doi: 10.1016/j.neubiorev.2010.11.002

Ghirardi, L., Brikell, I., Kuja-Halkola, R., Freitag, C. M., Franke, B., Asherson, P., et al. (2017). The familial co-aggregation of ASD and ADHD: a register-based cohort study. *Mol. Psychiatry*. doi: 10.1038/mp.2017.17. [Epub ahead of print].

Gioia, G., Isquith, P. K., Retzlaff, P. D., and Kimberly, A. E. (2002). Confirmatory factor analysis of the behavior rating inventory of executive function (BRIEF) in a clinical simple. *Child Neuropsychol.* 8, 249–257. doi: 10.1076/chin.8.4.249.13513

Gioia, G. A., Isquith, P. K., Guy, S. C., and Kenworthy, L. (2000). Behavior rating inventory of executive function. *Child Neuropsychol.* 6, 235–238. doi: 10.1076/chin.6.3.235.3152

Goldstein, S., Naglieri, J. A., Princiotta, D., and Otero, T. M. (2013). "Introduction: a history of executive functioning as a theoretical and clinical construct," in *Handbook of Executive Functioning*, eds S. Goldstein and J. A. Naglieri (New York, NY: Springer), 3–12.

Goodman, R. (1997). The strengths and difficulties questionnaire: a research note. *J. Child Psychol. Psychiatry* 38, 581–586. doi: 10.1111/j.1469-7610.1997.tb01545.x

Happé, F., and Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J. Autism Dev. Disord.* 36, 5–25. doi: 10.1007/s10803-005-0039-0

Happé, F. G.-E. (1995). The role of age and verbal ability in the theory of mind task performance of subjects with autism. *Child Dev.* 66, 843–855. doi: 10.1111/j.1467-8624.1995.tb00909.x

Hughes, C., and Ensor, R. (2007). Executive function and theory of mind. Predictive relations from ages 2 to 4. *Dev. Psychopathol.* 43, 1447–1459. doi: 10.1037/0012-1649.43.6.1447

Hutchins, T. L., Prelock, P. A., and Bonazinga, L. (2012). Psychometric evaluation of the Theory of Mind Inventory (ToMI): a study of typically developing children and children with autism spectrum disorder. *J. Autism Dev. Disord.* 42, 327–341. doi: 10.1007/s10803-011-1244-7

Hutchins, T. L., Prelock, P. A., and Bonazinga-Bouyea, L. (2014). *Technical Manual For the Theory of Mind Inventory and Theory if Mind Task Battery*. Available online at: theoryofmindinventory.com.

Hutchins, T. L., Prelock, P. A., Morris, H., Benner, J., LaVigne, T., and Hoza, B. (2016). Explicit vs applied theory of mind competence: a comparison of typically developing males, males with ASD, and males with ADHD. *Res. Autism Spectr. Disord.* 21, 94–108. doi: 10.1016/j.rasd.2015.10.004

Imuta, K., Henry, J., Slaughter, V., Selcuk, B., and Ruffman, T. (2016). Theory of mind and prosocial behaviour in childhood: a meta-analytic review. *Dev. Psychol.* 52, 1192–1205. doi: 10.1037/dev0000140

Joseph, R. M., and Tager–Flusberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Dev. Psychopathol.* 16, 137–155. doi: 10.1017/S095457940404444X

Kaufman, A. S., and Kaufman, N. I. (2000). *K-BIT, Test Breve de Inteligencia de Kauffman*. Madrid: Pearson.

Kenworthy, L., Black, D. O., Harrison, B., Della Rosa, A., and Wallace, G. L. (2009). Are executive control function related to autism symptoms in high-functioning children. *Child Neuropsychol.* 15, 425–440. doi: 10.1080/09297040802646983

Kimhi, Y., Kugelmas, D., Agam Ben Artzi, G., Ben Moshe, I., and Bauminger-Zviely, N. (2014). Theory of mind and executive function in preschoolers with typical development versus intellectually able preschoolers with autism spectrum disorder. *J. Autism Dev. Disord.* 44, 2341–2354. doi: 10.1007/s10803-014-2104-z

Korkman, M., Kirk, U., and Kemp, S. (2007). *NEPSY-II: Clinical and Interpretive Manual.* San Antonio, TX: T*he Psychological Corporation (Adaptación española,* 2013).

Korkmaz, B. (2011). Theory of mind and neurodevelopmental disorders of childhood. *Pediatr. Res.* 69, 101R–108R. doi: 10.1203/PDR.0b013e318212c177

Lai, C. L. E., Lau, Z., Lui, S. S. Y., Lok, E., Tam, V., Chan, Q., et al. (2017). Meta-analysis of neuropsychological measures of executive functioning in children and adolescents with high-functioning autism spectrum disorder. *Autism Res.* 10, 911–939. doi: 10.1002/aur.1723

Leung, R. C., Vogan, V. M., Powell, T. L., Anagnostou, E., and Taylor, M. J. (2016). The role of executive functions in social impairment in Autism Spectrum Disorder. *Child Neuropsychol.* 22, 336–344. doi: 10.1080/09297049.2015.1005066

Mary, A., Slama, H., Mousty, P., Massat, I., Capiau, T., Drabs, V., et al. (2016). Executive and attentional contributions to Theory of Mind in attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychol.* 22, 345–365. doi: 10.1080/09297049. 2015. 1012491.

Miranda-Casas, A., Baixauli-Fortea, I., Colomer-Diago, C., and Roselló-Miranda, B. (2013). Autismo y Trastorno por déficit de atención con hiperactividad: convergencias y divergencias en funcionamiento ejecutivo y teoría de la mente. *Rev. Neurol.* 57(Suppl. 1), S177–S184.

Papadopoulos, T. C., Panayiotou, G., Spanoudis, G., and Natsopoulos, D. (2005). Evidence of poor planning in children with attention deficits. *J. Abnorm. Child Psychol.* 33, 611–623. doi: 10.1007/s10802-005-6741-8

Pellicano, E. (2007). Links between theory of mind and executive function in young children: clues to developmental primacy. *Dev. Psychol.* 43, 974–990. doi: 10.1037/0012-1649.43.4.974

Pellicano, E. (2010). Individual differences in executive function and central coherence predict developmental changes in theory of mind in autism. *Dev. Psychol.* 46, 530–544. doi: 10.1037/a0018287

Phillips, M. L. (2003). Understanding neurobiology of emotion perception: implications for psychiatry. *Br. J. Psychiatry* 182, 190–192. doi: 10.1192/bjp.182.3.190

Pujals, E., Batlle, S., Camprodon, E., Pujals, S., Estrada, X., Ace-a, M., et al. (2016). Brief report: translation and adaptation of the Theory of Mind Inventory to spanish. *J. Autism Dev. Disord.* 46, 685–690. doi: 10.1007/s10803-015-2576-5

Rommelse, N. N. J., Geurts, H. M., Franke, B., Buitelaar, J. K., and Wallace, G. L. (2011). A review on cognitive and brain endophenotypes that may be common in autism spectrum disorder and attention-deficit/hyperactivity disorder and facilitate the search for pleiotropic genes. *Neurosci. Biobehav. Rev.* 35, 1363–1396. doi: 10.1016/j.neubiorev.2011.02.015

Rutter, M., Bailey, A., and Lord, C. (2003). *SCQ: The Social Communication Questionnaire*. Torrance, CA: Western Psychological Services.

Rutter, M., Le Couteur, A., and Lord, C. (2006). *ADI-R; Entrevista Clínica Para el Diagnóstico del Autismo-Revisada*. Madrid: TEA Ediciones.

Sinzig, J., Morsch, D., and Lehmkuhl, G. (2008). Do hyperactivity, impulsivity and inattention have an impact on the ability of facial affect recognition in children with autism and ADHD? *Eur. Child Adolesc. Psychiatry* 17, 63–72. doi: 10.1007/s00787-007-0637-9

Sodian, B., and Hulsken, C. (2005). "The developmental relation of theory of mind and executive functions: a study of advanced theory of mind abilities in children with attention deficit hyperactivity disorder," in *Young Children's Cognitive Development: Interrelationships among Executive Functioning, Working Memory, Verbal Ability, and Theory of Mind*, eds W. Schneider, R. Schumann-Hengsteler, and B. Sodian (Mahwah, NJ: Lawrence Erlbaum Associate), 175–187.

Vermeulen, P. (2014). Context blindness in Autism Spectrum Disorder: not using the forest to see the trees as trees. *Focus Autism Other Dev. Disab.* 30, 182–192. doi: 10.1177/1088357614528799

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV)*. San Antonio, TX: The Psychological Corporation.

Yang, J., Zhou, S., Yao, S., Su, L., and McWhinnie, C., (2009). The relationship between theory of mind and executive function in a simple of children from Mainland China. *Child Psychiatry Hum. Dev.* 40, 169–182. doi: 10.1007/s10578-008-0119-4

Zelazo, P. D., Jacques, S., Burack, J. A., and Frye, D. (2002). The relation between theory of mind and rule use: evidence from persons with autism-spectrum disorders. *Infant Child Dev.* 11, 171–195. doi: 10.1002/icd.304

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4.2.4. Estudio 4

Berenguer, C., Roselló, B., Colomer, C., Baixauli, I., & Miranda, A. (2018). Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and executive function, social cognition, and behavioral problems. *Research in Developmental Disabilities* (Manuscript Submitted)

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El cuarto estudio abordó el funcionamiento ejecutivo y las habilidades de teoría de la mente en el grupo comórbido TEA+TDAH. Además, analizó la relación entre los síntomas nucleares del TEA y TDAH y el FE, las habilidades de cognición social y los problemas emocionales y conductuales en niños con TEA+TDAH.

Cuando se comparó el funcionamiento ejecutivo en niños con TEA, TDAH, TEA+TDAH y DT, los hallazgos confirmaron en gran medida la hipótesis planteada, al presentar el grupo comórbido TEA+TDAH un déficit más pronunciado que el grupo con TEA y el grupo con DT. Además, el perfil del grupo comórbido y el grupo con TDAH, en el FE aplicado a la vida diaria fuebastante similar.

Los hallazgos se enmarcan en la línea de las investigaciones que apuntan a un mayor deterioro en el FE en los niños con TEA+TDAH y TDAH solo, cuando se comparan a niños con TEA (Adamo et al., 2014; Bühler et al., 2011; Chantiluke et al., 2014; Lundervold et al., 2016; Sinzig et al., 2008b; Tye et al., 2014). Es más, los síntomas de TDAH comórbidos

tuvieron un mayor impacto en los problemas de cambio atencional de niños con TEA, afectando negativamente a la capacidad para flexibilizar el foco de atención según las demandas cambiantes del entorno. Resultados similares obtuvieron Yerys et al. (2009) al comparar el FE en niños con DT, TEA y TEA+TDAH, utilizando la versión para padres del Cuestionario de funcionamiento ejecutivo (BRIEF).

Por otra parte, los análisis comparativos en las medidas de cognición social en los cuatro grupos sugirieron la existencia de un déficit similar en los grupos con TEA (TEA y TEA+TDAH), en la capacidad para aplicar las habilidades de ToM en contextos sociales cotidianos. Se reforzaría por tanto, la idea de que las dificultades en ToM son déficits primarios en niños con TEA (Baron-Cohen et al., 2000). No obstante, en reconocimiento de emociones no se observaron diferencias entre los grupos clínicos analizados. Estos resultados, que son similares a los de Bühler et al. (2011), divergen de otras investigaciones que han encontrado mayor afectación en el grupo comórbido (TEA+TDAH) en el reconocimiento facial de las emociones (Groom et al., 2017; Oerlemans et al., 2014; Sinzig et al., 2008; Tye et al., 2014; Van der Meer et al., 2012). Por último, alineándose con los resultados de estudios previos (Ashwood et al., 2015; Lyall, Schweitzer, Schmidt, Hertz-Picciotto, & Solomon, 2017; Rao & Landa, 2014; Sikora, Vora, Coury, & Rosenberg, 2012; Yerys et al., 2009) el grupo TEA+TDAH mostró más dificultades emocionales y conductuales que los otros dos grupos clínicos puros. Esto significa que la presencia de los síntomas de TDAH agravaría el funcionamiento social, adaptativo y comportamental de los niños con TEA. Resumiendo, los hallazgos sugieren la existencia de un déficit aditivo en el grupo comórbido TEA+TDAH, que comparte dificultades con ambos trastornos en el funcionamiento ejecutivo, cognitivo y social de la vida diaria.

El segundo objetivo de este estudio fue analizar desde una perspectiva dimensional la asociación entre los síntomas de TEA y síntomas de TDAH en el FE, la ToM y los problemas conductuales en los niños con TEA+TDAH. Los análisis de regresión revelaron que los síntomas de inatención tenían un impacto negativo en los procesos ejecutivos metacognitivos y en las habilidades de ToM. Por otra parte, los síntomas de TEA podían explicar mejor los problemas sociales y conductuales más acusados observados en el grupo comórbido. Los hallazgos se suman a los pocos trabajos que han profundizado en la implicación de los síntomas de TDAH en el funcionamiento ejecutivo (Neely et al., 2016; Sinzig et al., 2008b; Takeuchi et al., 2013), donde se ha observado que los síntomas de inatención están relacionados con procesos metacognitivos como la memoria de trabajo.

Por el contrario, aunque también se han encontrado asociaciones significativas entre el control inhibitorio y los síntomas de inatención en niños con TEA (Neely et al., 2016), nuestro estudio no detectó relaciones entre el índice de regulación comportamental (BRI) y los síntomas de TDAH en el grupo comórbido. Una posible explicación podría ser que las tareas neuropsicológicas suelen estar diseñadas con demandas de control inhibitorio diferentes a las que se presentan en los contextos naturales de la vida diaria. Así mismo, los hallazgos respaldan una fuerte relación entre los síntomas de inatención y las dificultades de ToM (Columbi & Ghaziddin, 2017; Sinzig et al., 2008), mientras que la severidad de los síntomas de autismo explicaría en gran medida los problemas adaptativos y sociales que sufren los niños con TEA y síntomas comórbidos de TDAH (Ashwood et al., 2015).

Resumiendo, este último estudio extiende la literatura anterior al abarcar un amplio rango de dominios ejecutivos, procesos de cognición

social y problemas de comportamiento en niños con TEA+TDAH. Además de implementar una metodología de evaluación más ecológica en todos los procesos analizados.

Title

Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and executive function, social cognition, and behavioral problems

Abstract

Background: The underlying mechanisms of comorbidity between autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) are still unknown. Executive function (EF) deficits and theory of mind (ToM) have been the most investigated cognitive processes.

Aims: This study proposed to analyze executive functions (EF), social cognition and behavioral problems in children with ASD+ADHD, ADHD, ASD and typical development (TD). The relationship between ADHD and ASD symptoms with EF, social cognition and behavioral problems in children with ASD+ADHD was also explored.

Methods and procedures: Participants were 124 children between 7 and 11 years old (22 ASD+ADHD, 35 ADHD, 30 ASD, and 37 TD), matched on age and IQ. Teachers evaluated EF, and parents ToM and behavioral problems.

Outcomes and results: ASD+ADHD and ADHD children showed a similar weak profile on EF, whereas the difficulties in ToM of ASD+ADHD group were similar to ASD group. Inattention symptoms were significantly associated with metacognitive deficits and ToM difficulties in ASD+ADHD, while ASD symptoms were associated with behavioral problems.

Conclusions and implications: These findings show the complex difficulties of children with both ASD and ADHD and support the need to take them into account when designing the treatments.

Key words. ASD+ADHD. Behavioral problems. Comorbidity. Executive functions. Theory of Mind.

What this Paper Adds?

The current paper adds to the scarce literature by providing an in-depth analysis of the specific profile of each diagnostic group, ADHD, ASD and, especially, the comorbid group ASD+ADHD, focusing on estimations of functioning in daily life, in order to design interventions that include strategies that address their specific needs. The findings of the characteristics that define comorbid ASD+ADHD have important effects on the evaluation and design of treatments. The identification and treatment of comorbid ASD and ADHD present a major challenge to special education services.

1. Introduction

1.1. Comorbidity between autism spectrum disorder and attention hyperactivity disorder

Autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) are two of the most common neurodevelopmental disorders. Recently, for the first time, the Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association [APA], 2013) allowed the joint diagnosis of ASD and ADHD (ASD+ADHD), based on the high comorbidity presented by the two disorders and the co-occurrence of symptoms. (Visser, Rommelse, Greven, & Buitelaar, 2016). Between 37-85% of children with ASD are estimated to present comorbid ADHD symptoms (Leitner, 2014), which may be due to common etiological mechanisms. Specifically, the research on psychological processes underlying the ASD+ADHD association has mainly revolved around impairments in executive function (EF) and theory of mind (ToM) (Antshel, Zhang-James, Wagner, Ledesma, & Faraone, 2016; Doyle et al., 2017), which have been shown to have important effects on social adaptation (Ashwood et al., 2015; Lyall, Schweitzer, Schmidt, Hertz-Picciotto, & Solomon, 2017).

1.2. Executive functions in children with ASD and ADHD

Executive functioning is conceptualized as the efficiency with which individuals go about acquiring knowledge, as well as how well problems can be solved in nine areas: attention, emotion regulation, flexibility, inhibitory control, initiation, organization, planning, self-monitoring, and working memory (Goldstein, Naglieri, Princiotta, & Otero, 2014). The ASD+ADHD group generally displays a more severe executive profile with characteristic deficits of both disorders. On sustained attention tasks, children with ASD+ADHD show worse performance, who is similar to the ADHD group in response time variability (Adamo et al., 2014; Lundervold et al., 2016) and attentional orientation impairments (Tye et al., 2014). Although children with ASD +ADHD, ADHD and ASD do not differ on attentional flexibility, the group with ASD and additional ADHD display the greatest number of errors (Sinzig, Bruning, Morsch, & Lehmkuhl, 2008). Moreover, in the ASD+ADHD group, worse performance has been observed on verbal working memory (Andersen, Hovik, Skogli, Egeland, & Øie, 2013; Sinzig, Morsch, Bruning, Schmidt, & Lehmkuhl, 2008; Takeuchi et al., 2013; Yerys et al., 2009) while no specific deficits have been found in spatial working memory (Gomarus, Wijers, Minderaa, & Althaus, 2009; Sinzig et al., 2008; Takeuchi et al., 2013). Inhibitory problems seem to be shared by the group with ASD+ADHD and the group with ADHD (Bühler, Bachmann, Goyert, Heinzel-Gutenbrunner, & Kamp-Becker, 2011; Chantiluke et al., 2014; Sinzig, Morsch, Bruning, Schmidt, & Lehmkuhl, 2008; Tye et al., 2014), but sometimes no inhibitory deficits have been found in the comorbid group (Van der Meer et al., 2012; Yerys et al., 2009). Finally, the few studies that have examined the domains of planning and cognitive

flexibility indicate a greater planning deficit in the ASD+ADHD group (Colombi & Ghaziuddin, 2017; Pitzianti et al., 2016; Unterrainer et al., 2016). By contrast, no flexibility problems have been observed on laboratory tasks in the comorbid group (Sinzig, Morsch, Bruning, Schmidt, & Lehmkuhl, 2008; Van der Meer et al., 2012). Some data even indicate that the presence of ADHD symptoms is associated with better performance on search strategies, which would indicate greater flexibility (Unterrainer et al., 2016). In this context of divergent results, it is necessary to consider the potential influence of different factors, such as the type of ADHD or ASD, the developmental stage, clinical versus educational recruitment of the participants, and, above all, the noteworthy importance of the measurement procedure. Generally, the neuropsychological tasks have been used in studies to assess the level of executive functioning performance. However, difficulties in shifting, for example, are not usually found in the ASD+ADHD group in comparison to the pure ASD group on laboratory tasks, while they have been identified using parent reports (Yerys et al., 2009).

Another question that has aroused interest has to do with the impact of the core ASD and ADHD symptoms on the EF of children who present both disorders. Studies on this topic highlight inattention's relationship with inhibitory control and verbal working memory problems (Neely, Green, Sciberras, Hazell, & Anderson, 2016; Sinzig, Morsch, Bruning, Schmidt, & Lehmkuhl, 2008; Takeuchi et al., 2013), as well as inattention relationship with stereotyped behavior and flexibility problems (Sinzig et al., 2008). Moreover, more severe ASD symptoms have been associated with poorer reasoning, whereas hyperactivity symptoms have not been related to any EF domain (Neely et al., 2016).

1.3. Social cognition in children with ASD and ADHD

The adaptive and social functioning of people with ASD are also affected by the inattention and hyperactivity/impulsivity symptomatology (Ashwood et al., 2015; Jang et al., 2013; Lyall et al., 2017; Rao & Landa, 2014; Sikora, Vora, Coury, & Rosenberg 2012; Tureck, Matson, May, & Turygin, 2013; Yerys et al., 2009). ADHD symptoms contribute to increasing social cognition difficulties in children with ASD, leading to less development of empathy, measured by "Reading the Mind in the Eyes" (Columbi & Ghaziddin, 2017). Electrophysiological studies have also shown atypical processing of the face and gaze in children with ADHD+ASD and ASD, compared to children with ADHD and typical development-TD (Groom et al., 2017; Tye et al., 2014). Increased sustained attention and inhibitory control problems probably worsen the capacity of children with ASD+ADHD to recognize facial emotions (Sinzig, Morsch, & Lehmkuhl, 2008; Van der Meer et al., 2012). Even more, after controlling reaction time speed, inattention, and inhibition, a greater impairment in affective prosody persists in the ASD+ADHD group (Oerlemans et al., 2014).

1.4. Study purpose

Summarizing, the ASD+ADHD group shares emotional and behavioral problems with the ADHD group and also participates in the adaptive impairment of the ASD group (Craig et al., 2015). The most worrisome data are related to the long-term development since children with ASD without associated symptoms of ADHD experience a reduction in behavior problems over time, whereas the behavioral difficulties remain and even present an incremental trajectory in children diagnosed with both ASD and ADHD (Flouri, Midouhas, Charman, & Sarmadi, 2015). It is considered a priority to perform an in-depth analysis of the specific profile of each diagnostic group, ADHD, ASD and, especially, the comorbid group, focusing on estimations of functioning in daily life, in order to design interventions that include strategies that address their specific needs. To this end, the first objective of the present study is to perform a comparison of children with ASD+ADHD, ADHD, ASD and TD on executive processes, social cognition skills, and behavioral functioning. Based on the results from the majority of the previous studies, we hypothesize that the clinical groups will present more impairments compared to the TD group; in particular, the group with ASD+ADHD will show an additive deficit of difficulties in inhibition, working memory, planning (Adamo et al., 2014; Bühler et al., 2011; Columbi & Ghaziddin, 2017; Gomarus et al., 2009; Lundervold et al., 2016; Sinzig et al., 2008; Takeuchi et al., 2013; Tye et al., 2014; Unterrainer et al., 2016; Van der Meer et al., 2012), and social cognition (Bühler et al., 2011; Columbi & Ghaziddin, 2017; Oerlemans et al., 2014; Van der Meer et al., 2012). The second objective is to explore the impact of the core ADHD and ASD symptoms on the EF, social cognition skills, and behavioral problems of children with ASD+ADHD. We expect that the ADHD symptoms will predict impairments in executive functioning, social cognition skills, and behavioral functioning (Jang et al., 2013; Lyall et al., 2017; Neely et al., 2016; Sinzig et al., 2008; Takeuchi et al., 2013; Tureck et al., 2013).

Unlike previous studies (Bühler et al., 2011; Columbi & Ghaziddin, 2017; Yerys et al., 2009), all the possible groups are represented, ADHD, ASD, ASD+ADHD and TD, composed of children with an IQ within the normal range. In addition, given the differences between the demands of a structured evaluation setting and those of the real world, the present study addresses a set of executive, behavioral, and social cognition abilities in daily life, rated by informants who know the subject well, that is, parents and teachers. A final contribution of the present study is the overall, comprehensive nature of the analysis of ASD and ADHD comorbidity, including executive processes, social cognition, and behavior.

2. Method

2.1. Participants

Participants in this study were 124 children with their families. The children were between 7 and 11 years old and distributed in four groups: 37 children with TD, 35 children with ADHD, and 52 children with ASD, 22 of whom also presented comorbid clinical symptoms with ADHD (ASD+ADHD). The participants had an intellectual quotient (IQ) within the limits of normality (>80), measured with the K-BIT (Kaufman & Kaufman, 2000), and they were matched on age and IQ. Moreover, 83.1% of the participants were boys, and 16.9% were girls. Language was assessed with the vocabulary subtest of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV) (Wechsler, 2003) because it represents a good measure of the level of general language (Snow, Cancino, Gonzalez, & Shriberg, 1989) (see table 1).

Table 1

Sample characteristics across the four groups (N=124).

	TD (n=37)	ASD (n=30)	ADHD (n=35)	ASD+ (n=22)			
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	$F_{3,120}$	χ^2	*p*
Age (years)	8.54 (1.2)	8.39 (1.3)	9.14 (1.4)	8.86 (1.3)	2.00	-	.118
IQ	102.11(8.9)	100.37 (12.4)	99.03 (9.8)	102.86(13.0)	.75	-	.521
Vocabulary	12.91 (2.7)	11.56 (3.3)	10.14 (2.2)	11.45 (3.4)	5.43	-	.002*
Parental education	3.5 (.96)	3.4 (1.0)	1.8 (1.4)	3.1 (1.2)	14.65	-	.000*
ASD Symptoms	-	15.70 (3.4)	-	16.36 (2.7)			
Inattention	6.83 (5.0)	22.96 (6.5)	41.31 (6.8)	37.59 (6.2)	218.0	-	.000*
H/I	5.83 (4.6)	15.82 (9.5)	31.54 (10.1)	25.59 (8.3)	63.1	-	.000*
Sex (% males)	62.1%	90.0%	91.4%	95.4%	-	16.65	.001*
Medication (% yes)	0.0%	26.6%	71.4%	40.9%	-	42.17	.000*

ASD+: ASD+ADHD; Inattention: Inattention DSM 5; H/I: Hyperactivity/Impulsivity DSM 5; ASD Sympt: Autism Symptoms DSM 5; Parental education was measured as highest level of mother or father (0=elementary school, 1 = Compulsory secondary school, 2 = Medium level vocational training, 3 = Upper secondary education (Bachiller) or Superior level vocational training, 4= University degree.
* $p < .05$

The participants in the clinical groups had been diagnosed in the Psychiatry and Neuropediatric departments of hospitals and medical centers in the Valencian Community, and they were enrolled in public schools. In order to confirm the ADHD diagnosis, the parents and teachers completed the 18 criteria for ADHD from the DSM-5 (APA, 2013). Considering the ratings of the parents and the teachers, 77.1% of the participants in the ADHD group showed a combined presentation, and 22.9% had a predominance of inattention. The Kappa-Cohen test value was $\kappa = 0.97$. In addition, 40% of the children with ADHD presented behavior problems, and 71.4% were taking psycho-medications, mainly psycho-

stimulants. To confirm the ASD diagnosis, recommended cut-off points for the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) and the revised autism diagnostic interview (ADI-R; Rutter, Le Couteur, & Lord, 2003) were used, and these instruments were administered by a psychologist from the research team who was accredited in their application. Likewise, to confirm the diagnosis of the 22 children with ASD and clinical symptoms of ADHD, they had to meet the diagnostic criteria for ASD and ADHD. At the time of the assessment, 32.6% of the children with ASD, with and without comorbid ADHD, were taking psycho-medications (mostly Risperidone and in some cases Methylphenidate) to control behavior problems and irritability.

The children with TD were selected in the schools where the clinical sample was obtained. They did not present a history of psychopathologies, and none of them met 6 or more criteria for inattention and hyperactivity/impulsivity from the DSM-5 or the DSM-5 criteria for ASD on the screening carried out before beginning the evaluation.

The exclusion criteria for the children who participated in this study were assessed through an extensive anamnesis carried out previously with the families. They included neurological or genetic diseases, brain lesions, visual, auditory, or motor impairments, and an intelligence quotient below 80.

2.2. Measures

2.2.1. Executive functioning

Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). The questionnaire rates the child's executive functions through the teacher's observations of his/her behavior in the school context. It consists of 86 items scored on a Likert-type scale with three response options (never, sometimes, often). The items are grouped in 8 scales that make up three indices. The behavioral regulation index (BRI) determines the child's capacity to change his/her affective state and modulate his/her emotions and behavior using appropriate self-control. It contains the subscales of inhibition, shift, and emotional control. The metacognitive index (MI) reflects the child's cognitive capacity to manage tasks and supervise his/her own performance. It includes the subscales of initiation, working memory, planning/organization, organization of materials, and monitoring. Finally, the general executive composite (GEC) is the sum of the two previous indices, the BRI and MI. Direct scores can be transformed into T scores, with scores equal to or above 65 indicating greater executive problems. In this study, the T scores for the two general BRI and MI indices and their subscales were used. The test-retest reliability of the Spanish adaptation of the teacher version of the BRIEF ranges between .86 and .92 (Maldonado, 2016). These values are similar to those obtained for the original version of the questionnaire (Gioia et al., 2000).

2.2.2. Social Cognition

Emotion recognition (Developmental Neuropsychological Assessment Battery) (NEPSY II; Korkman, Kirk, & Kemp, 2007). The NEPSY-II battery contains 32 subtests divided into six domains of cognitive functioning. The internal reliability coefficients are high (r ≥ .80) (Brooks, Sterman, & Strauss, 2010). For this study, the emotion recognition subtest was selected. It is composed of four different areas, and its objective is to rate the ability to recognize the six basic emotions (happy, sadness, fear, anger, neutral, and disgust) based on photographs of children's faces. The direct scores are converted into scalar scores (mean = 10, sd=3).

Theory of Mind Inventory (ToMI; Hutchins, Prelock, & Bonazinga, 2014; Spanish adaptation by Pujals et al., 2016). ToMI inventory was completed by the parents. It is composed of 42 items. The ToMI assesses early skills, such as social references and understanding basic emotions, meta-representations, and second-order inferences, on 3 subscales (early, basic, and advanced), and it offers a general average score that was used in this study. Each item is rated from 0 to 20, from "Definitely not" to "Definitely" with a mid-point of "Undecided". Higher scores show the perception of good ToM development. The ToMI has been widely validated and has good test-retest reliability, internal consistency, and criterion validity in samples with typical development and samples with ASD. It has shown excellent sensitivity (.9) and specificity (.9) when used to examine children with ASD (Hutchins, Prelock, & Bonazinga, 2012). In the Spanish population, it has also shown high internal consistency using Cronbach's alpha (.96) (Pujals et al., 2016).

2.2.3. Emotional and behavioral functioning

Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). This questionnaire has 25 items and is designed for children from 4 to 16 years old. The items are divided into 5 subscales: Emotional symptoms, Behavioral problems, Hyperactivity, Peer relationship problems, and Prosocial behaviors. In addition, it has a total difficulty score obtained by adding together all the subscales except prosocial behavior. The items are scored on a Likert-type scale from 1 (not true) to 3 (completely true). On all the scales, a higher score implies greater difficulty, except the prosocial behavior scale, where a higher score is more positive than a lower one. In this study, the SDQ was filled out by the parents, and the total score on the difficulties scale was used (SDQ Total). In addition, the behavior problems subscale was used to evaluate behavioral difficulties. The SDQ has good statistical and psychometric properties (.73) measured with Cronbach's alpha (Goodman, 2001), and it has shown good reliability in the Spanish population (.76) (Rodríguez et al., 2012).

2.3. Procedures

This study had the approval of the Ethics Committee of the University of Valencia (Helsinki Declaration in the Convention of the European Council, 1964). It also obtained the authorization of the Board of Education of the Valencian Government to approach the schools and the oral and written consent of all the parents of the children included in the study, after informing them about the study objectives. The parents and children were evaluated during the school day. The tests were administered by experienced professionals who were familiar with the application procedure for the different assessment instruments. In addition, information from teachers was collected in each of the participating schools.

2.3.1. Data analysis

The statistical analyses were performed with the Statistical Package for the Social Science (SPSS) software, version 22.00 (SPSS Inc., Chicago, IL USA). Before use of parametric test, histograms and Kolmogorof-Smirnov tests were performed to demonstrate normality of variables distribution. Differences between the groups with ASD, ADHD, ASD+ADHD, and TD on the scales of executive functioning, social cognition, and SDQ were analyzed. To do so, three multivariate analyses of covariance (MANCOVAs) were conducted, using sex, vocabulary, and the educational level of the parents as covariates. The differences on the tests were verified through covariate analyses of variance (ANCOVAs). For the additional ANCOVAs, the level of significance was established at $p < .005$ in the comparisons of the different executive functioning domains, after applying the Bonferroni correction, and the value of η^2_p was calculated to test the strength of the association. In a similar way, in the comparison of the social cognition variables (ER, ToMI) and the SDQ, a level of significance of $p<.01$ was established, after applying the Bonferroni correction.

From a dimensional perspective, four multiple linear regression analyses were performed in the comorbid ASD+ADHD group to evaluate the effect of the ASD and inattention and hyperactivity/impulsivity symptoms (independent variables) on the two EF scales (MI and BRI), the total ToMI score, and the total score on the SDQ (dependent variables).

3. Results

3.1. Comparison of children with ASD+ADHD, ADHD, ASD and TD on executive functioning measures

The MANCOVA carried out to evaluate the main effect of group on the executive functioning indicators was statistically significant [Wilk's Lambda (Λ) = .26, $F_{(30,317)} = 6.20$, $p < .001$, $\eta^2p = .36$]. The

confirmation ANCOVAs showed significant differences on Inhibition, $F_{3,117} = 20.13$, $p < .001$, $\eta^2_p = .34$; shift, $F_{3,117} = 22.18$, $p < .001$, $\eta^2_p = .36$; Emotional control, $F_{3,117} = 11.81$, $p < .001$, $\eta^2_p = .23$, and the BRI, $F_{3,117} = 19.84$, $p < .001$, $\eta^2_p = .33$. The confirmation ANCOVAs also yielded statistically significant differences between the groups on the metacognitive processes: initiative, $F_{3,117} = 23.54$, $p < .001$, $\eta^2_p = .37$; working memory, $F_{3,117} = 38.50$, $p < .001$, $\eta^2_p = .49$; planning, $F_{3,117} = 50.28$, $p < .001$, $\eta^2_p = .56$; organization of material, $F_{3,117} = 27.91$, $p < .001$, $\eta^2_p = .41$; monitoring, $F_{3,117} = 33.73$, $p < .001$, $\eta^2_p = .46$ and the total score on the MI, $F_{3,117} = 53.51$, $p < .001$, $\eta^2_p = .57$. The post hoc analyses revealed significant differences between the TD group and the clinical groups on all the BRIEF variables analyzed in this study, except inhibition and organization of materials, where the TD group and the ASD group showed a significant lower score (that is, less deficits) than the two groups with ADHD symptoms. Likewise, the ASD group showed a significantly lower score than the two groups with ADHD symptoms (ADHD and ASD+ADHD) on the executive domains of working memory, planning, monitoring, and the two general indexes from the BRI and MI (see table 2). The ASD+ADHD group was significantly different from the other two clinical groups showed a significantly higher score than the other two clinical groups on the shift domain. Finally, in the domains of emotional control and initiative, significant differences were only found between the clinical ASD and ADHD groups.

Table 2

Differences between groups on executive functions.

	1.TD (n=37)		2.ASD (n=30)		3.ADHD (n=35)		4.ASD+ADHD (n=22)		
EF	M	SD	M	SD	M	SD	M	SD	Post hoc
Inhibit	48.54	7.56	54.27	12.50	69.97	12.03	63.09	11.58	1,2 < 3,4
Shift	51.84	9.33	64.37	12.51	67.43	12.36	75.77	11.59	1< 2,3,4; 2,3<4
Emotional C	50.08	7.01	60.87	14.92	71.89	15.29	67.18	14.80	1<2,3,4; 2<3
BRI	49.65	6.49	60.20	14.11	70.86	12.65	70.14	12.04	1<2,3,4; 2< 3,4
Initiate	50.43	9.60	60.10	8.65	68.51	9.98	66.96	9.04	1<2,3,4; 2<3
WM	47.68	8.39	55.83	8.78	73.09	12.92	69.41	12.25	1<2,3,4; 2< 3,4
Plan	46.89	6.43	56.33	9.09	71.09	10.76	69.05	9.63	1<2,3,4; 2< 3,4
O. Materials	47.65	4.27	53.67	8.70	67.49	13.88	68.05	10.97	1,2<3,4
Monitor	48.14	7.50	58.27	10.88	72.46	10.51	68.14	8.49	1<2,3,4; 2< 3,4
MI	47.78	6.60	57.37	8.20	73.54	11.46	70.05	8.44	1<2,3,4; 2< 3,4

Emotional C: Emotional control; WM: Working memory; O. Material: Organization of Materials; BRI: Behavioral Regulation Index; MI: Metacognition Index

* p <.005 (Bonferroni correction)

3.2. Comparison of children with ASD+ADHD, ADHD, ASD and TD on social cognition measures (emotion recognition and ToMI Inventory)

The MANCOVA performed to evaluate the main effect of group on the social cognition indicators was statistically significant [Wilk's Lambda (Λ) = .27, $F_{(15,312)} = 12.65$, $p < .001$, $\eta^2p = .35$]. The confirmation ANCOVAs showed significant differences on emotion recognition, $F_{3,117} = 8.21$, $p < .001$, $\eta^2_p = .17$; ToMI Early, $F_{3,117} = 22.82$, $p < .001$, $\eta^2_p = .37$; ToMI Basic, $F_{3,117} = 37.46$, $p < .001$, $\eta^2_p = .49$; ToMI Advanced, $F_{3,117} = 83.94$, $p < .001$, $\eta^2_p = .68$, and the total score on the ToMI, $F_{3,117} = 62.20$, $p < .001$, $\eta^2_p = .61$. Post hoc analyses revealed significant differences between the TD group and the clinical groups on all the variables analyzed. On the ER test, no significant differences were found among the clinical groups, unlike on the ToMI, where there were significant differences between the group with ADHD alone and the two groups with ASD symptomatology (ASD and ASD+ADHD) on all the scales and the total score (see table 3).

Table 3

Differences between groups on ER and Theory of Mind.

	1.TD (n=37)		2.ASD (n=30)		3.ADHD (n=35)		4.ASD+ADHD (n=22)		
	M	SD	M	SD	M	SD	M	SD	Post hoc
ER	28.41	2.73	23.43	4.12	24.11	4.38	24.18	4.13	1>2,3,4
ToMI Early	18.98	1.13	14.89	3.13	17.22	1.83	14.01	3.72	1>2,3,4; 3>2,4
ToMI Basic	19.03	1.12	13.33	3.29	16.68	2.14	12.35	3.40	1>2,3,4; 3>2,4
ToMI Adv	17.24	2.36	8.77	3.18	14.13	3.05	7.00	2.47	1>2,3,4; 3>2,4
ToMI Total	18.38	1.42	12.04	2.86	15.87	2.13	10.78	2.82	1>2,3,4; 3>2,4

ER: Emotion recognition; ToMI: Theory of mind inventory total score; ToMI Adv: Theory of mind advanced
* p <.01 (Bonferroni correction)

3.3. Comparison of children with ASD+ADHD, ADHD, ASD and TD on emotional and behavioral problems

The MANCOVA performed to evaluate the main effect of group on the SDQ indicators was statistically significant [Wilk's Lambda (Λ) = .22, $F_{(12,301)} = 18.99$, $p < .001$, $\eta^2p = .39$]. The confirmation ANCOVAs showed significant differences on the scales of emotional symptoms, $F_{3,117} = 12.33$, $p < .001$, $\eta^2_p = .24$; behavioral problems, $F_{3,117} = 6.61$, $p < .001$, $\eta^2_p = .14$; hyperactivity, $F_{3,117} = 37.92$, $p < .001$, $\eta^2_p = .49$; peer problems, $F_{3,117} = 59.96$, $p < .001$, $\eta^2_p = .60$, and the total score on the SDQ, $F_{3,117} = 42.14$, $p < .001$, $\eta^2_p = .52$. Post hoc analyses revealed significant differences between the TD group and the clinical groups on all the SDQ scales, except the behavioral problems subscale, where the ASD group and the TD group did not present significant differences. Specifically, on hyperactivity the two groups with ADHD were more affected than the ASD group. For peer problems, the two groups with ASD presented higher scores than the group of children with ADHD. The results for the total score on the SDQ revealed significant differences between the group with ASD alone and the ASD+ADHD group (table 4).

Table 4

Differences between groups on Strengths and Difficulties Questionnaire.

	1.TD (n=37)		2.ASD (n=30)		3.ADHD (n=35)		4.ASD+ADHD (n=22)		
	M	SD	M	SD	M	SD	M	SD	Post hoc
Emotional	1.64	1.25	4.23	1.90	4.57	2.45	5.04	2.55	1<2,3,4
Behavioral	1.29	1.35	2.43	1.73	4.11	2.52	3.77	2.02	1<3,4; 2<3
Hyperactivity	2.08	1.84	5.13	2.66	8.22	1.92	7.86	1.88	1<2,3,4; 2<3,4
Peer problems	.40	.83	5.63	2.25	2.88	1.90	5.95	1.98	1<2,3,4; 3<2,4
SDQ Tot	5.43	3.48	17.43	6.04	19.80	6.87	22.63	5.24	1<2,3,4; 2<4

Emotional: Emotional symptoms scale; Behavioral: Behavioral problems scale; Hyperactivity: Hyperactivity scale; Peer problems: Peer problems scale; SDQ Tot (Strengths and Difficulties Questionnaire total difficulties scale)
* p <.01 (Bonferroni correction)

3.4. Multiple regression analyses measuring the contribution of inattention, H/I, and ASD symptoms to EF, ToM, and total SDQ in the comorbid ASD+ADHD group

Four separate multiple regression analyses were carried out to dimensionally explore whether the inattention, H/I, and ASD symptoms are differentially related to the main indices of executive functioning, the ToMI, and the total difficulties on the SDQ in the comorbid ASD+ADHD group. Only two models were significant (see Table 5).

Table 5

Multiple regression analysis for inattention, hyperactivity/impulsivity, and ASD symptom scales predicting executive functions, theory of mind, and behavioral problems in comorbid ASD+ADHD Group.

	B	*SE*	β	*t*
EF-BRI	F (3,18) = .86; R^2 = .12			
Inattention	.22	.42	.11	.52
H/I	.39	.32	.27	1.21
ASD Symptoms	.67	.98	.15	.68
EF-MI	F (3,18) = 2.91; R^2 = .32			
Inattention	.53	.26	.40	2.33*
H/I	.15	.19	.15	.79
ASD Symptoms	1.05	.60	.33	1.73
ToM	F (3,18) = 3.67*; R^2 = .38			
Inattention	-.23	.08	-.52	-2.76*
H/I	-.01	.06	-.04	-.22
ASD Symptoms	-.30	.19	-.29	-1.55
SDQ-Tot	F (3,18) = 3.11*; R^2 = .34			
Inattention	.15	.16	.18	.93
H/I	.09	.12	.14	.73
ASD Symptoms	1.09	.37	.53	2.73*

Inattention DSM 5; H/I: Hyperactivity/Impulsivity DSM 5; ASD Sympt: Autism spectrum disorder symptoms-DSM 5; BRI: Behavioral regulation index; MI: Metacognition index; ToM: Theory of mind inventory; SDQ: Social difficulties questionnaire total score

*p < .05

The regressions carried out indicated that the inattention symptoms were a significant individual predictor of both the metacognitive index (β = .40, t = 2.3, p = .05) and theory of mind (β = -.52, t = -2.7, p = .013). All of the indicators together explain 33 and 38% of the variance, respectively. The ASD symptoms were a significant individual predictor of the total difficulties on the SDQ (β = .53, t = 2.7, p = .014), with 34% of the explained variance. None of the inattention, H/I, or ASD symptoms were significant predictors of the behavioral regulation index (BRI).

4. Discussion

The first objective of the present study was to compare EF, TOM, and behavioral problems in children with ASD+ADHD, ADHD, ASD, and TD. The proposed hypothesis that the ASD+ADHD group would show additive effects, with impairments characteristic of ASD and ADHD, was generally confirmed.

With regard to the EF, the ASD+ADHD group presented more pronounced difficulties than the ASD group, but a similar profile to the ADHD group, on the domains of inhibitory control, working memory, planning, organization of materials, and monitoring, and on the two EF general indices, BRI and MI. The findings are framed within the line of research that shows greater impairment in the executive functioning of children with ASD+ADHD and ADHD, compared to children with ASD (Adamo et al., 2014; Bühler et al., 2011; Chantiluke et al., 2014; Lundervold et al., 2016; Sinzig et al., 2008; Tye et al., 2014). Moreover, the estimations of change for the comorbid group were significantly lower than those of the other two clinical groups, ADHD and ASD. This result suggested that the ADHD symptoms had a greater impact on the attention shifting problems of children with ASD, negatively affecting their flexibility in focusing their attention according to the changing demands of the environment. Similar results were obtained by Yerys et al. (2009) when comparing the EF in children with TD, ASD, and ASD+ADHD, using the parent version of the BRIEF.

The comparative analyses of the social cognition measures revealed the existence of a similar impairment in the groups with ASD+ADHD and ASD in their capacity to apply ToM (3 skills in social contexts in daily life. Therefore, the estimations of ToM application (early, basic and advanced) in the two groups with ASD were significantly lower than those obtained for the ADHD group, thus reinforcing the idea that ToM difficulties are primary deficits in children with ASD (Baron-Cohen, Tager-Flusberg, & Cohen, 2000). However, no differences in ER were observed among the clinical groups analyzed. These results, similar to those found by Bühler et al. (2011), diverge from other studies that observed greater impairments in facial recognition of emotions in the comorbid group ASD+ADHD (Groom et al., 2017; Oerlemans et al., 2014; Sinzig, Morsch, & Lehmkuhl, 2008; Tye et al., 2014; Van der Meer et al., 2012). Finally, as in previous studies (Ashwood et al., 2015; Jang et al., 2013; Lyall et al., 2017; Rao & Landa, 2014; Sikora et al., 2012; Tureck et al., 2013; Yerys et al., 2009), the ASD+ADHD group showed more behavioral difficulties than the two both clinical groups, which means that the presence of ADHD symptoms worsens the behavioral and social functioning of children with ASD. In summary, the findings suggest the existence of an additive deficit in the comorbid ASD+ADHD group, which shared difficulties with both disorders in executive, cognitive, and behavioral functioning in everyday life.

The second aim of this study was to analyze, from a dimensional perspective, the association between ASD symptoms and ADHD symptoms in EF, ToM, and behavioral and social problems of children with ASD+ADHD. The regression analyses revealed that inattention symptoms had a negative impact on EF metacognitive processes and ToM skills, while the ASD symptoms could better explain the behavioral problems observed in the comorbid group. The findings are added to the few studies that examined the involvement of ADHD symptoms in executive functioning in children with ASD (Neely et al., 2016; Sinzig et al., 2008; Takeuchi et al., 2013), finding that inattention symptoms are related to metacognitive processes such as working memory. By contrast, although significant associations have also been found between a key domain of BRI as inhibitory control and inattention symptoms in children with ASD (Neely et al., 2016), our study did not detect relationships between the behavioral regulation index (BRI) and the ADHD symptoms in the comorbid group. However, it should be noted that the hyperactive and impulsive symptoms had the highest value in the regression equation to predict the behavioral regulation index. Likewise, the results support a strong relationship between inattention symptoms and ToM difficulties (Columbi & Ghaziddin, 2017; Sinzig, Morsch, & Lehmkuhl, 2008), whereas the severity of the autism symptoms would largely explain the behavioral and adaptive problems of children with ASD and comorbid ADHD symptoms, as indicated by a previous work where ASD symptoms had less influence in the adaptive functioning in the ASD+ADHD group (Ashwood et al., 2015).

4.1. Limitations and future research

The present study extends the previous literature by studying a wide range of executive functioning, social cognition, and behavioral problems in children with ASD+ADHD and by using a more ecological evaluation methodology. Even so, the data need to be considered in light of several limitations. One of them is the small number of participants, especially in the comorbid ASD+ADHD group, which could affect the generalization of the results. In addition, it would be necessary to incorporate longitudinal study designs into the research on the co-occurrence of ASD+ADHD. The evolution of the adaptive and social functioning of children with ASD seems to be determined, in part, by the influence of the comorbid ADHD symptoms, which could worsen the behavior problems (Flouri et al., 2015), and so it would be advisable to examine the directionality of this co-occurrence in the developmental cycle. The research is currently focused on childhood, in spite of evidence that changes occur in the cognitive and social processes throughout development (Hartman, Geurts, Franke, Buitelaar, & Rommelse, 2016). It would be equally important to examine the influence of the different presentations of comorbid ADHD in ASD, especially in terms of the therapeutic approach. Our study suggests that inattention problems would have the most impact on the metacognitive processes and ToM difficulties.

Despite the limitations, the findings of the characteristics that define comorbid ASD+ADHD have important effects on the evaluation and design of treatments. It is a proven fact that children diagnosed with both ASD and ADHD have greater treatment needs, both in school and outside of school services, than children with only one diagnosis (Zablotsky, Bramlett & Blumbeg, 2017). The identification and treatment of comorbid ASD and ADHD present a major challenge to special education services. However, unfortunately the topic has not received enough attention until now, and so a large percentage of children with ASD+ADHD have not been diagnosed or treated (Joshi et al., 2017), in spite of the negative repercussions on the adaptive and social functioning (Rao & Landa, 2014) and academic capabilities (Lyall et al., 2017). Some evidence has been found for the usefulness of atomoxetine and methylphenidate for coping with ADHD symptoms in individuals with ASD, but the effect sizes are small and side effects are common. In addition, the limited efficacy of psychosocial interventions for children with ASD+ADHD suggests that ADHD needs to be considered when developing treatment plans. Due to the poor impulse control of these children, intervention at the point of performance seems to be more effective than programs implemented in a clinical setting (Antshel et al., 2016).

4.2. Conclusions

Undoubtedly, research on the effectiveness of interventions for comorbid ASD and ADHD will advance in the coming decade. An excellent review highlights the relevance of the emerging neuroscience of joint attention in the neurodevelopmental study of ASD, offering support for target activities to build executive functioning and attentional skills from early ages, through family collaboration (Mundy, 2017). In addition, cognitive-behavioral strategies implemented in the school, when focused on flexibility and planning, can improve organization skills (Kenworthy et al., 2014). We hope that more effective treatments will probably take place either in schools directly or by including a significant school-based component, responding to the behavioral and academic needs of students with ASD +ADHD.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

Adamo, N., Huo, L., Adelsberg, S., Petkova, E., Castellanos, F. X., & Di Martino, A. (2014). Response time intra-subject variability: commonalities between children with autism spectrum disorders and children with ADHD. *European Child & Adolescent Psychiatry*, *23*, 69-79.

American Psychiatric Association [APA] (2013). *Diagnostic and statistical manual of mental disorders* (5th edn.). Washington, DC: American Psychiatric Association.

Andersen, P. N., Hovik, K. T., Skogli, E. W., Egeland, J., & Øie, M. (2013). Symptoms of ADHD in children with high-functioning autism are related to impaired verbal working memory and verbal delayed recall. *PloS One*, *8*, e64842.

Antshel, K. M., Zhang-James, Y., Wagner, K. E., Ledesma, A., & Faraone, S. V. (2016). An update on the comorbidity of ADHD and ASD: A focus on clinical management. *Expert Review of Neurotherapeutics*, *16*, 279-293.

Ashwood, K. L., Tye, C., Azadi, B., Cartwright, S., Asherson, P., & Bolton, P. (2015). Brief report: Adaptive functioning in children with ASD, ADHD and ASD+ ADHD. *Journal of Autism and Developmental Disorders*, *45*, 2235-2242.

Baron-Cohen, S., Tager-Flusberg, H. & Cohen, D.J. (2000). *Understanding Other Minds*. Oxford: Oxford University Press.

Brooks, B., Sterman, E. & Strauss, E. (2010). Test Review: NEPSY-II: A developmental Neuropsychological assessment, Second Ed. *Child Neuropsychology, 16*, 80-101.

Bühler, E., Bachmann, C., Goyert, H., Heinzel-Gutenbrunner, M., & Kamp-Becker, I. (2011). Differential diagnosis of autism spectrum disorder and attention deficit hyperactivity disorder by means of inhibitory control and 'theory of mind'. *Journal of Autism and Developmental Disorders*, *41,* 1718-1726.

Colombi, C., & Ghaziuddin, M. (2017). Neuropsychological Characteristics of Children with Mixed Autism and ADHD. *Autism Research and Treatment*, *2017*,1-5.

Craig, F., Lamanna, A. L., Margari, F., Matera, E., Simone, M., & Margari, L. (2015). Overlap between autism spectrum disorders and attention deficit hyperactivity disorder: searching for distinctive/common clinical features. *Autism Research*, *8*, 328-337.

Doyle, A. E., Vuijk, P. J., Doty, N. D., McGrath, L. M., Willoughby, B. L., O'Donnell, E. H., ... & Blais, J. E. (2017). Cross-Disorder Cognitive Impairments in Youth Referred for Neuropsychiatric Evaluation. *Journal of the International Neuropsychological Society*, 1-13.

Chantiluke, K., Christakou, A., Murphy, C. M., Giampietro, V., Daly, E. M., Ecker, C., ... & MRC AIMS Consortium. (2014). Disorder-specific functional abnormalities during temporal discounting in youth with Attention Deficit Hyperactivity Disorder (ADHD), Autism and comorbid ADHD and Autism. *Psychiatry Research: Neuroimaging*, *223*, 113-120.

Flouri, E., Midouhas, E., Charman, T., & Sarmadi, Z. (2015). Poverty and the growth of emotional and conduct problems in children with autism with and without comorbid ADHD. *Journal of Autism and Developmental Disorders*, *45*, 2928-2938.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test review behavior rating inventory of executive function. *Child Neuropsychology, 6*, 235-238.

Goldstein S., Naglieri J. A., Princiotta D., Otero T. M. (2014). Introduction: a history of executive functioning as a theoretical and clinical construct. In S. Goldstein, and J.A Naglieri, (Eds.) *Handbook of Executive Functioning*. (p 3-12) New York, NY: Springer.

Gomarus, H. K., Wijers, A. A., Minderaa, R. B., & Althaus, M. (2009). ERP correlates of selective attention and working memory capacities in children with ADHD and/or PDD-NOS. *Clinical Neurophysiology*, *120*, 60-72.

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry, 38*, 581-586.

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*, 1337-1345.

Groom, M. J., Kochhar, P., Hamilton, A., Liddle, E. B., Simeou, M., & Hollis, C. (2017). Atypical processing of gaze cues and faces explains comorbidity between autism spectrum disorder (ASD) and attention deficit/hyperactivity disorder (ADHD). *Journal of Autism and Developmental Disorders*, *47*, 1496-1509.

Hartman, C. A., Geurts, H. M., Franke, B., Buitelaar, J. K., & Rommelse, N. N. (2016). Changing ASD-ADHD symptom co-occurrence across the lifespan with adolescence as crucial time window: Illustrating the need to go beyond childhood. *Neuroscience & Biobehavioral Reviews*, *71*, 529-541.

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2012). Psychometric evaluation of the Theory of Mind Inventory (ToMI): A study of typically developing children and children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *42*, 327-341.

Hutchins, T.L., Prelock, P.A. & Bonazinga, L. (2014). *Technical Manual for the Theory of Mind Inventory and Theory of Mind Task Battery*. Unpublished copyrighted manuscript. http://www.theoryofmindinventory.com.

Jang, J., Matson, J. L., Williams, L. W., Tureck, K., Goldin, R. L., & Cervantes, P. E. (2013). Rates of comorbid symptoms in children with ASD, ADHD, and comorbid ASD and ADHD. *Research in Developmental Disabilities*, *34*, 2369-2378.

Joshi, G., Faraone, S. V., Wozniak, J., Tarko, L., Fried, R., Galdo, M., ... & Biederman, J. (2017). Symptom profile of ADHD in youth with high-functioning autism spectrum disorder: a comparative study in psychiatrically referred populations. *Journal of Attention Disorders*, *21*, 846-855.

Kaufman, A.S. & Kaufman, N.I. (2000). *K-BIT, Test breve de inteligencia de Kauffman* [*Kaufman Brief Intelligence Test*]. Madrid: Pearson.

Kenworthy, L., Anthony, L.G., Naiman, D.Q., Cannon, L.,Wills, M.C., Luong-Tran, C., . . . Wallace, G.L. (2014). Randomized controlled effectiveness trial of executive function intervention for children on the autism spectrum. *Journal of Child Psychology and Psychiatry, 55*, 374–383.

Korkman, M., Kirk, U. & Kemp, S. (2007). *NEPSY-II: Clinical and Interpretive Manual*. San Antonio, TX: The Psychological Corporation (Adaptación española, 2013).

Leitner, Y. (2014). The co-occurrence of autism and attention deficit hyperactivity disorder in children – what do we know? *Frontiers in Human Neuroscience, 8*, 268.

Lundervold, A. J., Stickert, M., Hysing, M., Sørensen, L., Gillberg, C., & Posserud, M. B. (2016). Attention deficits in children with combined autism and ADHD: a CPT study. *Journal of Attention Disorders*, *20*, 599-609.

Lyall, K., Schweitzer, J. B., Schmidt, R. J., Hertz-Picciotto, I., & Solomon, M. (2017). Inattention and hyperactivity in association with autism spectrum disorders in the CHARGE study. *Research in Autism Spectrum Disorders*, *35*, 1-12.

Maldonado Belmonte, M.J. (2016). *Adaptation of the behavior rating inventory of executive function (BRIEF) to the Spanish population and its usefulness for the diagnosis of attention deficit hyperactivity disorder inattentive and combined subtypes*. Doctoral dissertation, Universidad Complutense de Madrid, Spain.

Mundy, P. (2017). A Review of Joint Attention and Social-Cognitive Brain Systems in Typical Development and Autism Spectrum Disorder. *European Journal of Neuroscience*. Accepted Author Manuscript. doi:10.1111/ejn.13720.

Neely, R. J., Green, J. L., Sciberras, E., Hazell, P., & Anderson, V. (2016). Relationship Between Executive Functioning and Symptoms of Attention-Deficit/Hyperactivity Disorder and Autism

Spectrum Disorder in 6–8 Year Old Children. *Journal of Autism and Developmental Disorders*, *46*, 3270-3280.

Oerlemans, A. M., Van der Meer, J. M., Van Steijn, D. J., De Ruiter, S. W., De Bruijn, Y. G., De Sonneville, L. M., ... & Rommelse, N. N. (2014). Recognition of facial emotion and affective prosody in children with ASD (+ ADHD) and their unaffected siblings. *European Child & Adolescent Psychiatry*, *23*, 257-271.

Pitzianti, M., D'Agati, E., Pontis, M., Baratta, A., Casarelli, L., Spiridigliozzi, S., ... & Pasini, A. (2016). Comorbidity of ADHD and high-functioning autism: A pilot study on the utility of the overflow movements measure. *Journal of Psychiatric Practice*, *22*, 22-30.

Pujals, E., Batlle, S., Camprodon, E., Pujals, S., Estrada, X., Aceña, M., ... & Pérez-Solá, V. (2016). Brief report: Translation and adaptation of the theory of mind inventory to Spanish. *Journal of Autism and Developmental Disorders*, *46*, 685-690.

Rao, P.A. & Landa, R.J. (2014). Association between severity of behavioral phenotype and comorbid attention deficit hyperactivity disorder symptoms in children with autism spectrum disorders. *Autism, 18*, 272-280.

Rodríguez-Hernández, P. J., Betancort, M., Ramírez-Santana, G. M., García, R., Sanz-Álvarez, E. J., & De las Cuevas-Castresana, C. (2012). Psychometric properties of the parent and ASDcher versions of the strength and difficulties questionnaire (SDQ) in a Spanish sample. *International Journal of Clinical Health and Psychology, 12,* 265-279.

Rutter, M., Bailey, A. & Lord, C. (2003). *Social Communication Questionnaire*. Los Angeles, CA: Western Psychological Services.

Rutter, M., Le Couteur, A. & Lord, C. (2003). *ADI-R. Autism Diagnostic Interview Revised. Manual*. Los Angeles: Western Psychological Services.

Sikora, D. M., Vora, P., Coury, D. L., & Rosenberg, D. (2012). Attention- deficit/hyperactivity disorder symptoms, adaptive functioning, and quality of life in children with autism spectrum disorder. *Pediatrics, 130*, S91–S97.

Sinzig, J., Bruning, N., Morsch, D., & Lehmkuhl, G. (2008). Attention profiles in autistic children with and without comorbid hyperactivity and attention problems. *Acta Neuropsychiatrica*, *20*, 207-215.

Sinzig, J., Morsch, D., Bruning, N., Schmidt, M. H., & Lehmkuhl, G. (2008). Inhibition, flexibility, working memory and planning in autism spectrum disorders with and without comorbid ADHD-symptoms. *Child and Adolescent Psychiatry and Mental Health*, *2*, 4.

Sinzig, J., Morsch, D., & Lehmkuhl, G. (2008). Do hyperactivity, impulsivity and inattention have an impact on the ability of facial affect recognition in children with autism and ADHD? *European Child and Adolescent Psychiatry, 17*, 63-72.

Snow, C., Cancino, H., Gonzalez, P., & Shriberg, E. (1989). Giving formal definitions: an oral language correlate of school literacy. In D. Bloome (Ed.), *Classrooms and Literacy* (pp. 233-249). Norwood, NJ: Ablex.

Takeuchi, A., Ogino, T., Hanafusa, K., Morooka, T., Oka, M., Yorifuji, T., & Ohtsuka, Y. (2013). Inhibitory function and working memory in attention deficit/hyperactivity disorder and pervasive developmental disorders: does a continuous cognitive gradient explain ADHD and PDD traits? *Acta Medica Okayama*, 67, 293-303.

Tureck, K., Matson, J. L., May, A., & Turygin, N. (2013). Externalizing and tantrum behaviours in children with ASD and ADHD compared to children with ADHD. *Developmental Neurorehabilitation*, *16*, 52-57.

Tye, C., Asherson, P., Ashwood, K. L., Azadi, B., Bolton, P., & McLoughlin, G. (2014). Attention and inhibition in children with ASD, ADHD and co-morbid ASD+ ADHD: an event-related potential study. *Psychological Medicine*, *44*, 1101-1116.

Tye, C., Battaglia, M., Bertoletti, E., Ashwood, K. L., Azadi, B., Asherson, P., ... & McLoughlin, G. (2014). Altered neurophysiological responses to emotional faces discriminate children with ASD, ADHD and ASD+ ADHD. *Biological Psychology*, *103*, 125-134.

Unterrainer, J. M., Rauh, R., Rahm, B., Hardt, J., Kaller, C. P., Klein, C., ... & Biscaldi, M. (2016). Development of Planning in Children with High-Functioning Autism Spectrum Disorders and/or Attention Deficit/Hyperactivity Disorder. *Autism Research*, *9*, 739-751.

Van der Meer, J. M., Oerlemans, A. M., van Steijn, D. J., Lappenschaar, M. G., de Sonneville, L. M., Buitelaar, J. K., & Rommelse, N. N. (2012). Are autism spectrum disorder and attention-deficit/hyperactivity disorder different manifestations of one overarching disorder? Cognitive and symptom evidence from a clinical and population-based sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *51*, 1160-1172.

Visser, J. C., Rommelse, N. N., Greven, C. U., & Buitelaar, J. K. (2016). Autism spectrum disorder and attention-deficit/hyperactivity disorder in early childhood: A review of unique and shared characteristics and developmental antecedents. *Neuroscience & Biobehavioral Reviews*, *65*, 229-263.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children: WISC-IV*. San Antonio, TX: The Psychological Corporation.

Yerys, B. E., Wallace, G. L., Sokoloff, J. L., Shook, D. A., James, J. D., & Kenworthy, L. (2009). Attention deficit/hyperactivity disorder symptoms moderate cognition and behavior in children with autism spectrum disorders. *Autism Research*, *2*, 322-333.

Zablotsky, B., Bramlett, M.D., & Blumbeg, S. J. (2017). The co-occurrence of autism spectrum disorders in children with ADHD. *Journal of Attention Disorders*. Jun 1:1087054717713638. doi: 10.1177/1087054717713638. [Epub ahead of print].

5. Conclusiones

5.1. Conclusiones

El TEA y el TDAH son dos trastornos del neurodesarrollo que a pesar de las diferencias en la sintomatología nuclear comparten déficits en el FE y en procesos de COS con importantes repercusiones en el desarrollo de la competencia social. En consecuencia, la investigación sobre los déficits en el funcionamiento social en niños con TEA y niños con TDAH ha aumentado exponencialmente en los últimos años, sugiriendo una superposición clínica entre estos dos trastornos en términos de deficiencias en el FE y en procesos de COS como las habilidades en ToM.

La disfunción ejecutiva se sitúa entre los candidatos propuestos como posibles fenotipos cognitivos del TEA y del TDAH. Este enfoque en la investigación sobre los trastornos del neurodesarrollo, abre posibilidades de análisis interesantes y puede aportar información valiosa para la intervención, ayudando a identificar posibles antecedentes de las manifestaciones conductuales.

La presente investigación ha evidenciado que los problemas ejecutivos son compartidos por los niños con TEA y por los niños con TDAH. Coincidiendo con Geurts et al. (2004) ambos grupos han mostrado diferencias con el grupo con DT en todas las funciones valoradas por el BRIEF: Inhibición, cambio, control emocional, iniciativa, memoria de trabajo, planificación, organización de materiales, monitoreo y en los índices de regulación conductual, metacognitivo y general. De manera que, en línea con otros resultados (Andersen et al., 2013; Craig et al., 2016; Sinzig et al., 2014) se ha identificado un perfil ejecutivo claramente distinto entre el TEA y el TDAH, de manera que los niños con TDAH mostraron déficits más significativos que los niños con TEA en inhibición, control emocional, índice de regulación comportamental y en los procesos metacognitivos. En suma, los hallazgos indican que el deterioro de las funciones cognitivas es más

grave en los niños con un trastorno por déficit de atención con hiperactividad, en relación con los niños con autismo solo.

Además, cuando se ha considerado la condición comórbida, los hallazgos han revelado la existencia de un perfil ejecutivo similar entre el TDAH y el grupo TEA+TDAH. No obstante, comparado con el grupo TEA solo, en el grupo TEA con síntomas comórbidos de inatención e hiperactividad/impulsividad se han observado porcentajes más elevados de afectación. Esta tendencia pone de manifiesto que el grupo comórbido está en especial riesgo de experimentar fallos ejecutivos, lo que sugiere que sufre anomalías más pronunciadas en el funcionamiento cerebral (Chantiluke et al., 2014).

Por otro lado, la cognición social es un constructo complejo y multifacético que engloba habilidades mentalistas y procesamiento de emociones. Las consecuencias del deterioro social en la trayectoria de ambos trastornos es uno de los temas menos explorados y solo un pequeño grupo de investigaciones ha examinado los déficits de cognición social comparando niños con TEA, TDAH y DT. La revisión de la literatura en esta área de estudio ha revelado dos cuestiones importantes. Primero, hay una falta de consistencia en los hallazgos relacionados con el perfil de las habilidades de ToM en individuos con TEA y TDAH. En segundo lugar, otra pregunta todavía no resuelta se relaciona con el posible impacto de los déficits de ToM en el funcionamiento ejecutivo en niños con TEA y TDAH.

En el estudio del compendio que ha abordado estas cuestiones, se ha evidenciado que los niños con TEA presentan mayores déficits en estos procesos cuando se comparan con niños con TDAH y DT. No obstante, los sujetos con TDAH también presentan disfunciones en la cognición social. Por tanto, aunque los sujetos con TEA evidencian más déficits socio-cognitivos, los resultados sugieren que los patrones de esos déficits guardan

algunas semejanzas con el TDAH. En cuanto al análisis del grupo TEA+TDAH, en comparación con los dos trastornos solos, los datos indican cierta similitud entre los dos grupos con TEA. Pero además, la magnitud de la afectación en habilidades de ToM se ha revelado mayor en la condición comórbida, tal y como se esperaba, tras los resultados previos que han analizado el reconocimiento facial de las emociones.

En cuanto a la asociación entre el FE con los procesos de COS los hallazgos muestran claras diferencias entre ambos trastornos puros. En niños con TDAH parece que las dificultades a la hora de inhibir conductas inapropiadas, los problemas para cambiar rápidamente de una tarea a otra, y la pobre regulación emocional inciden negativamente en la capacidad para poder percibir las emociones, creencias o sentimientos propios y de otras personas. Es decir, tal y como sugiere Mary et al. (2016) en un reciente estudio, los déficits en inhibición en niños con TDAH afectarían a la forma en que procesan la información social. Sin embargo, se ha observado que las FE metacognitivas valoradas en los contextos de la vida diaria, se asocian en los niños con TEA con habilidades sociales y adaptativas (Gardiner & Iarocci, 2017). Nuestros hallazgos apuntan en la misma dirección, ya que en los niños con TEA los componentes del procesamiento metacognitivo tienen mayor incidencia en las habilidades de ToM. Así, las dificultades en iniciativa, es decir la pobre capacidad de decisión, los problemas para iniciar una tarea o conversación indicarían una menor habilidad de mentalización en contextos sociales cotidianos.

Otro hallazgo significativo de nuestra investigación por su repercusión práctica, se refiere al impacto de los síntomas en el FE, la ToM y los problemas conductuales de los niños con TEA y TDAH comórbido. En este sentido, la sintomatología de inatención se revela como el predictor más significativo tanto en los procesos metacognitivos, como en las habilidades

de ToM, coincidiendo en parte, con otros estudios donde la inatención presenta una asociación significativa con dominios ejecutivos (Neely et al., 2016; Sinzig et al., 2008; Takeuchi et al., 2013). En cambio, los síntomas nucleares del TEA parecen tener mayor poder predictivo para explicar los problemas conductuales y emocionales de los niños con autismo y con TDAH.

La cuestión de si los síntomas combinados de TEA y TDAH representan un fenotipo distinto o meramente la superposición de fenotipos sigue sin estar clara (Stevens, Peng, & Barnard-Brak, 2016). Esta situación está de acuerdo con lo que acontece en la práctica clínica, donde el diagnóstico diferencial es un asunto polémico (Antshel et al., 2016). Como se mencionó en la introducción, a pesar de que el TEA y el TDAH son dos categorías diagnósticas diferenciadas, algunos estudios sugieren que estos síndromes podrían ser manifestaciones de un trastorno común (Van der Meer et al., 2012). Pero también, otras investigaciones basadas en estudios de gemelos concluyen que ambos trastornos son distintos, aunque comparten "endofenotipos", por los que los niños de una condición muestras características de la otra (Ronald et al., 2014).

En resumen, basándonos en nuestros resultados resulta difícil pronunciarse sobre una posible diferenciación en habilidades de FE y en habilidades de COS entre el TEA, TDAH y TEA+TDAH y que, por consiguiente, es una pregunta abierta a futuras investigaciones. No cabe duda de que una mejor comprensión de las diferencias individuales dará lugar a mayores posibilidades de llevar a cabo intervenciones exitosas. Pero, a pesar de su naturaleza preliminar, los hallazgos obtenidos advierten de la necesidad de una implementación temprana de los programas en la familia y la escuela que enfatizan la enseñanza de estrategias de FE y habilidades de ToM para optimizar el desarrollo social y personal en niños con TEA y TDAH.

5.2. Limitaciones

A pesar de su interés, esta investigación no está exenta de limitaciones. Cabe destacar el reducido número de participantes. Igualmente, los resultados son sólo aplicables a niños con un CI dentro de los límites de la normalidad, limitando la generalización de los hallazgos.

Además, la mayoría de los niños de los grupos clínicos eran varones por lo que los resultados no podrían generalizarse a chicas con TEA o con TDAH, dado el bajo número de participantes. Esta limitación no es única en nuestro estudio, sin embargo, debería ser un tema central para futuras investigaciones con niños con TEA y con TDAH. En el caso concreto de niñas con un diagnóstico clínico de TEA, los hallazgos hasta el momento son escasos, sugiriendo ciertas limitaciones en FE y habilidades generales de la vida diaria (Whyte & Scherf, 2017).

Una cuestión no menos importante es la presentación de los niños diagnosticados de TDAH, que en una amplia mayoría era combinada, es decir con inatención e hiperactividad/impulsividad. Así mismo, un alto porcentaje de niños con TDAH y niños con TEA+TDAH estaban recibiendo medicación.

Otra limitación se refiere a algunas de las medidas de evaluación utilizadas. Por ejemplo, para valorar la socialización de niños con TEA, en el estudio 1 se utilizó la información de los padres mediante la entrevista VABS. Este tipo de entrevista ha sido utilizada en estudios anteriores y posee buenas propiedades psicométricas, pero la naturaleza multidimensional del constructo de socialización debería ser analizada tomando en consideración aspectos específicos del constructo como la relación con los compañeros, la conducta prosocial, el procesamiento de la información social, además de

medidas y procedimientos plurales, como la percepción de los profesores. Del mismo modo, sería necesario incorporar medidas neuropsicológicas de funcionamiento ejecutivo, además de incorporar mayor número de informantes en la evaluación de los procesos ejecutivos y de cognición social.

Por otro lado, se necesitarían diseños de corte longitudinal para determinar la direccionalidad de relación causal entre las variables analizadas en nuestro estudio. La escasez de estudios longitudinales pone de manifiesto la necesidad de profundizar en los componentes del FE y de los procesos de cognición social que afectarían al procesamiento de la información social de niños con TEA y TDAH. Actualmente la investigación está muy focalizada en la infancia, a pesar de la evidencia de los cambios evolutivos que se producen a lo largo del desarrollo en los procesos cognitivos y sociales (Hartman et al., 2016).

No menos importante sería examinar la influencia de las diferentes presentaciones del TDAH, especialmente de cara al abordaje terapéutico.

5.3. Implicaciones prácticas y nuevas vías de estudio

En España durante las últimas décadas se está produciendo un cambio en la tendencia de las políticas educativas con el fin de implementar programas inclusivos que atiendan las necesidades educativas específicas del alumnado. Los niños con TEA y los niños con TDAH se consideran alumnos con necesidades específicas de apoyo educativo y están siendo incluidos en aulas ordinarias, siguiendo la tendencia de otros países europeos y de Estados Unidos. Este hecho está propiciando un cambio en los programas educativos de los colegios para dotar de recursos adecuados al alumnado con trastornos

del neurodesarrollo. El presente estudio representa un intento de colaboración para avanzar en esta dirección.

Aunque todavía son necesarios muchos más estudios en esta área, los programas multicomponente, por ejemplo, tienen en cuenta estos aspectos y consideran los entornos naturales en los que se desenvuelven los niños con TEA y con TDAH. Es más, en el caso de niños con TEA, algunos de ellos han evidenciado resultados prometedores, mostrando mejoras significativas en la responsividad y en la cognición social (Laugeson, Ellingsen, Sanderson, Tucci, & Bates, 2014). Otra cuestión importante que también se ha de afrontar, especialmente en niños con TEA, es el déficit en la motivación social (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012). Quizás la asociación con experiencias emocionales positivas pueda promover la orientación espontánea hacia la interacción social, aumentar las oportunidades de socialización y facilitar el aprendizaje y práctica de habilidades mentalistas y pragmáticas.

Respecto a los contenidos a tratar, las implicaciones clínicas que se derivan del presente estudio apuntan a la necesidad de diseñar programas de intervención que profundicen en la mejora del funcionamiento social en niños con TDAH, TEA y TEA+TDAH. Para ello es necesario considerar de forma conjunta la relevancia de factores implicados en la conducta social, como el FE y los procesos de COS. Los hallazgos obtenidos sugieren planteamientos diferenciados de cara al desarrollo de programas de intervención psicosocial para niños con TEA de alto funcionamiento, niños con TDAH y para la condición comórbida, donde la respuesta al tratamiento farmacológico es menos adecuada que cuando se consideran ambos trastornos independientemente (Dawson & Burner, 2011).

Por tanto, una de las principales implicaciones prácticas de la presente investigación se refiere a la necesidad de abordar de manera diferenciada el diseño y aplicación de tratamientos para niños con TDAH y TEA con y sin comorbilidad con TDAH. Los hallazgos obtenidos en niños con TDAH muestran la mayor implicación de los componentes ejecutivos en el desarrollo de una conducta social adaptativa. En consecuencia, la intervención terapéutica de niños con TDAH debería considerar prioritario la mejora del funcionamiento ejecutivo, ya que las dificultades ejecutivas parecen ser un déficit central en los niños con TDAH. Por su parte, los resultados del estudio de los procesos ejecutivos y cognitivos en niños con TEA sugieren un planteamiento distinto. En este caso, los déficits en ToM parecen ser un déficit primario en niños con autismo. Por lo que las estrategias de intervención deberían basarse en el entrenamiento de las habilidades sociales, en técnicas para potenciar las interacciones sociales, y las habilidades pragmáticas. Todo ello tendría repercusiones positivas en la competencia social de niños con TEA. En cuanto a la condición comórbida, las conclusiones que se derivan del estudio realizado resaltan la implicación de los síntomas de inatención en los procesos ejecutivos de metacognición y en las habilidades de ToM, así como de los síntomas nucleares del TEA en la conducta social y emocional. Además de las técnicas recomendadas para los niños con TEA, la intervención debería incluir el tratamiento de los síntomas de inatención.

Hasta ahora, la literatura muestra que en el TDAH hay apoyo empírico para los programas de entrenamiento conductual a padres así como para las técnicas cognitivo conductuales. Por el contrario, las intervenciones basadas en la mejora de las habilidades sociales han mostrado una eficacia menor (Evans, Owens, Wymbs, & Ray, 2017). Estos resultados están en línea con los de un extenso metaanálisis sobre la evidencia empírica de

tratamientos farmacológicos y no farmacológicos en el TDAH (Catala-Lopez, et al., 2017). La terapia conductual, por parte de los padres y con la participación activa de niños y docentes, es la única intervención no farmacológica que se asociaba con beneficios estadísticamente significativos en ese metaaálisis.

Debido a que la disfunción ejecutiva es una limitación central en el TDAH, varios estudios han explorado los efectos del entrenamiento cognitivo con resultados prometedores (ver metaanálisis de Cortese et al., 2015). Los programas abordan una amplia gama de funciones cognitivas, incluida la atención y las FE para niños y adolescentes, no sólo con TDAH. Un ejemplo es el Attention Improvement Management (AIM) (Sohlberg, Harn, MacPherson, & Wade, 2014) un tratamiento computarizado de 10 semanas que incorpora el establecimiento de metas, el uso de estrategias metacognitivas y ejercicios diseñados para mejorar varios aspectos de la atención y memoria de trabajo.

En cuanto al TEA, las intervenciones conductuales tempranas e intensivas han mostrado mejoras en el lenguaje y en la comunicación social. Igualmente, el entrenamiento en habilidades sociales ha demostrado su eficacia. Las intervenciones basadas en la "educación parental", a diferencia de lo que sucede en el TDAH, suelen poner más énfasis en los tratamientos individualizados que ofrecen a los padres, herramientas para potenciar habilidades adaptativas y sociales de sus hijos (Davis & Kollins, 2012).

En este sentido, hay programas basados en técnicas cognitivo conductuales que han demostrado su eficacia, como la intervención ecológica cognitivo conductual (CB-E) de Bauminger (2007). Este programa basado en el entrenamiento de habilidades sociales para niños con TEA de alto funcionamiento evidenció mejoras en cognición social, cooperación,

autorregulación y asertividad. Los resultados se mantuvieron después del tratamiento. Al igual que el mencionado programa PEERS de Laugeson et al. (2014) implantado en el contexto escolar, que evidenció mejoras en competencia social en adolescentes con TEA.

Del mismo modo, en un estudio de Kenworthy et al. (2014) se normalizaron las puntuaciones en las FE de cambio y planificación medidas a través de las estimaciones de padres y profesores en el BRIEF con un abordaje cognitivo-conductual centrado en el entrenamiento de estas funciones ejecutivas en un grupo de niños con TEA en la escuela y en casa. También se han obtenido resultados muy prometedores en control emocional, memoria de trabajo, planificación y monitoreo con niños con autismo de alto funcionamiento con un programa en la escuela para el desarrollo de la competencia social en adolescentes (Stichter, Herzog, Owens, & Malugen, 2016).

Otras ayudas consisten en el uso de tecnología para adolescentes con TEA en la escuela, y en casa (Odom, Boyd, Hall, & Hume, 2010). Además de la efectividad de los planes individuales de adaptación curricular en el contexto escolar. La individualización de las prácticas de instrucción permite una instrucción académica personalizada que es suficientemente flexible para conseguir los objetivos de aprendizaje en diferentes materias académicas teniendo en cuenta las necesidades de los estudiantes con trastornos del neurodesarrollo como el TEA y el TDAH.

Por último, las características que definen la comorbilidad TEA+TDAH tienen importantes repercusiones para la evaluación y el diseño de tratamientos. Hasta ahora, el abordaje psicosocial de los síntomas comórbidos de inatención e hiperactividad/impulsividad en el TEA no ha recibido suficiente atención, de manera que hay un porcentaje elevado de

niños con TEA+TDAH que no han sido diagnosticados ni tratados (Mansour, Dovi, Lane, Loveland, & Pearson, 2017), a pesar de las repercusiones negativas de la comorbilidad en el funcionamiento adaptativo y social (Rao & Landa, 2014) y en las capacidades académicas (Lyall et al., 2017).

La investigación sobre la eficacia de los tratamientos no farmacológicos en TEA+TDAH de los últimos cinco años es insuficiente, aunque hay excepciones como el trabajo de Schafer et al. (2013) que examinaron el posible beneficio del sistema de modulación de frecuencia (FM) en niños con TEA, TEA+TDAH, TDAH y DT. Las valoraciones de los observadores externos y los propios profesores indicaron que el uso del sistema FM produjo mejoras significativas en el reconocimiento de voz sobre el ruido de fondo en los niños con TEA y TDAH. Asimismo, se registraron aumentos significativos de comportamientos en la tarea y comportamientos de escucha, en los grupos clínicos.

El tipo concreto de comorbilidad puede influir en la eficacia del entrenamiento en habilidades sociales en el TEA, tal y como sugiere la investigación de Antshel et al. (2011) con un grupo de niños con TEA, TEA+TDAH y TEA+ansiedad. El grupo TEA+ TDAH no obtuvo mejoras tras el entrenamiento en habilidades sociales, a causa de los problemas de inatención y pobre control de impulsos, mientras que en los niños con TEA+ansiedad se observaron mejoras en comunicación, comportamientos asertivos, responsabilidad y autocontrol. Por consiguiente, la ausencia de mejoras en el grupo TEA+TDAH sugiere que la sintomatología TDAH debería ser considerada en los programas de tratamiento. Resultados más satisfactorios ha aportado el único trabajo que ha estudiado el impacto del entrenamiento de la función ejecutiva en TEA + TDAH: se encontró una mejoría en la atención, en los síntomas de impulsividad y en el rendimiento académico de niños y adolescentes con TEA y TDAH comórbido, después

de recibir un entrenamiento computerizado con el Cogmed Working Memory Training (CWMT) (Weckstein, Weckstein, Parker, & Westerman, 2017).

Por consiguiente, el diseño de programas para niños con TEA y síntomas de TDAH, debe incluir entre sus objetivos estrategias que fortalezcan las habilidades atencionales, incorporándolas en el tratamiento desde edades tempranas. Una posible vía sería la combinación de estrategias psicosociales eficaces utilizadas en el TEA y en el TDAH (Gargaro et al., 2011).

En resumen, los hallazgos empíricos ayudarán a incorporar las mejores prácticas basadas en la evidencia en el diseño de programas de intervención para niños con TDAH, TEA y TEA+TDAH. Pero además, las instituciones educativas públicas deben de comprometerse a dotar de recursos y de formación adecuada a los profesionales de la salud, a los profesores y a los padres para la implementación adecuada de programas de tratamiento para niños con trastornos del neurodesarrollo. Sin un adecuado entrenamiento a profesores en técnicas básicas involucradas en la terapia cognitiva conductual o en entrenamiento conductual a los padres, no se puede garantizar la eficaz implantación de técnicas de intervención, aunque estén basadas en la evidencia.

Por otro lado, un asunto que la investigación empírica tendrá que abordar en un futuro próximo se refiere a cómo evolucionan los déficits en los diferentes dominios de funcionamiento ejecutivo y habilidades de cognición social, a lo largo de las etapas de desarrollo en niños con TEA, TDAH y TEA+TDAH. Por ejemplo, hay etapas críticas como la adolescencia, donde se abren "grades ventanas" de desarrollo neuronal, en las que se producen cambios que pueden ser irreversibles en términos de funcionamiento ejecutivo y competencia social (Hartman et al., 2016). Por

lo tanto, es necesario conocer las trayectorias de los síntomas de TEA y de TDAH así como de su coocurrencia y cómo afectan a las estrategias ejecutivas y a las habilidades de ToM.

Otro asunto que queda abierto a futuras investigaciones consiste en determinar el papel que desempeñan las habilidades lingüísticas tanto en el TEA como en el TDAH, y especialmente en la presentación comórbida de ambos trastornos. En este sentido, la valoración de la competencia pragmática puede ser muy útil, teniendo en cuenta su importancia en procesos de cognición social, como la ToM, y en el desarrollo adaptativo de las habilidades sociales.

De todo ello se derivarían importantes repercusiones prácticas, además de resultar útil para los profesionales del campo de la educación y de la rehabilitación neuropsicológica.

6. English version

EXECUTIVE FUNCTIONS AND SOCIAL COMPETENCE IN CHILDREN WITH AUTISM SPECTRUM DISORDER AND ATTENTION DEFICIT HYPERACTIVITY DISORDER

ABSTRACT

Recent studies have pointed out the need to understand the underlying mechanisms of autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD), as well as the comorbidity of both. The deficits in executive functions (EF) and in social cognition (SC) have been the most intensively researched processes, with findings that are not unanimous. The main objective of the present investigation is to study the EF and the abilities of SC that contribute to the social, behavioral and adaptive functioning of children with high functioning ASD, ADHD and ASD + ADHD. The participants were 124 children between 7 and 11 years old, divided into four groups: 37 typically developing (TD), 35 ADHD, 30 ASD and 22 ASD + ADHD, matched in age and IQ. Different measures of executive functioning, cognition and social competence were applied. The results showed a profile of similar executive deficits between ADHD and ASD + ADHD. However, in social cognition processes, groups with ASD with and without comorbidity with ADHD presented more difficulties. In addition, the symptoms of inattention aggravated social competence in children with ASD. These findings reinforce the need to take into account the symptoms of ADHD, along with executive functioning training and mentalist skills, in the design of treatments for children with ASD.

INTRODUCTION

Neurodevelopmental disorders are a group of heterogeneous conditions that have their origins during the early stages of development and are characterized by cognitive and functional deficits (American Psychological Association [APA], 2013). This type of disorders causes impairments in the adaptive functioning, not only in the individuals who suffer it but also in the immediate family nucleus, due to the severity and persistence of symptoms along the life cycle. Therefore, its study and understanding are essential for planning strategies that optimize prevention and intervention programs.

Autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) are two of the most common neurodevelopmental disorders. The prevalence of ADHD is around 6.5% (Willcutt, 2012) in population-based studies. ASD has multiplied its prevalence by 4 in the last decade with a rate of 1/68 in the USA (U.S. Department of Health and Human Services, 2014). The greatest increase has occurred in the subgroup of ASD that does not present intellectual disability, that is, the high functioning autism or level 1 severity, with a prevalence of 62% (Baron-Cohen et al., 2009; Christensen, Baio & Braun, 2016). In Spain we do not have a rigorous census, but, according to the Spanish Confederation of Autism, the current percentage is at 1/100.

ASD is characterized by deficits in communication and social interaction and in the existence of restricted and repetitive patterns of behavior, interests, or activities (APA, 2013). On the other hand, ADHD is characterized by symptoms of inattention, hyperactivity and impulsivity. In both disorders there are often difficulties in attention and different degrees of impulsivity and restlessness. Both share an early onset, delays in brain development, both structural and functional, difficulties in executive

functioning, a clear male predominance and genetic and biological risk factors (Rommelse & Hartman, 2016, Visser, Rommelse, Greven, & Buitelaar, 2016). In addition, these two neurodevelopmental disorders have negative consequences in multiple areas of functioning, which cause negative consequences in the long-term adaptation and social competence of the individual. Specifically, children with ASD suffer consequences related to social interaction deficits, such as less social support and more loneliness than their typically developing peers (Bauminger & Kasari, 2000). Similarly, ADHD is associated with a decline in the ability to interact socially, including poor relationships with peers and family. Among the multiple factors determining the rejection of peers is the inability to participate in social exchanges that is observed in behaviors such as sharing, initiating, cooperating and waiting for the turn. In the long term, the rejection of peers is associated with emotional and behavioral problems, criminal behavior and deficits in global functioning (Mrug et al., 2012).

Recently, the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013) allowed for the first time the combined diagnosis of ASD and ADHD (ASD + ADHD), based on the high comorbidity of both disorders.

The review of recent literature shows that the average prevalence of ASD and ADHD comorbidity is between 37-85% (Gjevik, Eldevik, Fjæran-Granum, & Sponheim, 2011; Leitner, 2014; Stratis & Lecavalier, 2013) even in samples with intellectual disability (ID) (Amr et al., 2012). Moreover, a recent study based on an extensive population-based twin cohort between 9 and 12 years old, concluded that 82% of boys and 95% of girls with ASD traits showed deficits in at least one of the core ADHD symptom domains (inattention, hyperactivity, impulsivity). In turn, 42% of boys and 62% of girls with ASD traits showed deficits in at least two core symptom domains

of ADHD (Ronald, Happé, & Plomin, 2008; Ronald, Larsson, Anckarsäter, & Lichtenstein, 2014). However, there are data of 53% (Caamaño et al., 2013), 68% (Mannion, Leader, & Healy, 2013), or lower percentages (Russell, Rodgers, Ukoumunne, & Ford, 2014). The variations may be due to the small number of participants, the recruitment of the sample in specific centers of ASD, or a greater coexistence with other disorders. In general, the research agrees that ADHD is one of the most common comorbid conditions in children with ASD (Simonoff et al., 2008). On the contrary, 15-25% of children with ADHD have clinical symptoms of ASD (Kotte et al., 2013).

The literature shows the existence of a genetic predisposition and similar cognitive profiles in ASD and ADHD. Both share explanatory theories based on deficits in executive functioning (Barkley, 1997; Pennington & Ozonoff, 1996) and experience difficulties in social cognition processes such as theory of mind or emotion recognition (Bora & Pantelis, 2016; Demopoulos, Hopkins, & Davis, 2013; Happé & Ronald, 2008; Happé & Frith, 2014). On the other hand, the combined phenotype ASD + ADHD seems to reflect an "additive" comorbidity, rather than a separate condition with different deficits (Oerlemans et al., 2016; Rommelse, Geurts, Franke, Buitelaar, & Hartman, 2011).

The comorbidity of ADHD symptoms in children with ASD is associated with worse executive functioning (EF) and more difficulties in the social cognition processes (Antshel, Zhang-James, Wagner, Ledesma, & Faraone, 2016; Dajani, Llabre, Nebel, Mostofsky, & Uddin, 2016), with an important impact on social competence (Factor, Ryan, Farley, Ollendick, & Scarpa, 2017; Luteijn et al., 2000). The few studies that have addressed the socio-emotional adaptation in the comorbid condition show that children with ASD + ADHD present more severe deficits of adaptation than children with ADHD, especially in the socialization domain (Ashwood et al., 2015).

Another finding, even more relevant if possible, is the greater similarity of the comorbid group with the ASD group than with the ADHD group in terms of the deficits profile in adaptive behaviors, focused on communication, socialization and daily living skills (Craig et al., 2015). A recent study in the same line has found that children with ASD + ADHD have worse quality of life, regarding both psychosocial and physical health, and greater problems with peers compared to the ADHD group (Thomas, Sciberras, Lycett, Papadopoulos, & Rinehart, 2015).

Given the importance of adaptation and social competence in people's lives, it is important to thoroughly examine the factors that can explain the deficits in social functioning, specifically EF and key processes of social cognition such as ToM and ER. There is no conclusive evidence that the impaired processes and the factors that originate social problems are different in ASD and in ADHD, and even more limited is the knowledge in relation to the ASD + ADHD subgroup.

The main objective of this Doctoral Thesis is to study the EF skills and key social cognition processes, particularly ToM and ER skills, which contribute to the social, behavioral and adaptive functioning of children with high functioning ASD, ADHD and ASD + ADHD. First, studies 1 and 2 explore the profile of EF and ToM skills, both in children with ASD and in children with ADHD. According to this objective, study 1 focuses on the understanding of the effect of this set of cognitive processes on the social competence of children with ASD. Study 2 examines the underlying mechanisms that operate between ADHD symptoms, executive functioning, ToM skills and social competence of children with ADHD. Second, study 3 aims to identify possible similarities and differences in ToM skills in children with ASD and children with ADHD, as well as, the interaction between ToM

skills and executive functioning in children with ASD and children with ADHD.

Finally, taking into account the executive profile and the mentalist abilities of both disorders, Study 4 attempts to explore EF and ToM skills in the comorbid group ASD + ADHD and analyze the relationship between ASD and ADHD symptoms with EF, social cognition and emotional and behavioral problems in children with ASD + ADHD. Despite the importance of taking comorbidity into account, especially in the design of intervention programs, the degree of contribution of ADHD symptoms to executive processes and social cognition in children with ASD is still unknown. So far, at least that we know, this is the first research that studied developmental disorders, ASD, ADHD and comorbid presentation, from this perspective. It is expected that the information obtained will improve the standardized evaluation protocols and the design of interventions more adjusted to the personal needs of children with these disorders.

CONCLUSIONS

ASD and ADHD are two neurodevelopmental disorders that, despite differences in nuclear symptomatology, share deficits in EF and social cognition processes with important impact in the development of social competence. Consequently, research on deficits in social functioning in children with ASD and children with ADHD has increased exponentially in recent years, suggesting a clinical overlap between these two disorders in terms of impairments in EF and social cognition processes as ToM abilities.

Executive dysfunction is among the candidates proposed as possible cognitive phenotypes of ASD and ADHD. This approach on research on neurodevelopmental disorders opens up interesting possibilities for analysis and can provide valuable information for the intervention, helping to identify possible antecedents of behavioral manifestations.

The present investigation showed that children with ASD and children with ADHD share executive problems. Coinciding with Geurts et al. (2004) both groups showed differences with the TD group in all the functions assessed by the BRIEF: Inhibition, shifting, emotional control, initiative, working memory, planning, organization of materials, monitoring and in behavioral regulation, metacognitive and general indices. Thus, in line with other results (Andersen et al., 2013; Craig et al., 2016; Sinzig et al., 2014), a clearly different executive profile has been identified between ASD and ADHD, so that children with ADHD showed more significant deficits than children with ASD in inhibition, emotional control, behavioral regulation index and in metacognitive processes. In summary, the findings indicate that the deterioration of cognitive functions is more severe in children with attention deficit hyperactivity disorder, in relation to children with autism alone.

In addition, when considering the comorbid condition, the findings revealed the existence of a similar executive profile between ADHD and ASD + ADHD groups. However, higher percentages of involvement were observed in the ASD group with comorbid symptoms of inattention and hyperactivity / impulsivity, compared to the ASD alone. This trend shows that the comorbid group is at special risk of experiencing executive impairments, which suggests that it suffers more pronounced deficits in brain functioning (Chantiluke et al., 2014).

On the other hand, social cognition is a complex and multifaceted construct that encompasses mentalist abilities and emotional processing. The consequences of social impairment in the trajectory of both disorders is one of the least explored topics and only a small group of research has examined social cognition deficits comparing children with ASD, ADHD and TD. The review of the literature in this area of study has revealed two important issues. First, there is a lack of consistency in the findings related to the profile of ToM skills in individuals with ASD and ADHD. Second, another unresolved question is related to the possible impact of ToM deficits on executive functioning in children with ASD and ADHD.

The study of these issues showed that children with ASD present greater deficits in these processes when compared with children with ADHD and TD. However, individuals with ADHD also have dysfunctions in social cognition. Therefore, although individuals with ASD show more socio-cognitive deficits, the results suggest that the patterns of these deficits present some similarities with ADHD. Regarding the analysis of the ASD + ADHD group, in comparison with the two disorders alone, the data indicate a certain similarity between the two groups with ASD. In addition, the magnitude of ToM skills deficits has been shown to be greater in the

comorbid condition, as expected, after the previous results that have analyzed the facial emotion recognition.

Regarding the association between EF with social cognition processes, the findings show clear differences between the two pure disorders. In children with ADHD it seems that the difficulties in inhibiting inappropriate behaviors, the problems to change quickly from one task to another, and the poor emotional regulation negatively affect the ability to perceive one's and other people emotions, beliefs or feelings. That is, as suggested by Mary et al. (2016) in a recent study, deficits in inhibition in children with ADHD would affect the way they process social information. However, it has been shown that in children with ASD, metacognitive EFs assessed in the contexts of daily life are associated with social and adaptive skills (Gardiner & Iarocci, 2017). Our findings point in the same direction, since in children with ASD the components of metacognitive processing have a higher incidence in ToM skills. Thus, the difficulties in initiate, that is, the poor decision-making capacity, the problems to initiate a task or conversation, would indicate a lower mentalizing abilities in everyday social contexts.

Another significant finding of our research, due to its practical repercussion, refers to the impact of the disorders' symptoms on EF, ToM and the behavioral problems of children with ASD and comorbid ADHD. In this sense, the symptomatology of inattention is revealed as the most significant predictor in both metacognitive processes, as well as ToM skills, coinciding in part with other studies where inattention has a significant association with executive domains (Neely et al., 2016; Sinzig et al., 2008; Takeuchi et al., 2013). In contrast, the core symptoms of ASD seem to have greater predictive power to explain the behavioral and emotional problems of children with autism and ADHD.

The question of whether the combined symptoms of ASD and ADHD represent a distinct phenotype or merely overlap of phenotypes remains unclear (Stevens, Peng, & Barnard-Brak, 2016). This situation is similar to what happens in clinical practice, where the differential diagnosis is a controversial issue (Antshel et al., 2016). As mentioned in the introduction, although ASD and ADHD are two distinct diagnostic categories, some studies suggest that these syndromes could be manifestations of a common disorder (Van der Meer et al., 2012). But also, other research based on twin studies conclude that both disorders are different, although they share "endophenotypes", by which the children of one condition show characteristics of the other (Ronald et al., 2014).

In summary, based on our results, it is difficult to pronounce on a possible differentiation in EF skills and social cognition abilities between ASD, ADHD and ASD + ADHD and that, therefore, is an open question for future research. There is no doubt that a better understanding of individual differences will lead to greater possibilities of carrying out successful interventions. However, despite its preliminary nature, the findings warn of the need for early implementation of programs in the family and school that emphasize the teaching of ToM strategies and ToM skills to optimize social and personal development in children with ASD and ADHD.

Limitations

Despite its interest, this research is not exempt of limitations. One of them is related to the small number of participants. Likewise, the results are only applicable to children with IQ within the limits of normality, limiting the generalization of the findings.

In addition, most of the children in the clinical groups were male, so the results could not be generalized to girls with ASD or ADHD, given the

low number of participants. This limitation is not unique to our study and it should be a central topic for future research with children with ASD and ADHD. In the specific case of girls with a clinical diagnosis of ASD, the findings so far are scarce, suggesting certain limitations in EF and general daily life abilities (Whyte & Scherf, 2017).

A no less important issue are the presentations of children diagnosed with ADHD, which in a large majority were combined, that is, with inattention and hyperactivity/impulsivity. Likewise, a high percentage of children with ADHD and children with ASD + ADHD were receiving medication.

Another limitation refers to some of the assessment measures used. For example, to assess the socialization of children with ASD, in study 1 the information of the parents was used through the VABS interview. This type of interview has been used in previous studies and has good psychometric properties, but the multidimensional nature of the socialization construct should be analyzed taking into account specific aspects such as peer relationship, prosocial behavior, social information processing, in addition to plural measures and procedures, such as the perception of teachers. Similarly, it would be necessary to incorporate neuropsychological measures of executive functioning, in addition to including a greater number of informants in the evaluation of executive processes and social cognition.

Moreover, longitudinal cut designs are needed to determine the directionality of the causal relationship between the variables analyzed in our study. The lack of longitudinal studies highlights the need to delve into the EF components and the processes of social cognition that would affect the processing of social information of children with ASD and ADHD. Currently, research is focused on childhood, despite the evidence of the

developmental changes that occur throughout development in cognitive and social processes (Hartman et al., 2016).

No less important is to examine the influence of the different presentations of ADHD, especially for the therapeutic approach.

Practical implications and new areas of research

During the last decades in Spain there is a change in the trend of educational policies in order to implement inclusive programs that meet the specific educational needs of students. Children with ASD and children with ADHD are considered students with specific educational support needs and are included in regular classrooms, following the trend of other European countries and the United States. This fact is favoring a change in the educational programs of the schools to provide adequate resources to students with neurodevelopmental disorders. The present study represents an attempt to collaborate to advance in this direction.

Although many more studies are still needed in this area, multicomponent programs take these aspects into account and consider the natural environments in which children with ASD and ADHD develop. Moreover, in the case of children with ASD, some of them have shown promising results, showing significant improvements in social responsivity and social cognition (Laugeson, Ellingsen, Sanderson, Tucci, & Bates, 2014). Another important issue that must also be addressed, especially in children with ASD, is the deficit in social motivation (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012). Perhaps the association with positive emotional experiences can promote spontaneous orientation towards social interaction, increase opportunities for socialization and facilitate the learning and practice of mentalist and pragmatic skills.

Regarding the contents, the clinical implications derived from this study point to the need to design intervention programs that address the improvement of social functioning in children with ADHD, ASD and ASD + ADHD. For this purpose, it is necessary to consider together the factors involved in social behavior, such as EF and social cognition processes. The findings suggest differentiated approaches to the development of psychosocial intervention programs for children with high functioning ASD, children with ADHD and for the comorbid condition, where the response to pharmacological treatment is less adequate than when both disorders are considered independently (Dawson & Burner, 2011).

Therefore, one of the main practical implications of this research refers to the need to address in a differentiated way the design and application of treatments for children with ADHD and ASD with and without comorbidity with ADHD. The findings related to children with ADHD show the greater involvement of the executive components in the development of an adaptive social behavior. Consequently, the therapeutic intervention of children with ADHD should consider the improvement of executive functioning as a priority, since executive difficulties seem to be a central deficit in children with ADHD. On the other hand, the results of the study of executive and cognitive processes in children with ASD suggest a different approach. In this case, deficits in ToM appear to be a primary deficit in children with autism. Therefore, intervention strategies should be based on the training of social skills and on techniques to enhance social interactions, and pragmatic skills. All this would have a positive impact on the social competence of children with ASD. Regarding the comorbid condition, the conclusions derived from the study highlight the implication of the symptoms of inattention in the executive processes of metacognition and in ToM skills, as well as the nuclear symptoms of ASD in the social and

emotional behavior. In addition to the techniques recommended for children with ASD, the intervention should include the treatment of inattention symptoms.

So far, the literature shows that in ADHD there is empirical support for parent behavioral training programs as well as for cognitive-behavioral techniques. On the contrary, interventions based on the improvement of social skills have shown less efficacy (Evans, Owens, Wymbs, & Ray, 2017). These results are in line with those of an extensive meta-analysis on the empirical evidence of pharmacological and non-pharmacological treatments in ADHD (Catala-Lopez, et al., 2017). Behavioral therapy, particularly given by parents and with active child and teacher involvement, is the only non-pharmacological intervention that was associated with statistically significant benefits in that meta-analysis.

Because executive dysfunction is a central limitation in ADHD, several studies have explored the effects of cognitive training with promising results (see meta-analysis by Cortese et al., 2015). The programs address a wide range of cognitive functions, including attention and EF for children and adolescents, not only with ADHD. One example is Attention Improvement Management (AIM) (Sohlberg, Harn, MacPherson, & Wade, 2014), a 10-week computerized treatment that incorporates goal setting, the use of metacognitive strategies and exercises designed to improve various aspects of attention and working memory.

As for ASD, early and intensive behavioral interventions have shown improvements in language and social communication. Similarly, social skills trainings have proven its effectiveness. Interventions based on "parental education", unlike what happens in ADHD, tend to place more

emphasis on individualized treatments that offer parents tools to enhance their children's social and adaptive skills (Davis & Kollins, 2012).

In this sense, there are programs based on cognitive behavioral techniques that have demonstrated their effectiveness, such as the cognitive-behavioral-ecological (CB-E) intervention of Bauminger (2007). This program based on social skills training for high functioning children with ASD showed improvements in social cognition, cooperation, self-regulation and assertiveness. The results were maintained after the treatment, like the PEERS program by Laugeson et al. (2014) implemented in the school context, which showed improvements in social competence in adolescents with ASD.

Similarly, in a study by Kenworthy et al. (2014) the shifting and planning EF scores of the BRIEF (parents and teacher reports) were normalized through a cognitive-behavioral approach focused on the training of these executive functions at school and home in a group of children with ASD. Very promising results have also been shown in emotional control, working memory, planning and monitoring of adolescents with high functioning autism with a school program for the development of social competence (Stichter, Herzog, Owens, & Malugen, 2016).

Other options include the use of technology for adolescents with ASD at school, and at home (Odom, Boyd, Hall, & Hume, 2010), in addition to the effectiveness of individual curricular adaptation plans in the school context. Individualization of instructional practices allows personalized academic instruction that is flexible enough to achieve learning objectives in different academic subjects, taking into account the needs of students with neurodevelopmental disorders such as ASD and ADHD.

Finally, the characteristics that define the ASD+ADHD comorbidity have an important impact for the assessments and design of treatments. Until now, the psychosocial approach to the comorbid symptoms of inattention and hyperactivity/impulsivity in ASD has not received enough attention, so that there is a high percentage of children with ASD+ADHD who have not been diagnosed or treated (Mansour, Dovi, Lane, Loveland, & Pearson, 2017), despite the negative repercussions of comorbidity on adaptive and social functioning (Rao & Landa, 2014) and on academic abilities (Lyall et al., 2017).

Research on the efficacy of non-pharmacological treatments in ASD+ADHD over the past five years is insufficient, although there are exceptions such as the work of Schafer et al. (2013) that examined the possible benefit of the remote-microphone (RM) technology in children with ASD, ASD+ADHD, ADHD and DT. The ratings of the external observers and the teachers themselves indicated that the use of the RM system produced significant improvements in speech recognition in noise for children with ASD and ADHD. Likewise, there were significant increases in on-task behaviors and listening behaviors in the clinical groups.

The specific type of comorbidity can influence the effectiveness of the social skills training in ASD, as suggested by the research of Antshel et al. (2011) with groups of children with ASD, ASD + ADHD and ASD + anxiety. The ASD + ADHD group did not obtain improvements after the social skills training, due to problems of inattention and poor impulse control, while in children with ASD + anxiety improvements in communication, assertive behaviors, responsibility and self-control were observed. Therefore, the absence of improvements in the ASD + ADHD group suggests that ADHD symptomatology should be considered in treatment programs. More satisfactory results were presented by the only

work that has studied the impact of an executive function training in ASD+ADHD: an improvement in attention, impulsivity symptoms and academic performance was found in children and adolescents with ASD and comorbid ADHD, after receiving a computerized training with the Cogmed Working Memory Training (CWMT) (Weckstein, Weckstein, Parker, & Westerman, 2017).

Therefore, the design of programs for children with ASD and ADHD symptoms, should include among their objectives strategies that strengthen the attention skills, incorporating them in the treatment from an early age. One possible way would be the combination of effective psychosocial strategies used in ASD and ADHD (Gargaro et al., 2011).

In summary, the empirical findings will help the incorporation of evidence-based best practices into the design of intervention programs for children with ADHD, ASD, and ASD + ADHD. In addition, public educational institutions must commit to providing resources and adequate training to health professionals, teachers and parents for the appropriate implementation of treatment programs for children with neurodevelopmental disorders. Without adequate training of teachers in basic techniques involved in cognitive behavioral therapy or in parent behavioral training, the effective implementation of intervention techniques, although based on evidence, cannot be guaranteed.

On the other hand, an issue that empirical research will have to address in the near future refers to how deficits in the different domains of executive functioning and social cognition skills evolve throughout the stages of development in children with ASD, ADHD and ASD + ADHD. For example, there are critical stages such as adolescence, where "crucial time windows" of neuronal development are opened, in which there are changes that can be irreversible in terms of executive functioning and social

competence (Hartman et al., 2016). Therefore, it is necessary to know the trajectories of the symptoms of ASD and ADHD as well as their co-occurrence and how they affect the executive strategies and ToM skills.

Important practical repercussions would arise from all this, and it would also be useful for professionals in the field of education and neuropsychological rehabilitation.

REFERENCIAS BIBLIOGRÁFICAS

Adamo, N., Huo, L., Adelsberg, S., Petkova, E., Castellanos, F. X., & Di Martino, A. (2014). Response time intra-subject variability: commonalities between children with autism spectrum disorders and children with ADHD. *European Child & Adolescent Psychiatry*, *23*, 69-79. doi:10.1007/s00787-013-0428-4

Ahmadi, N., Goodarzi, M. A., Hadianfard, H., Mohamadi, N., Farid, D., Kholasehzadeh, G., ... & Hemyari, C. (2013). Comparing iconic memory in children with and without attention deficit hyperactivity disorder. *Iranian Journal of Psychiatry*, *8*, 131-137.

American Psychiatric Association [APA] (2013). *Diagnostic and statistical manual of mental disorders* (5th edn.). Washington, DC: American Psychiatric Association.

Amr, M., Raddad, D., El-Mehesh, F., Bakr, A., Sallam, K., & Amin, T. (2012). Comorbid psychiatric disorders in Arab children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *6*, 240-248. doi:10.1016/j.rasd.2011.05.005

Andersen, P. N., Hovik, K. T., Skogli, E. W., Egeland, J., & Øie, M. (2013). Symptoms of ADHD in children with high-functioning autism are related to impaired verbal working memory and verbal delayed recall. *PloS One*, *8*, e64842. doi:10.1371/journal.pone.0064842

Antshel, K. M., Polacek, C., McMahon, M., Dygert, K., Spenceley, L., Dygert, L., … Faisal, F. (2011). Comorbid ADHD and anxiety affect social skills group intervention treatment efficacy in children with autism spectrum disorders. *Journal of Develop- mental & Behavioral Pediatrics, 32*, 439–446. doi:10.1097/DBP.0b013e318222355d

Antshel, K. M., Zhang-James, Y., Wagner, K. E., Ledesma, A., & Faraone, S. V. (2016). An update on the comorbidity of ADHD and ASD: A

focus on clinical management. *Expert Review of Neurotherapeutics*,*16*,279-293. doi: 10.1586/14737175.2016.1146591

Ashwood, K. L., Tye, C., Azadi, B., Cartwright, S., Asherson, P., & Bolton, P. (2015). Brief report: Adaptive functioning in children with ASD, ADHD and ASD+ ADHD. *Journal of Autism and Developmental Disorders*, *45*, 2235-2242. doi:10.1007/s10803-014-2352-y

Barendse, E. M., Hendriks, M. P., Jansen, J. F., Backes, W. H., Hofman, P. A., Thoonen, G., ... & Aldenkamp, A. P. (2013). Working memory deficits in high-functioning adolescents with autism spectrum disorders: neuropsychological and neuroimaging correlates. *Journal of Neurodevelopmental Disorders*, *5*, 14. doi:10.1186/1866-1955-5-14

Baribeau, D. A., Doyle-Thomas, K. A., Dupuis, A., Iaboni, A., Crosbie, J., McGinn, H., ... & Schachar, R. J. (2015). Examining and comparing social perception abilities across childhood-onset neurodevelopmental disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, *54*, 479-486. doi:10.1016/j.jaac.2015.03.016

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*,65-79. doi:10.1037/0033-2909.121.1.65

Barkley, R. A. (2005). *ADHD and the nature of self-control.* New York: Guilford.

Barkley, R.A. (2011). *Executive Functioning and Self Regulation. Integration, Extended Phenotype and Clinical Implications.* New York: Guilford Press.

Baron-Cohen, S. (1995). *Mindblindness*. Cambridge, MA: MIT Press.

Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*, 37-46. doi:10.1016/0010-0277(85)90022-8

Baron-Cohen, S., Scott, F. J., Allison, C., Williams, J., Bolton, P., Matthews, F. E., & Brayne, C. (2009). Prevalence of autism-spectrum conditions: UK school-based population study. *The British Journal of Psychiatry*, *194*, 500-509. doi:10.1192/bjp.bp.108.059345

Baron-Cohen, S., Tager-Flusberg, H., & Cohen, D.J. (2000). *Understanding other minds*. Oxford: Oxford University Press.

Basile, A. G., & Toplak, M. E. (2015). Four converging measures of temporal discounting and their relationships with intelligence, executive functions, thinking dispositions, and behavioral outcomes. *Frontiers in Psychology*, *6*. 728-742. doi: 10.3389/fpsyg.2015.00728

Bauminger, N., & Kasari, C. (2000). Loneliness and friendship in high-functioningchildren with autism. *Child Development, 71,* 447–456. doi:10.1111/1467-8624.00156

Bauminger, N. (2007). Brief report: Individual social-multi-modal intervention for HFASD. *Journal of Autism and Developmental Disorders*, *37*, 1593-1604. doi: 10.1007/s10803-006-0245-4

Biederman, J., Petty, C. R., Fried, R., Doyle, A. E., Spencer, T., Seidman, L. J., ... & Faraone, S. V. (2007). Stability of executive function deficits into young adult years: A prospective longitudinal follow-up study of grown up males with ADHD. *Acta Psychiatrica Scandinavica*, *116*, 129-136. doi:10.1111/j.1600-0447.2007.01008.x

Bishop-Fitzpatrick, L., Mazefsky, C. A., Eack, S. M., & Minshew, N. J. (2017). Correlates of social functioning in autism spectrum disorder: The role of social cognition. *Research in Autism Spectrum Disorders*, *35*,25-34. doi:10.1016/j.rasd.2016.11.013

Bora, E., & Pantelis, C. (2016). Meta-analysis of social cognition in attention-deficit/hyperactivity disorder (ADHD): comparison with healthy controls and autistic spectrum disorder. *Psychological Medicine*, *46*, 699-716. doi: 10.1017/S0033291715002573

Bradshaw, J.L. (2001). *Developmental disorders of the frontostriatal system: neuropsychological, neuropsychiatric and evolutionary perspectives*. East Susex: Psychology Press.

Brent, E., Rios, P., Happé, F., & Charman, T. (2004). Performance of children with autism spectrum disorder on advanced theory of mindtasks.*Autism*, *8*,283-299. doi:10.1177/1362361304045217

Bühler, E., Bachmann, C., Goyert, H., Heinzel-Gutenbrunner, M., & Kamp-Becker, I. (2011). Differential diagnosis of autism spectrum disorder and attention deficit hyperactivity disorder by means of inhibitory control and 'theory of mind'. *Journal of Autism and Developmental Disorders*, *41*, 1718-1726. doi:10.1007/s10803-011-1205-1

Buitelaar, J. K., Van der Wees, M., Swaab–Barneveld, H., & Van der Gaag, R. J. (1999). Theory of mind and emotion-recognition functioning in autistic spectrum disorders and in psychiatric control and normal children. *Development & Psychopathology*, *11*,39-58. doi:10.1017/S0954579499001947

Burgess, P.W., Alderman, N., Evans, J., Emslie, H., & Wilson, B.A. (1998). The ecological validity of tests of executive function. *Journal of the*

International Neuropsychological Society, 4, 547–558. doi:10.1017/S1355617798466037

Caamaño, M., Boada, L., Merchán-Naranjo, J., Moreno, C., Llorente, C., Moreno, D., ... & Parellada, M. (2013). Psychopathology in children and adolescents with ASD without mental retardation. *Journal of Autism and Developmental Disorders*, *43*, 2442-2449. doi:10.1007/s10803-013-1792-0

Caillies, S., Bertot, V., Motte, J., Raynaud, C., & Abely, M. (2014). Social Cognition in ADHD: Irony understanding and recursive theory of mind. *Research in Developmental Disabilities, 35*, 3191-3198. doi:10.1016/j.ridd.2014.08.002

Catala-Lopez, F., Hutton, B., Núñez-Beltrán, A., Page, M. J., Ridao, M., Saint-Gerons, D. M., ... & Moher, D. (2017). The pharmacological and non-pharmacological treatment of attention deficit hyperactivity disorder in children and adolescents: a systematic review with network meta-analyses of randomised trials. *PLoS One*, *12*, e0180355. doi: 10.1371/journal.pone.0180355.

Chantiluke, K., Christakou, A., Murphy, C. M., Giampietro, V., Daly, E. M., Ecker, C., ... & MRC AIMS Consortium. (2014). Disorder-specific functional abnormalities during temporal discounting in youth with Attention Deficit Hyperactivity Disorder (ADHD), Autism and comorbid ADHD and Autism. *Psychiatry Research: Neuroimaging*, *223*, 113-120. doi:10.1016/j.pscychresns.2014.04.006

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E.S., & Schultz, RT. (2012). The social motivation theory of autism. *Trends in Cognitive Science,16*, 231-239. doi:10.1016/j.tics.2012.02.007

Christensen, D. L., Baio, J., & Braun, K. (2016). Community Report on Autism. *CDC Community Report on Autism*, *65*, 01-23.

Colombi, C., & Ghaziuddin, M. (2017). Neuropsychological Characteristics of Children with Mixed Autism and ADHD. *Autism Research and Treatment*, *2017*,1-5. doi:10.1155/2017/5781781

Corbett, B. A., Constantine, L. J., Hendren, R., Rocke, D., & Ozonoff, S. (2009). Examining executive functioning in children with autism spectrum disorder, attention deficit hyperactivity disorder and typical development. *Psychiatry Research*, *166*, 210-222. doi:10.1016/j.psychres.2008.02.005

Cortese, S., Ferrin, M., Brandeis, D., Buitelaar, J., Daley, D., Dittmann, R. W., ... & Zuddas, A. (2015). Cognitive training for attention-deficit/hyperactivity disorder: meta-analysis of clinical and neuropsychological outcomes from randomized controlled trials. *Journal of the American Academy of Child & Adolescent Psychiatry*, *54*, 164-174.
doi: 10.1016/j.jaac.2014.12.010

Craig, F., Lamanna, A. L., Margari, F., Matera, E., Simone, M., & Margari, L. (2015). Overlap between autism spectrum disorders and attention deficit hyperactivity disorder: searching for distinctive/common clinical features. *Autism Research*, *8*, 328-337. doi:10.1002/aur.1449

Craig, F., Margari, F., Legrottaglie, A. R., Palumbi, R., de Giambattista, C., & Margari, L. (2016). A review of executive function deficits in autism spectrum disorder and attention-deficit/hyperactivity disorder. *Neuropsychiatric Disease and Treatment*, *12*, 1191-1202 .doi:10.2147/NDT.S104620

Dajani, D. R., Llabre, M. M., Nebel, M. B., Mostofsky, S. H., & Uddin, L. Q. (2016). Heterogeneity of executive functions among comorbid neurodevelopmental disorders. *Scientific Reports*, *6*, 36566. doi:10.1038/srep36566

Davis, N. O., & Kollins, S. H. (2012). Treatment for co-occurring attention deficit/hyperactivity disorder and autism spectrum disorder. *Neurotherapeutics*, *9*, 518-530. doi:10.1007/s13311-012-0126-9

Dawson, G., & Burner, K. (2011). Behavioral interventions in children and adolescents with autism spectrum disorder: a review of recent findings. *Current Opinion in Pediatrics*, *23*,616-620. doi: 10.1097/MOP.0b013e32834cf082

de Vries, M., & Geurts, H. (2015). Influence of autism traits and executive functioning on quality of life in children with an autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *45*,2734-2743.
doi:10.1007/s10803-015-2438-1

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., ... & Guastella, A. J. (2017). Autism spectrum disorders: a meta-analysis of executive function. *Molecular Psychiatry*, 0, 1-7. doi:10.1038/mp.2017.75

Demopoulos, C., Hopkins, J., & Davis, A. (2013). A comparison of social cognitive profiles in children with autism spectrum disorders and attention-deficit/hyperactivity disorder: a matter of quantitative but not qualitative difference? *Journal of Autism and Developmental Disorders*, *43*, 1157-1170.
doi:10.1007/s10803-012-1657-y

Demurie, E., de Core, M., & Roeyers, H. (2011). Empathic accuracy in adolescents with autism spectrum disorders and adolescents with attention deficit/ hyperactivity disorder. *Research in Autism Spectrum Disorders*, *5*, 126–134. doi:10.1016/j.rasd.2010.03.002

Diamantopoulou S., Rydell, A. M., Thorell, L. B., & Bohlin, G. (2007). Impact of executive functioning and symptoms of attention deficit hyperactivity disorder on children's peer relations and school performance. *Developmental Neuropsychology,32*,521542. doi:10.1080/87565640701360981

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135-168. doi:10.1146/annurev-psych-113011-143750

Downs, A., & Smith, T. (2004). Emotional understanding, cooperation, and social behavior in high-functioning children with autism. *Journal of Autism and Developmental Disorders*, *34*, 625-635. doi:10.1007/s10803-004-5284-0

Dyck, M. J., Ferguson, K., & Shochet, I. M. (2001). Do autism spectrum disorders differ from each other and from non-spectrum disorders on emotion recognition tests?. *European Child & Adolescent Psychiatry*, *10*, 105-116. doi:10.1007/s007870170033

Evans, S. W., Owens, J. S., Wymbs, B. T., & Ray, A. R. (2017). Evidence-based psychosocial treatments for children and adolescents with attention deficit/hyperactivity disorder. *Journal of Clinical Child & Adolescent Psychology*, 1-42. doi: doi.org/10.1080/15374416.2017.1390757

Factor, R. S., Ryan, S. M., Farley, J. P., Ollendick, T. H., & Scarpa, A. (2017). Does the Presence of Anxiety and ADHD Symptoms Add to

Social Impairment in Children with Autism Spectrum Disorder? *Journal of Autism and Developmental Disorders*, *47*, 1122-1134. doi:10.1007/s10803-016-3025-9

Freeman, L. M., Locke, J., Rotheram-Fuller, E., & Mandell, D. (2017). Brief Report: Examining Executive and Social Functioning in Elementary-Aged Children with Autism. *Journal of Autism and Developmental Disorders*, *47*, 1890-1895. doi:10.1007/s10803-017-3079-3

Frith, U. (1989). *Autism: Explaining the enigma*. Oxford: Basil Blackwell. [Trad. cast. de Á. Rivière & M. Núnez, *Autismo: Hacia una explicación del enigma*. Madrid: Alianza, 1991].

Frith, U., Happé, F., & Siddons, F. (1994). Autism and theory of mind in everyday life. *Social Development, 3,* 108-124. doi:10.1111/j.1467-9507.1994.tb00031.x

Fuster, J. M. (2008). The Prefrontal Cortex, 4th Edn. London: Academic Press.

Gardiner, E., & Iarocci, G. (2017). Everyday executive function predicts adaptive and internalizing behavior among children with and without autism spectrum disorder. *Autism Research*, 1-12. doi: 10.1002/aur.1877

Gargaro, B. A., Rinehart, N. J., Bradshaw, J. L., Tonge, B. J., & Sheppard, D. M. (2011). Autism and ADHD: how far have we come in the comorbidity debate? *Neuroscience & Biobehavioral Reviews*, *35*,1081-1088. doi: 10.1016/j.neubiorev.2010.11.002

Geurts, H. M., Bergh, S. F., & Ruzzano, L. (2014). Prepotent response inhibition and interference control in autism spectrum disorders:

Two meta-analyses. *Autism Research*, *7*, 407-420. .doi:10.1002/aur.1369

Geurts, H. M., Grasman, R. P., Verté, S., Oosterlaan, J., Roeyers, H., van Kammen, S. M., & Sergeant, J. A. (2008). Intra-individual variability in ADHD, autism spectrum disorders and Tourette's syndrome. *Neuropsychologia*, *46*,3030-3041. doi:10.1016/j.neuropsychologia.2008.06.013

Geurts, H. M., Verte, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. A. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? *Journal of Child Psychology and Psychiatry*, *45*, 836-854. doi:10.1111/j.1469-7610.2004.00276.x

Gilotty, L., Kenworthy, L., Sirian, L., Black, D.O., & Wagner, A.E. (2002). Adaptative skills and executive funtion in autism spectrum disorders. *Child Neuropyschology, 8,* 241-248. doi:10.1076/chin.8.4.241.13504

Gioia, G.A., Isquith, P.K., Guy, S.C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function*. Odessa, FL: Psychological Assessment Resources.

Gjevik, E., Eldevik, S., Fjæran-Granum, T., & Sponheim, E. (2011). Kiddie-SADS reveals high rates of DSM-IV disorders in children and adolescents with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 41*, 761–769. doi:10.1007/s10803-010-1095-7

Goldberg, M. C., Mostofsky, S. H., Cutting, L. E., Mahone, E. M., Astor, B. C., Denckla, M. B., & Landa, R. J. (2005). Subtle executive impairment in children with autism and children with

ADHD. *Journal of Autism and Developmental Disorders*, *35*, 279-293. doi:10.1007/s10803-005-3291-4

Goldman-Rakic, P. (1987). Circuitry of primate prefrontal cortex and regulation of behavior by representational memory. In F. Plum (Ed.), *Handbook of physiology: The nervous system* (pp. 373– 417). New York: Oxford University Press.

Goldstein, S., & Naglieri, J. A. (Eds.). (2013). *Handbook of executive functioning*. New York: Springer Science & Business Media.

Gomarus, H. K., Wijers, A. A., Minderaa, R. B., & Althaus, M. (2009). ERP correlates of selective attention and working memory capacities in children with ADHD and/or PDD-NOS. *Clinical Neurophysiology*, *120*, 60-72. doi:10.1016/j.clinph.2008.10.018

Green, M.F., Penn, D.L., Bentall, R., Carpenter, W.T., Gaebel, W., Gur, R.C., … Heinssen, R. (2008). Social cognition in schizophrenia: an NIMH workshop on definitions, assessment, and research opportunities. *Schizophrenia Bulletin, 34*, 1211–1220. doi:10.1093/schbul/sbm145

Groom, M. J., Kochhar, P., Hamilton, A., Liddle, E. B., Simeou, M., & Hollis, C. (2017). Atypical processing of gaze cues and faces explains comorbidity between autism spectrum disorder (ASD) and attention deficit/hyperactivity disorder (ADHD). *Journal of Autism and Developmental Disorders*, *47*, 1496-1509. doi:10.1007/s10803-017-3078-4

Happé, F., & Frith, U. (2014). Annual research review: towards a developmental neuroscience of atypical social cognition. *Journal of Child Psychology and Psychiatry*, *55*, 553-577. doi:10.1111/jcpp.12162

Happé, F., & Ronald, A. (2008). The 'fractionable autism triad': a review of evidence from behavioural, genetic, cognitive and neural research. *Neuropsychology Review*, *18*, 287-304. doi:10.1007/s1106500890768

Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: examining profiles across domains and ages. *Brain and Cognition*, *61*, 25-39. doi:10.1016/j.bandc.2006.03.004

Hartman, C. A., Geurts, H. M., Franke, B., Buitelaar, J. K., & Rommelse, N. N. (2016). Changing ASD-ADHD symptom co-occurrence across the lifespan with adolescence as crucial time window: Illustrating the need to go beyond childhood. *Neuroscience & Biobehavioral Reviews*, *71*, 529-541. doi:10.1016/j.neubiorev.2016.09.003

Hill, E. L. (2004). Evaluating the theory of executive dysfunction in autism. *Developmental Review*, *24*, 189-233. doi:10.1016/j.dr.2004.01.001

Hughes, C., & Devine, R. T. (2015). A social perspective on theory of mind. In M. E. Lamb (Ed.), Handbook of child psychology and developmental science (Vol. 3): Socioemotional processes (7th ed., pp. 564–609). Hoboken, NJ: Wiley.

Hutchins, T. L., Prelock, P. A., Morris, H., Benner, J., LaVigne, T., & Hoza, B. (2016). Explicit vs applied theory of mind competence: A comparison of typically developing males, males with ASD, and males with ADHD. *Research in Autism Spectrum Disorder, 21*,94-108. doi:10.1016/j.rasd.2015.10.004

Imuta, K., Henry, J. D., Slaughter, V., Selcuk, B., & Ruffman, T. (2016). Theory of mind and prosocial behavior in childhood: A meta-analytic review. *Developmental Psychology, 52*, 1192-1205. doi:10.1037/dev0000140

Jahromi, L. B., Bryce, C. I., & Swanson, J. (2013). The importance of self-regulation for the school and peer engagement of children with high-functioning autism. *Research in Autism Spectrum Disorders*, *7*, 235-246. doi:10.1016/j.rasd.2012.08.012

Johnson, M. H., Gliga, T., Jones, E., & Charman, T. (2015). Annual Research Review: Infant development, autism, and ADHD–early pathways to emerging disorders. *Journal of Child Psychology and Psychiatry*, *56*, 228-247. doi:10.1111/jcpp.12328

Jones, C. R., Simonoff, E., Baird, G., Pickles, A., Marsden, A. J., Tregay, J., ... & Charman, T. (2017). The association between theory of mind, executive function, and the symptoms of autism spectrum disorder. *Autism Research*, doi.org/10.1002/aur.1873

Joseph, R. M., & Tager–Flusberg, H. (2004). The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Development and Psychopathology*, *16*,137-155. doi:10.1017/S095457940404444X

Keehn, B., Müller, R. A., & Townsend, J. (2013). Atypical attentional networks and the emergence of autism. *Neuroscience & Biobehavioral Reviews*, *37*, 164-183. doi:10.1016/j.neubiorev.2012.11.014

Kempton, S., Vance, A., Maruff, P., Luk, E., Costin, J., & Pantelis, C. (1999). Executive function and attention deficit hyperactivity disorder: stimulant medication and better executive function performance in

children. *Psychological medicine*, *29*(3), 527-538. doi:10.1017/S0033291799008338

Kenworthy, L., Anthony, L.G., Naiman, D.Q., Cannon, L.,Wills, M.C., Luong-Tran, C., . . . Wallace, G.L. (2014). Randomized controlled effectiveness trial of executive function intervention for children on the autism spectrum. *Journal of Child Psychology and Psychiatry, 55*, 374–383. doi:10.1111/jcpp.12161

Kenworthy, L., Yerys, B. E., Anthony, L. G., & Wallace, G. L. (2008). Understanding executive control in autism spectrum disorders in the lab and in the real world. *Neuropsychology Review*, *18*, 320-338. doi:10.1007/s11065-008-9077-7

Kim, J.W., Kim, B-N., Kim, J.I., Lee, Y.S., Min, K.J., Kim, H-J., & Lee, J. (2015). Social network analysis reveals the negative effects of attention-deficit/hyperactivity disorder (ADHD) symptoms on friend-based student networks. *PloS One, 10*, 1-14. doi:10.1371/journal.pone.0142782

Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger Syndrome: the Social Attribution Task. *Journal of Child Psychology and Psychiatry, 41*, 831-846. doi:10.1111/1469-7610.00671

Kotte, A., Joshi, G., Fried, R., Uchida, M., Spencer, A., Woodworth, K. Y., ... & Biederman, J. (2013). Autistic traits in children with and without ADHD. *Pediatrics*, *132*, e612-e622. doi:10.1542/peds.2012-3947

Lai, C. L. E., Lau, Z., Lui, S. S., Lok, E., Tam, V., Chan, Q., ... & Cheung, E. F. (2017). Meta-analysis of neuropsychological measures of executive functioning in children and adolescents with high-

functioning autism spectrum disorder. *Autism Research*, *10*, 911-939.doi: 10.1002/aur.1723

Lam, Y. G., & Yeung, S. S. (2012). Towards a convergent account of pragmatic language deficits in children with high-functioning autism: Depicting the phenotype using the Pragmatic Rating Scale. *Research in Autism Spectrum Disorders, 6*, 792–797. doi:10.1016/j.rasd.2011.08.004

Laugeson, E., Ellingsen, R., Sanderson,J., Tucci, L., & Bates, S. (2014). The ABC's of teaching social skills to adolescents with autism spectrum disorder in the classroom: the UCLA PEERS (©) Program. *Journal of Autism and Devevelopmental Disorders, 44*(9), 2244-2256. doi:10.1007/s10803-014-2108-8

Lawson, R. A., Papadakis, A. A., Higginson, C. I., Barnett, J. E., Wills, M. C., Strang, J. F., ... & Kenworthy, L. (2015). Everyday executive function impairments predict comorbid psychopathology in autism spectrum and attention deficit hyperactivity disorders. *Neuropsychology*, *29*, 445-453. doi:10.1037/neu0000145

Leitner, Y. (2014). The co-occurrence of autism and attention deficit hyperactivity disorder in children – what do we know? *Frontiers in Human Neuroscience, 8*, 268. doi:10.3389/fnhum.2014.00268

Leung, R. C., Vogan, V. M., Powell, T. L., Anagnostou, E., & Taylor, M. J. (2016). The role of executive functions in social impairment in Autism Spectrum Disorder. *Child Neuropsychology*, *22*,336-344. doi:10.1080/09297049.2015.1005066

Li, J., Zhu, L., Liu, J., & Li, X. (2014). Social and non-social deficits in children with high-functioning autism and their cooperative

behaviors. *Research in Autism Spectrum Disorders*, *8*, 1657-1671. doi:10.1016/j.rasd.2014.08.016

Lundervold, A. J., Stickert, M., Hysing, M., Sørensen, L., Gillberg, C., & Posserud, M. B. (2016). Attention deficits in children with combined autism and ADHD: a CPT study. *Journal of Attention Disorders*, *20*, 599-609.
doi:10.1177/1087054712453168

Luteijn, E. F., Serra, M., Jackson, S., Steenhuis, M. P., Althaus, M., Volkmar, F., & Minderaa, R. (2000). How unspecified are disorders of children with a pervasive developmental disorder not otherwise specified? A study of social problems in children with PDD-NOS and ADHD. *European Child and Adolescent Psychiatry, 9*, 168–179.
doi:10.1007/s007870070040

Lyall, K., Schweitzer, J. B., Schmidt, R. J., Hertz-Picciotto, I., & Solomon, M. (2017). Inattention and hyperactivity in association with autism spectrum disorders in the CHARGE study. *Research in Autism Spectrum Disorders*, *35*, 1-12. doi:10.1016/j.rasd.2016.11.011

Mannion, A., Leader, G., & Healy, O. (2013). An investigation of comorbid psychological disorders, sleep problems, gastrointestinal symptoms and epilepsy in children and adolescents with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *7*, 35-42.
doi:10.1016/j.rasd.2012.05.002

Mansour, R., Dovi, A. T., Lane, D. M., Loveland, K. A., & Pearson, D. A. (2017). ADHD severity as it relates to comorbid psychiatric symptomatology in children with Autism Spectrum Disorders (ASD). *Research in Developmental Disabilities*, *60*, 52-64. doi:10.1016/j.ridd.2016.11.009

Mary, A., Slama, H., Mousty, P., Massat, I., Capiau, T., Drabs, V., & Peigneux, P. (2016). Executive and attentional contributions to Theory of Mind deficit in attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *22*, 345-365. doi:10.1080/09297049.2015.1012491

Matsuura, N. Ishitobi, M., Arai, S., Kawamura, K., Asano, M., Inohara, K., & Kosaka, H. (2014). Distinguising between autism spectrum disorder and attention déficit hyperactivity disorder by using behavioral checklist cognitive assessment and neuropsychological test battery. *Asian Journal of Psychiatry, 12*, 50-57. doi:10.1016/j.ajp.2014.06.011

Mazza, M., Mariano, M., Peretti, S., Masedu, F., Pino, M. C., & Valenti, M. (2017). The Role of Theory of Mind on Social Information Processing in Children with Autism Spectrum Disorders: A Mediation Analysis. *Journal of Autism and Developmental Disorders*, *47*, 1369-1379. doi:10.1007/s10803-017-3069-5

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the Behavior Rating Inventory of Executive Function more strongly associated with measures of impairment or executive function? *Journal of the International Neuropsychological Society*, *16*, 495-505. doi:10.1017/S1355617710000093

Middleton, F.A., & Strick, P.L. (2001). Cerebellar projections to the prefrontal cortex of the primate. *Journal of Neuroscience, 21*, 700-712.

Mikami, A. Y. (2010). The importance of friendship for youth with attention-deficit/hyperactivity disorder. *Clinical Child and Family Psychology Review*, *13*, 181-198. doi:10.1007/s10567-010-0067-y

Miyake, A., & Friedman, N.P. (2012). The nature and organization of individual differences in executive functions: four general conclusions. *Current Directions in Psychological Science, 21*, 8–14. doi:10.1177/0963721411429458

Mostert-Kerckhoffs, M. A., Staal, W. G., Houben, R. H., & de Jonge, M. V. (2015). Stop and change: Inhibition and flexibility skills are related to repetitive behavior in children and young adults with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *45*, 3148-3158. doi:10.1007/s10803-015-2473-y

Mrug, S., Molina, B. S., Hoza, B., Gerdes, A. C., Hinshaw, S. P., Hechtman, L., & Arnold, L. E. (2012). Peer rejection and friendships in children with attention-deficit/hyperactivity disorder: Contributions to long-term outcomes. *Journal of Abnormal Child Psychology, 40*, 1013-1026. doi:10.1007/s10802-012-9610-2

Neely, R. J., Green, J. L., Sciberras, E., Hazell, P., & Anderson, V. (2016). Relationship Between Executive Functioning and Symptoms of Attention-Deficit/Hyperactivity Disorder and Autism Spectrum Disorder in 6–8 Year Old Children. *Journal of Autism and Developmental Disorders, 46*, 3270-3280. doi:10.1007/s10803-016-2874-6

Nigg, J. T., Willcutt, E. G., Doyle, A. E., & Sonuga-Barke, E. (2005). Causal heterogeneity in attention deficit/hyperactivity disorder: do we need neuropsychologically impaired subtypes?. *Biological Psychiatry*, *57*,1231-1238. doi:10.1016/j.biopsych.2004.08.025

Nomi, J. S., & Uddin, L. Q. (2015). Developmental changes in large-scale network connectivity in autism. *NeuroImage: Clinical*, *7*, 732-741. doi:10.1016/j.nicl.2015.02.024

Odom, S. L., Boyd, B. A., Hall, L. J., & Hume, K. (2010). Evaluation of comprehensive treatment models for individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *40*, 425-436. doi:10.1007/s10803-009-0825-1

Oerlemans, A. M., Burmanje, M. J., Franke, B., Buitelaar, J. K., Hartman, C. A., & Rommelse, N. N. (2016). Identifying unique versus shared pre-and perinatal risk factors for ASD and ADHD using a simplex-multiplex stratification. *Journal of Abnormal Child Psychology*, *44*, 923-935.
doi:10.1007/s10802-015-0081-0

Oerlemans, A. M., Van der Meer, J. M., Van Steijn, D. J., De Ruiter, S. W., De Bruijn, Y. G., De Sonneville, L. M., ... & Rommelse, N. N. (2014). Recognition of facial emotion and affective prosody in children with ASD (+ ADHD) and their unaffected siblings. *European child & adolescent psychiatry*, *23*, 257-271. doi:10.1007/s00787-013-0446-2

Orinstein, A. J., Suh, J., Porter, K., De Yoe, K. A., Tyson, K. E., Troyb, E., ... & Fein, D. A. (2015). Social function and communication in optimal outcome children and adolescents with an autism history on structured test measures. *Journal of Autism and Developmental Disorders*, *45*, 2443-2463.
doi:10.1007/s10803-015-2409-6

Ozonoff, S., & Jensen, J. (1999). Brief report: Specific executive function profiles in three neurodevelopmental disorders. *Journal of Autism and Developmental Disorders*, *29*, 171-177.

Ozonoff, S., Cook, I., Coon, H., Dawson, G., Joseph, R.M., Klin, …., Wrathall, D. (2004). Performance on Cambridge Neuropsychological Test Automated Battery subtests sensitive to frontal lobe function in people with autistic disorder: evidence from the Collaborative Programs of Excellence in Autism network. *Journal of Autism and Developmental Disorders,34*,139-150. doi:10.1023/B:JADD.0000022605.81989.cc

Pellicano, E. (2007). Links between theory of mind and executive function in young children with autism: clues to developmental primacy. *Developmental Psychology*, *43*, 974-990. doi:10.1037/0012-1649.43.4.974

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, *37*, 51-87. doi:10.1111/j.1469-7610.1996.tb01380.x

Pennington, B.F. (2002). *The Development of Psychopathology*. New York: Guilford Press.

Pennington, B.F., Bennetto, L., McAleer, O.K., & Roberts, R.J. (1996). Executive functions and working memory: Theoretical and measurement issues. In G.R. Lyon & N.A. Krasnegor (Eds.), *Attention, memory and executive function*. Baltimore: Paul H. Brookes.

Peterson, C., Garnett, M., Kelly, A., & Attwood, T. (2009). Everyday social and conversation applications of theory-of-mind understanding by children with autism-spectrum disorders or typical development. *European Child & Adolescent Psychiatry*, *18*, 105-115. doi:10.1007/s00787-008-0711-y

Peterson, C., Slaughter, V., Moore, C., & Wellman, H. M. (2016). Peer social skills and theory of mind in children with autism, deafness, or typical development. *Developmental Psychology*, *52*, 46-57. doi:10.1037/a0039833

Pitzianti, M., D'Agati, E., Pontis, M., Baratta, A., Casarelli, L., Spiridigliozzi, S., ... & Pasini, A. (2016). Comorbidity of ADHD and high-functioning autism: A pilot study on the utility of the overflow movements measure. *Journal of Psychiatric Practice, 22*, 22-30. doi:10.1097/PRA.0000000000000120

Pugliese, C. E., Anthony, L., Strang, J. F., Dudley, K., Wallace, G. L., & Kenworthy, L. (2015). Increasing adaptive behavior skill deficits from childhood to adolescence in autism spectrum disorder: Role of executive function. *Journal of Autism and Developmental Disorders*, *45*, 1579-1587. doi:10.1007/s10803-014-2309-1

Rao, P. A., & Landa, R. J. (2014). Association between severity of behavioral phenotype and comorbid attention deficit hyperactivity disorder symptoms in children with autism spectrum disorders. *Autism*, *18*, 272-280. doi:10.1177/1362361312470494

Roberts, B. A., Martel, M. M., & Nigg, J. T. (2017). Are there executive dysfunction subtypes within ADHD? *Journal of Attention Disorders*, *21*, 284-293. doi.org/10.1177/1087054713510349

Rommelse, N. N., Geurts, H. M., Franke, B., Buitelaar, J. K., & Hartman, C. A. (2011). A review on cognitive and brain endophenotypes that may be common in autism spectrum disorder and attention-

deficit/hyperactivity disorder and facilitate the search for pleiotropic genes. *Neuroscience & Biobehavioral Reviews*, *35*, 1363-1396.

Rommelse, N., Buitelaar, J. K., & Hartman, C. A. (2017). Structural brain imaging correlates of ASD and ADHD across the lifespan: a hypothesis-generating review on developmental ASD–ADHD subtypes. *Journal of Neural Transmission*, *124*, 259-271. doi:10.1016/j.neubiorev.2011.02.015

Rommelse, N.N., & Hartman, C.A. (2016). Review: changing (shared) heritability of ASD and ADHD across the lifespan. *European Child and Adolescent Psychiatry, 25*, 213-215. doi:10.1007/s00787-016-0830-9

Ronald, A., Happé, F., & Plomin, R. (2008). A twin study investigating the genetic and environmental aetiologies of parent: teacher and child ratings of autistic-like traits and their overlap. *European Child & Adolescent Psychiatry, 17,* 473–483. doi:10.1007/s00787-008-0689-5

Ronald, A., Larsson, H., Anckarsäter, H., & Lichtenstein, P. (2014). Symptoms of autism and ADHD: A Swedish twin study examining their overlap. *Journal of Abnormal Psychology*, *123*, 440-451. doi:10.1037/a0036088

Rubia, K., Alegria, A., & Brinson, H. (2014). Imaging the ADHD brain: disorder- specificity, medication effects and clinical translation. *Expert Review of Neurotherapeutics, 14*, 519–538. doi:10.1586/14737175.2014.907526

Russell, G., Rodgers, L. R., Ukoumunne, O. C., & Ford, T. (2014). Prevalence of parent-reported ASD and ADHD in the UK: findings from the Millennium Cohort Study. *Journal of Autism and Developmental Disorders*, *44*, 31-40.

doi:10.1007/s10803-013-1849-0

Salcedo, M.D., Moreno, J.M., Ruiz, M., & Ferrín, M. (2013). Evaluation of planning dysfuntion in attention déficit hyperactivity disorder and autistic spectrum disorder using the zoo map task. *Chid Psychiatry and Human Development, 44*, 166-185. doi.10.1007/s10578-012-0317-y

Sanderson, C., & Allen, M. L. (2013). The specificity of inhibitory impairments in autism and their relation to ADHD-type symptoms. *Journal of Autism and Developmental Disorders*, *43*, 1065-1079. doi:10.1007/s10803-012-1650-5

Schafer, E. C., Mathews, L., Mehta, S., Hill, M., Munoz, A., Bishop, R., & Moloney, M. (2013). Personal FM systems for children with autism spectrum disorders (ASD) and/or attention-deficit hyperactivity disorder (ADHD): An initial investigation. *Journal of Communication Disorders, 46*(1), 30-52.

Scheeren, A.M., de Rosnay,' M., Koot,' H.M., & Begeer, S. (2013). Rethinking theory of mind in high-functioning autism spectrum disorder. *Journal of Child Psychology and Psychiatry, 54*, 628-635. doi:10.1111/jcpp.12007

Schoemaker, K., Mulder, H., Dekovic, M., & Matthys, W. (2013). Executive Functions in preschool children with externalizing behavior problems: a meta-analysis. *Journal of Abnormal Child Psychology, 41*, 457–471. doi:10.1007/s10802-012-9684-x

Senju, A. (2012). Spontaneous theory of mind and its absence in autism spectrum disorder. *The Neuroscientist, 18,* 108–113. doi:10.1177/1073858410397208

Senju, A. (2013). Atypical development of spontaneous social cognition in autism spectrum disorders. *Brain and Development, 35,* 96-101. doi:10.1016/j.braindev.2012.08.002

Senju, A., Southgate, V., White, S., & Frith, U. (2009). Mindblind eyes: an absence of spontaneous theory of mind in Asperger syndrome. *Science, 325*, 883–885. doi:10.1126/science.1176170

Sikora, D. M., Vora, P., Coury, D. L., & Rosenberg, D. (2012). Attention-deficit/hyperactivity disorder symptoms, adaptive functioning, and quality of life in children with autism spectrum disorder. *Pediatrics, 130*, S91–S97. doi:10.1542/peds.2012-0900G

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry, 47*, 921–929. doi:10.1097/CHI.0b013e318179964f

Sinzig, J., Bruning, N., Morsch, D., & Lehmkuhl, G. (2008a). Attention profiles in autistic children with and without comorbid hyperactivity and attention problems. *Acta Neuropsychiatrica*, *20*, 207-215. doi:10.1111/j.1601-5215.2008.00292.x

Sinzig, J., Morsch, D., & Lehmkuhl, G. (2008). Do hyperactivity, impulsivity and inattention have an impact on the ability of facial affect recognition in children with autism and ADHD?. *European Child & Adolescent Psychiatry*, *17*, 63-72. doi:10.1007/s00787-007-0637-9

Sinzig, J., Morsch, D., Bruning, N., Schmidt, M. H., & Lehmkuhl, G. (2008b). Inhibition, flexibility, working memory and planning in autism spectrum disorders with and without comorbid ADHD-symptoms. *Child and Adolescent Psychiatry and Mental Health*, *2*, 4. doi:10.1186/1753-2000-2-4

Sinzig, J., Vinzelberg, I., Evers, D., & Lehmkuhl, G. (2014). Executive function and attention profiles in preschool and elementary school children with autism spectrum disorders or ADHD. *International Journal of Developmental Disabilities*,*60*,144-154. doi:10.1179/2047387714Y.0000000040

Sodian, B., Hulsken, C., & Thoermer, C. (2003). The self and action in theory of mind research. *Consciousness and Cognition, 12,* 777-782. doi:10.1016/S1053-8100(03)00082-5

Sohlberg, M. M., Harn, B., MacPherson, H., & Wade, S. L. (2014). A pilot study evaluating attention and strategy training following pediatric traumatic brain injury. *Clinical Practice in Pediatric Psychology*, *2*, 263-280. doi:10.1037/cpp0000072

Stevens, T., Peng, L., & Barnard-Brak, L. (2016). The comorbidity of ADHD in children diagnosed with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *31*, 11-18. doi:10.1016/j.rasd.2016.07.003

Stichter, J.P., Herzog, M.J., Owens, S.A., & Malugen, E. (2016). Manualization, feasibility, and effectiveness of the school-based Social Competence Intervention for Adolescents (SCIA). *Psychology in the Schools, 53,* 583–600. doi:10.1002/pits.21928

Stratis, E. A., & Lecavalier, L. (2013). Restricted and repetitive behaviors and psychiatric symptoms in youth with autism spectrum

disorders. *Research in Autism Spectrum Disorders*, *7*, 757-766. doi:10.1016/j.rasd.2013.02.017

Tager-Flusberg, H. (1999). A psychological approach to understanding the social and language impairments in autism. *International Review of Psychiatry*, *11*, 325-334. doi:10.1080/09540269974203

Takeuchi, A., Ogino, T., Hanafusa, K., Morooka, T., Oka, M., Yorifuji, T., & Ohtsuka, Y. (2013). Inhibitory function and working memory in attention deficit/hyperactivity disorder and pervasive developmental disorders: does a continuous cognitive gradient explain ADHD and PDD traits?. *Acta Medica Okayama, 67*, 293-303.

Thomas, S., Sciberras, E., Lycett; Papadopoulos, N., & Rinehart, N. (2015). Physical functioning, emotional, and behavioral problems in children with ADHD and comorbid ASD: A cross-sectional study. *Journal of Attention Disorder*. Advance online publication. doi:10.1177/1087054715587096

Thorell, L. B. (2007). Do delay aversion and executive function deficits make distinct contributions to the functional impact of ADHD symptoms? A study of early academic skill deficits. *Journal of Child Psychology and Psychiatry, 48*, 1061-1070. doi:10.1111/j.1469-7610.2007.01777.x

Tirapu, J., Pérez, G., Erekatxo, M., & Pelegrín, C. (2007) ¿Qué es la Teoría de la Mente? *Revista de Neurología, 44*, 479-489.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner Review: Do performance-based measures and ratings of executive function assess the same construct?. *Journal of Child Psychology and Psychiatry*, *54*, 131-143.
doi:10.1111/jcpp.12001

Tseng, W. L., Kawabata, Y., Gau, S. S., & Crick, N. R. (2014). Symptoms of attention-deficit/hyperactivity disorder and peer functioning: a transactional model of development. *Journal of Abnormal Child Psychology*, *42*, 1353-1365. doi: 10.1007/s10802-014-9883-8

Tye, C., Asherson, P., Ashwood, K. L., Azadi, B., Bolton, P., & McLoughlin, G. (2014). Attention and inhibition in children with ASD, ADHD and co-morbid ASD+ ADHD: an event-related potential study. *Psychological Medicine*, *44*, 1101-1116. doi:10.1017/S0033291713001049

Tye, C., Battaglia, M., Bertoletti, E., Ashwood, K. L., Azadi, B., Asherson, P., ... & McLoughlin, G. (2014). Altered neurophysiological responses to emotional faces discriminate children with ASD, ADHD and ASD+ ADHD. *Biological psychology*, *103*,125-134. doi:10.1016/j.biopsycho.2014.08.013

Tye, C., Mercure, E., Ashwood, K. L., Azadi, B., Asherson, P., Johnson, M. H., ... & McLoughlin, G. (2013). Neurophysiological responses to faces and gaze direction differentiate children with ASD, ADHD and ASD+ ADHD. *Developmental Cognitive Neuroscience*, *5*, 71-85. doi:10.1016/j.dcn.2013.01.001

U.S. Department of Health and Human Services. (2014). Prevalence of autism spectrum disorder among children aged 8 years-Autism and developmental disabilities monitoring network, 11 sites, United States, 2010. Morbidity and Mortality Weekly Report. Surveillance Summaries (Washington, DC: 2002), 63, 1–21. doi:24670961

Unterrainer, J. M., Rauh, R., Rahm, B., Hardt, J., Kaller, C. P., Klein, C., ... & Biscaldi, M. (2016). Development of Planning in Children with High-Functioning Autism Spectrum Disorders and/or Attention

Deficit/Hyperactivity Disorder. *Autism Research*, *9*, 739-751.doi: 10.1002/aur.1574

Van der Meer, J. M., Oerlemans, A. M., van Steijn, D. J., Lappenschaar, M. G., de Sonneville, L. M., Buitelaar, J. K., & Rommelse, N. N. (2012). Are autism spectrum disorder and attention-deficit/hyperactivity disorder different manifestations of one overarching disorder? Cognitive and symptom evidence from a clinical and population-based sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *51*, 1160-1172. doi:10.1016/j.jaac.2012.08.024

Visser, J. C., Rommelse, N. N., Greven, C. U., & Buitelaar, J. K. (2016). Autism spectrum disorder and attention-deficit/hyperactivity disorder in early childhood: A review of unique and shared characteristics and developmental antecedents. *Neuroscience & Biobehavioral Reviews*, *65*, 229-263. doi:10.1016/j.neubiorev.2016.03.019

Volden, J., Coolican, J., Garon,N., White, J., & Bryson, S. (2009). Brief Report: Pragmatic language in Autism Spectrum Disorder: Relationships to measures of ability and disability. *Journal of Autism and Developmental Disorders, 39,* 388-393. doi:10.1007/s10803-008-0618-y

Wåhlstedt, C., Thorell, L.B., & Bohlin, G. (2008). ADHD symptoms and executive function impairment: early predictors of later behavioral problems. *Developmental Neuropsychology*, *33*, 160-178. doi:10.1080/87565640701884253

Wallace, G. L., Yerys, B. E., Peng, C., Dlugi, E., Anthony, L. G., & Kenworthy, L. (2016). Assessment and Treatment of Executive Function Impairments in Autism Spectrum Disorder: An Update. In

R. M. Hodapp, & D. J. Fidler (Eds.), *International Review of Research in Developmental Disabilities* (pp. 85–122). Elsevier.

Weckstein, S. M., Weckstein, E. J., Parker, C. D., & Westerman, M. W. (2017). A Retrospective Chart Analysis with Follow-Up of Cogmed Working Memory Training in Children and Adolescents with Autism Spectrum Disorder. *Medical Science Monitor Basic Research*, *23*, 336. doi:10.12659/MSMBR.904930

Whyte, E., & Nelson, K. (2015). Trajectories of pragmatic and nonliteral language development in children with autism spectrum disorders. *Journal of Communication Disorders, 54,* 2-14. doi:10.1016/j.jcomdis.2015.01.001

Whyte, E. M., & Scherf, K. S. (2017). Gaze Following Is Related to the Broader Autism Phenotype in a Sex-Specific Way: Building the Case for Distinct Male and Female Autism Phenotypes. *Clinical Psychological Science*, 1-8. doi:10.117 7/267026177380

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biological Psychiatry*, *57*, 1336-1346. doi:10.1016/j.biopsych.2005.02.006

Willcutt, E.G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: a meta-analytic review. *Neurotherapeutics, 9*, 490–99. doi:10.1007/s13311-012-0135-8

Yang, J., Zhou, S., Yao, S., Su, L., & Mc Whinnie, C. (2009). The relationship between theory of mind and executive function in a sample of children from Mainland China. *Child Psychiatry and*

Human Development, *40*, 169–182. doi:10.1007/s10578-008-0119-4

Yerys, B. E., Hepburn, S. L., Pennington, B. F., & Rogers, S. J. (2007). Executive function in preschoolers with autism: Evidence consistent with a secondary deficit. *Journal of Autism and Developmental Disorders*, *37*, 1068-1079. doi:10.1007/s10803-006-0250-7

Yerys, B. E., Wallace, G. L., Sokoloff, J. L., Shook, D. A., James, J. D., & Kenworthy, L. (2009). Attention deficit/hyperactivity disorder symptoms moderate cognition and behavior in children with autism spectrum disorders. *Autism Research*, *2*, 322-333. doi:10.1002/aur.103

ANEXOS

Anexo 1: *Criterios diagnósticos DSM 5 Trastorno del Espectro Autista (TEA)*

A. Déficits persistentes en comunicación social e interacción social a lo largo de múltiples contextos, según se manifiestan en los siguientes síntomas, actuales o pasados:

1. Déficits en reciprocidad socio-emocional; rango de comportamientos que, por ejemplo, van desde mostrar acercamientos sociales inusuales y problemas para mantener el flujo de ida y vuelta normal de las conversaciones; a una disposición reducida por compartir intereses, emociones y afecto; a un fallo para iniciar la interacción social o responder a ella.

2. Déficits en conductas comunicativas no verbales usadas en la interacción social; rango de comportamientos que, por ejemplo, van desde mostrar dificultad para integrar conductas comunicativas verbales y no verbales; a anomalías en el contacto visual y el lenguaje corporal o déficits en la comprensión y uso de gestos; a una falta total de expresividad emocional o de comunicación no verbal.

3. Déficits para desarrollar, mantener y comprender relaciones; rango de comportamientos que van, por ejemplo, desde dificultades para ajustar el comportamiento para encajar en diferentes contextos sociales; a dificultades para compartir juegos de ficción o hacer amigos; hasta una ausencia aparente de interés en la gente.

B. Patrones repetitivos y restringidos de conductas, actividades e intereses, que se manifiestan en, al menos dos de los siguientes síntomas, actuales o pasados:

1. Movimientos motores, uso de objetos o habla estereotipados o repetitivos (ejs., movimientos motores estereotipados simples, alinear objetos, dar vueltas a objetos, ecolalia, frases idiosincrásicas).

2. Insistencia en la igualdad, adherencia inflexible a rutinas o patrones de comportamiento verbal y no verbal ritualizado (ejs., malestar extremo ante pequeños cambios, dificultades con las transiciones, patrones de pensamiento rígidos, rituales para saludar, necesidad de seguir siempre el mismo camino o comer siempre lo mismo).

3. Intereses altamente restringidos, obsesivos, que son anormales por su intensidad o su foco (ejs., apego excesivo o preocupación excesiva con objetos inusuales, intereses excesivamente circunscritos o perseverantes).

4. Hiper- o hipo-reactividad sensorial o interés inusual en aspectos sensoriales del entorno (ej., indiferencia aparente al dolor/temperatura, respuesta adversa a sonidos o texturas específicas, oler o tocar objetos en exceso, fascinación por las luces u objetos que giran).

C. Los síntomas deben estar presentes en el período de desarrollo temprano (aunque pueden no manifestarse plenamente hasta que las demandas del entorno excedan las capacidades del niño, o pueden verse enmascaradas en momentos posteriores de la vida por habilidades aprendidas).

D. Los síntomas causan alteraciones clínicamente significativas a nivel social, ocupacional o en otras áreas importantes del funcionamiento actual.

E. Estas alteraciones no se explican mejor por la presencia de una discapacidad intelectual (trastorno del desarrollo intelectual) o un retraso global del desarrollo. La discapacidad intelectual y el trastorno del espectro de autismo con frecuencia coocurren; para hacer un diagnóstico de comorbilidad de trastorno del espectro de autismo y discapacidad intelectual, la comunicación social debe estar por debajo de lo esperado en función del nivel general de desarrollo.

Nota: Los individuos con un diagnóstico DSM-IV bien establecido de trastorno autista, síndrome de Asperger o trastorno generalizado del desarrollo no especificado, deben recibir el diagnóstico de trastorno del espectro de autismo. Los individuos que tienen marcados déficits en comunicación social, pero cuyos síntomas no cumplen los criterios para el trastorno de espectro de autismo, deberán ser evaluados para el trastorno de comunicación social (pragmática).

Del mismo modo habría que especificar la gravedad y la severidad basada en la alteración social y comunicativa y en la presencia de patrones de comportamientos repetitivos y restringidos.

Tabla 1. Niveles de severidad del trastorno del espectro autista

Nivel de gravedad	Comunicación social	Comportamientos restringidos repetitivos
Nivel 3 Necesita ayuda muy notable	Déficits severos en habilidades de comunicación social verbal y no verbal que causan alteraciones severas en el	La inflexibilidad del comportamiento, la extrema dificultad afrontando cambios u otros comportamientos

	funcionamiento, inicia muy pocas interacciones y responde mínimamente a los intentos de relación de otros.	restringidos/repetitivos, interfieren marcadamente en el funcionamiento en todas las esferas. Gran malestar o dificultad al cambiar el foco de interés o la conducta.
Nivel 2 Necesita ayuda notable	Déficits marcados en habilidades de comunicación social verbal y no verbal; los déficit sociales son aparentes incluso con apoyos; inician un número limitado de interacciones sociales; y responden de manera atípica o reducida a los intentos de relación de otros.	El comportamiento inflexible, las dificultades para afrontar el cambio, u otras conductas restringidas/repetitivas, aparecen con la frecuencia suficiente como para ser obvios a un observador no entrenado e interfieren con el funcionamiento en una variedad de contextos. Gran malestar o dificultad al cambiar el foco de interés o la conducta.
Nivel 1 Necesita ayuda	Sin apoyos, las dificultades de comunicación social causan alteraciones evidentes. Muestra	La inflexibilidad del comportamiento causa una interferencia significativa en el

	dificultades iniciando interacciones sociales y ofrece ejemplos claros de respuestas atípicas o fallidas a las aperturas sociales de otros. Puede parecer que su interés por interactuar socialmente está disminuido.	funcionamiento en uno o más contextos. Los problemas de organización y planificación obstaculizan la independencia.

Nota. Adaptación del DSM-5

Especificar si:

Se acompaña o no de discapacidad intelectual.

Se acompaña o no de un trastorno del lenguaje.

Se asocia con una condición médica o genética o con un factor ambiental conocido (Nota de codificación: use un código adicional para identificar la condición médica o genética).

Se asocia con otro trastorno del neurodesarrollo, mental o del comportamiento (Nota de codificación: use otro(s) código(s) adicional(es) para identificar el trastorno del neurodesarrollo, mental o del comportamiento asociado).

Con catatonia (hacer referencia a los criterios de catatonia asociada con otro trastorno mental) (Nota de codificación: use el código adicional 293.89

[F06.1] catatonia asociada con trastorno del espectro de autismo para indicar la presencia de catatonia comorbida).

Anexo 2: *Criterios diagnósticos DSM 5 Trastorno por déficit de Atención con Hiperactividad/impulsividad (TDAH)*

A Patrón persistente de inatención y/o hiperactividad-impulsividad que interfiere con la función o el desarrollo, caracterizado por (1) y/o (2)

1. Inatención: 6 o más de los siguientes síntomas, o al menos 5 para mayores de 16 años, con persistencia durante al menos 6 meses hasta un grado inconsistente con el nivel de desarrollo y que impacta negativamente en las actividades sociales y académicas/ ocupacionales.

(a) A menudo no presta atención suficiente a los detalles o incurre en errores por descuido en las tareas escolares, en el trabajo o en otras actividades. (b) A menudo tiene dificultades para mantener la atención en tareas o en actividades lúdicas. (c) A menudo parece no escuchar cuando se le habla directamente. (d) A menudo no sigue instrucciones y no finaliza tareas escolares, encargos, u obligaciones en el centro de trabajo. (e) A menudo tiene dificultades para organizar tareas y actividades. (f) A menudo evita, le disgusta o es renuente en cuanto a dedicarse a tareas que requieren un esfuerzo mental sostenido. (g) A menudo extravía objetos necesarios para tareas o actividades. (h) A menudo se distrae fácilmente por estímulos irrelevantes. (i) A menudo es descuidado en las actividades diarias.

2. Hiperactividad e impulsividad: 6 o más de los siguientes síntomas, o al menos 5 para mayores de 16 años, con persistencia durante al menos 6 meses hasta un grado inconsistente con el nivel de desarrollo y que impacta negativamente en las actividades sociales y académicas/ocupacionales.

(a) A menudo mueve en exceso manos o pies, o se remueve en su asiento. (b) A menudo abandona su asiento en la clase o en otras situaciones en que se espera que permanezca sentado. (c) A menudo corre o salta excesivamente en situaciones en que es inapropiadohacerlo. (d) A menudo tiene dificultades para jugar o dedicarse tranquilamente a actividades de ocio. (e) A menudo "está en marcha" o suele actuar como si tuviera un motor. (f) A menudo habla en exceso. (g) A menudo precipita respuestas antes de haber sido completadas las preguntas. (h) A menudo tiene dificultades para guardar tumo. (i) A menudo interrumpe o se inmiscuye en las actividades de otros.

B) Algunos síntomas de desatención o hiperactividad-impulsividad estaban presentes antes de los 12 años de edad.
C) Algunos síntomas de desatención o hiperactividad-impulsividad se presentan en dos o más ambientes (por ejemplo, en casa, escuela o trabajo; con amigos o familiares; en otras actividades).

D) Existen pruebas claras de que los síntomas interfieren o reducen la calidad de la actividad social, académica o laboral.
E) Los síntomas no aparecen exclusivamente motivados por esquizofrenia u otro trastorno psicótico, y no se explican mejor por la presencia de otro trastorno mental (trastornos del estado de ánimo, ansiedad, trastorno disociativo, trastorno de la personalidad, abuso de sustancias o síndrome de abstinencia).

En función de los resultados se podrán clasificar las siguientes presentaciones:

Presentación combinada: Si se cumplen el Criterio A1 (inatención) y el Criterio A2 (hiperactividad-impulsividad) durante los últimos 6 meses.

Presentación predominante con falta de atención: Si se cumple el Criterio A1 pero no se cumple el criterio A2 (hiperactividad-impulsividad) durante los últimos 6 meses.

Presentación predominante hiperactiva/impulsiva: Si se cumple el Criterio A2 (hiperactividad- impulsividad) y no se cumple el Criterio A1 (inatención) durante los últimos 6 meses.