Bilingualism effects in pronoun comprehension: Evidence from children with autism

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Abstract
The prevalence of autism worldwide has risen steadily in the last two decades, while bilingualism is also becoming increasingly prevalent in today’s rapidly globalizing world. The current study aimed to investigate bilingualism effects in the pronoun resolution skills of children with autism in comparison to age-matched monolingual children with autism, as well as monolingual and bilingual children of typical development (N = 20 participants per group). Results showed that autistic children had general difficulty anchoring ambiguous pronouns to entities that were linguistically expressed in discourse, yet, the bilingual children with autism were more sensitive to the topicality of the entities in syntactic subject position and more prone to identify them as suitable referents of ambiguous null pronouns as compared to their monolingual peers. The findings suggest that bilingualism is not detrimental to autistic children’s pronoun resolution skills. The current study aimed at determining how bilingualism influences ambiguous pronoun comprehension in children with autism as compared to bilingual and monolingual children of typical development. The findings show that bilingualism was not detrimental to the autistic children’s pronoun resolution skills, further suggesting that having acquired more than one language does not exacerbate autistic children’s deficits in the comprehension of pronouns.

KEYWORDS
autism spectrum disorder, bilingualism, language deficits, pronoun resolution

INTRODUCTION
Worldwide, bilingualism is common with the use of two languages being the norm for over half of the world’s population (Jaumont, 2017). Many families with children with autism are told to refrain from using their minority language with their child for fear that it will exacerbate language deficits (Yu, 2013). However, little is known about bilingual autistic children’s language abilities and how they compare to neurotypically developing (TD) bilingual children in one or both of their languages. In fact, the studies that have looked into the language abilities of bilingual children with autism have focused on vocabulary and morphosyntactic skills (Gonzalez-Barrero & Nadig, 2018; Hamibly & Fombonne, 2012; Meir & Novogrodsky, 2020; Ohashi et al., 2012; Petersen et al., 2012; Valicenti-McDermott et al., 2013), while discourse-related aspects of language, including the interpretation of referential expressions, are to a significant extent underexplored (but see Hoang, Buchanan, et al., 2018; Hoang, Gonzalez-Barrero, et al., 2018; Meir & Novogrodsky, 2019; Peristeri et al., 2020). This study aims to shed light on this subject by investigating pronoun comprehension in a group of simultaneous bilingual Albanian-Greek children with autism in comparison to age-matched monolingual children with ASD as well as to TD monolingual and bilingual peers.

Bilingualism in children with autism
Bilingualism in autism has recently gained attention in research, mostly with respect to evidence on the beneficial
effect it may have on cognitive skills that are considered to be impaired in ASD, including executive functions (EF) and Theory of Mind (ToM) (Baron-Cohen et al., 2000; Nguyen & Astington, 2014). Preliminary results indicate a bilingual advantage for children with autism in set-shifting, attention-switching, working memory and updating (Gonzalez-Barrero & Nadig, 2019; Peristeri et al., 2020), as well as in social cognition, which has been mainly reflected in bilingual autistic children’s enhanced false-belief attribution skills (Andreou et al., 2020). Recently, the interest of research has shifted towards investigating the extent to which bilingualism in autism affects language skills, with the studies converging to show that bilingualism in children with ASD has no detrimental effects on a range of language skills, including receptive and expressive vocabulary, sentence repetition and syntactic skills (Gonzalez-Barrero & Nadig, 2018; Hambly & Fombonne, 2012; Meir & Novogrodsky, 2020; Ohashi et al., 2012; Petersen et al., 2012; Valicenti-McDermott et al., 2013). The overall results indicate that bilingual children with autism seem to develop similar core language abilities to those of monolingual children with autism and, frequently, of their TD peers, be they monolingual or bilingual. However, little is known about bilingual autistic children’s performance in language phenomena, such as referential processing, that presuppose an interplay between different components of language, as well as interactions with non-verbal cognitive systems. Few studies have investigated reference strategies in bilingual autistic children but pronoun comprehension, specifically, is important to explore, because it is an essential component of verbal communication and social interaction. Since pronouns link discourse to the real-world, deficits in pronoun comprehension in autistic children may seriously compromise access to the real-world content, thus, further challenging their communication skills.

Reference patterns in children with ASD

The majority of the studies that have been conducted in the realm of referential processing in children with autism has focused on reference production. Arnold et al.’s (2009) story-telling study has investigated reference use in 23 children and adolescents with autism (9–17 years of age) and normal to high IQ in comparison to a group of age-, gender-, and IQ-matched TD participants. They found that the individuals with high functioning autism tended to produce more explicit referential expressions (overspecification) to maintain a character in the story, which, according to the authors, indicates impaired ability to appropriately assess the cognitive status and the mental state of the listener. However, they did not detect significant group differences overall. Novogrodsky (2013) has also investigated third-person subject pronoun use in children with autism, by assessing their performance in a story-telling and retelling task. Participants were 23 children with autism, as well as age- and language-matched TD controls. The retelling task revealed no significant group differences; yet, the group with autism tended to produce more ambiguous referential expressions than their TD peers on the story-telling task, which suggests that, when children with autism were faced with the challenging task of telling a story, high cognitive demands exacerbated reference use deficits mainly manifested in the elevated use of underspecified forms.

Bilingualism effects on reference use by autistic children are highly under-investigated. In fact, reference management in bilingual populations with autism has been explored through narrative production tests, which are considered to be appropriate for testing character reference skills in terms of both syntactic and discourse knowledge. Hoang, Buchanan, et al. (2018) and Hoang, Gonzalez-Barrero, et al. (2018) have recently examined reference use in the narrative production of 10 8-year-old monolingual French-Canadian children with autism and 10 bilingual children with autism having French as their dominant language and different L2s (5 English, 1 Russian, 4 Spanish). Both bilingual and monolingual children with autism presented the tendency to use overt pronouns when introducing a new character. In a very recent study, Peristeri et al. (2020) have examined bilingual autistic children’s production of referential expressions in clitic object position in terms of referential appropriateness. Bilingual children with autism were found to produce significantly fewer ambiguous cliticized objects than their monolingual peers with autism, which was partially explained in terms of the bilingual children’s more efficient working memory and updating skills as assessed through a 2-back task.

The existent results show that bilingualism buffers the detrimental effect of autism on reference use, or at least, it does not exacerbate autistic children’s deficits in the use of referential expressions. The goal of the present study is to empirically investigate the effect of bilingualism on ambiguous pronoun comprehension in children with autism. Crucially, the effect of bilingualism on the language comprehension abilities of children with autism has so far received little attention. The bilingual Albanian-Greek children with autism that have participated in the current study were simultaneous (L1) bilinguals with dominance in Greek, while the two languages spoken (i.e., Albanian and Greek) are very similar in terms of their pronoun systems.

It should be mentioned that the Albanian population constitutes the largest immigrant community in Greece, that is, 57.5% of the total immigrant population, while about 10% of the students attending primary and secondary education in Greece are of Albanian origin (Labrianidis & Hatziprokopiou, 2005). In spite of the fact that the need to integrate Albanian students in the host educational system is widely acknowledged, the literacy
opportunities in their mother tongue (i.e., Albanian) for the majority of the Albanian-Greek bilingual children that are raised in Greece are not sufficient. These children follow in the majority of the cases a monolingual educational approach (Andreou, Tsimpili, et al., 2021). This phenomenon can be explained as a result of the lack of interest in maintaining the Albanian language by those children’s families, as well as an outcome of the low prestige status the Albanian language receives in Greece, in combination with the fact that the immigrant Albanian families demonstrate no interest in maintaining connections to their heritage country. Hence, the fact that they decide against participating in any heritage language learning opportunity or even accommodating bilingual practices for their children within and outside of the household, appears to be a conscious choice (Tsokalidou, 2005). Denying bilingual upbringing for the Albanian-Greek children also results from the mentality that bilingual language acquisition is detrimental to the proper development of the majority language of their country of residence (Kostoulas & Motsiou, 2020). Sociolinguistic evidence shows that Greek is the preferred medium of second-generation children of Albanian origin when communicating among peers, while the use of Albanian is mostly restricted to the family context, especially through informal communication with the mother and relatives in the homeland (Chatzidaki & Maligkoudi, 2013).

Referential processing in TD bilingual children has been shown to be determined by both language dominance factors (Andreou, Torregrossa, & Bongartz, 2021) and crosslinguistic influence driven by typological similarities and deviations between the two spoken languages (Sorace & Serratrice, 2009). It is thus important to consider that, when dealing with bilingual populations, the effect of dominance and language input are factors that should be taken into account, as they reflect competency both in language production and comprehension (Montrul, 2014).

The current study addresses a gap in the literature as pronoun comprehension in bilingual autistic children remains a highly underexplored area, and questions remain unanswered regarding the way pronoun comprehension in the same population is affected by language ability, age and bilingual status. As such, the first research question of the current study concerns the effect of bilingualism on the reference assignment strategies of autistic children. We predicted that bilingualism would not be detrimental to the autistic children’s pronoun resolution skills, or at least it would not accentuate the pronoun comprehension difficulties potentially observed in the monolingual children with autism. The second research question aimed to investigate the relation between autistic children’s pronoun comprehension performance and their age and language ability (specifically, expressive vocabulary), as well as language input factors, such as current language use and home language history, in both Greek and Albanian for the bilingual children.

**Pronominal systems in Greek and Albanian**

Pronominal subject realization in Greek and Albanian pattern alike, as they both are null subject languages. More specifically, pronominal forms traditionally involve null (the default option) and overt pronouns (the marked option) in both languages and each form exhibits different referential preferences. Null pronouns in Greek, and in other null subject languages, are phonetically empty anaphoric expressions which occupy the subject position in a tensed clause (e.g., Ø pezi ‘(S/he) plays’). The person and number features of null subject pronouns are retrieved from the inflectional morphology (i.e., /–i/ in ‘pezi’) of the tensed verb. Overt pronouns, on the other hand, are phonetically overt, they can occupy a subject position and morphophonologically agree with the verbal inflection (e.g., aftos pezi (‘He plays’). Several studies in Greek have shown that null subject pronouns (Ø) facilitate topic-continuity within contexts, where the relation between the null pronoun and the context-induced topic is easily identifiable (Andreou et al., 2016, see Examples 1a and 1b).

(1a) Greek:

| Ø | πυέ | στο | έρο | λάγος |
|---|---|---|---|---|
| O | layó* | 0eli | na voitiši | tín |

The rabbit.SING.MASC.NOM want.3P.SING.IND. to help.3P.SING. PST.SBJV. the.SING.MASC.ACC. fíli tu. friend. his.PR. SING. MASC. MASC. ACC. GEN.

(1b) Albanian:

| Ø* | πυέ | στο | έρο | λάγος |
|---|---|---|---|---|
| O | go.3P. to-the. old rabbit. |

The rabbit wanted to help his friend. He (i.e. the rabbit) went to the old rabbit.

Menjehere Øa vendosi te kape te tullumbacen

Immediately, Ø decide.3P.SING.PST.IND. catch.3P.SING. PST.SBJV the balloon.SING.NEUT.ACC. pe te lozur me shoqen e tij in order to play.3P.SING.PST.SBJV with his.PR SING. MASC. GEN. friend.SING.MASC.ACC.

Immediately, he (i.e. the rabbit) decided to catch the balloon in order to play with his friend.

Overt pronouns, on the other hand, either in subject or object position, are usually linked with the less
prominent or accessible non-subject referents (see underlined Examples 2a and 2b).

(2a) Greek:

Ø Pīye  sto yéro layób  Aftósb  
Ø go.3P.SING. PST.IND. to-the old rabbit.SING. He.PR.SING. 
PST.IND. MASC.ACC. MASC.NOM. 
the pola balónia. 
have.3P.SING. PST.IND. lots-of balloons.PL. 
NEUT.ACC. 

(He, i.e., the rabbit) went to the old rabbit. He (i.e., the old rabbit) had lots of balloons.

(2b) Albanian:

Aib  po  e shikonte  
He.PR.SING. look.3P.SING.PST.PROGR. at her.PR.SING. 
MASC.NOM. FEM.ACC. 
terrified.SING. 
MASC.PTCP. 

He (i.e., the old rabbit) was looking at her terrified.

Abbreviations: 3P, 3rd person;  SING, singular;  PST, past tense;  PROGR, progressive;  Ø, null pronoun;  ACC, accusative;  NOM, nominative;  MASC, masculine;  PR, overt pronoun;  GEN, genitive;  NEUT, neuter.

The aforementioned reference patterns of Greek null and overt pronouns have been attested in adult written corpora (Charatzidis et al., in press; Dimitriadis, 1996; Papadopoulou, 2020) but also in comprehension experiments (Papadopoulou, 2020; Papadopoulou et al., 2015). The linking of subject pronouns with topics has been attributed, on one hand, to that more attenuated referring expressions tend to be linked to topic antecedents (Ariel, 1990), and, on the other, to Position Antecedent Strategy (Carminati, 2002), according to which the preferred referent of a null pronoun is located in syntactic subject position. Moreover, overt pronouns are preferably linked with an antecedent that is not the subject of the previous sentence, thus, signaling a shift in subject reference (also, called ‘topic-shift’) (Papadopoulou et al., 2015, 113–14). Papadopoulou et al. (2015) examined the resolution of null and overt pronouns not only by Greek adults but also by Greek monolingual children, with the use of a self-paced listening sentence picture matching task. Children were divided into three age groups, (a) 6- to 7-year old, (b) 7- to 8-year old, and (c) older ones aging 10–11 years. Participants had to indicate whether the sentence that they listened to matched the constant picture on the screen. The experimental sentences consisted of a main clause, where two referents of the same gender were introduced, immediately followed by a subordinate clause, the subject of which was either a null or overt pronoun (see Example 3).

The findings of the study showed that discourse features were not yet acquired even at the age of 10–11 years and that each type of pronoun was resolved differently across the various age groups. Analysis of the null pronoun showed that children follow a U-shaped development with no steady resolution preference towards the subject antecedent even at older age. Specifically, although the younger group exhibited a clear preference for topic-continuity contexts (subject antecedent), 10- and 11-year old children did not show any biases to link the null pronoun with the subject referent. Nonetheless, a developmental pattern is visible in their overt pronoun resolutions since younger children experienced difficulties in showing a bias whereas older children displayed a preference for the object antecedent and were sensitive to the topic-shift context.

**METHODOLOGY**

**Participants**

The study included 80 children in total, 20 children in each group (typically developing monolingual children (henceforth, TDmono): 4 girls/16 boys; $M_{age} = 10.4$ years, age range: from 8.8 to 12.2 years; typically developing bilingual children (henceforth, TDbi): 4 girls/16 boys; $M_{age} = 9.9$ years, age range: from 7.9 to 11.6 years; monolingual children with autism (henceforth, ASDmono): 3 girls/17 boys; $M_{age} = 9.9$ years, age range: from 7.0 to 12.0 years; bilingual children with autism (henceforth, ASDbi): 4 girls/16 boys; $M_{age} = 10.2$ years, age range: from 8.1 to 12.2 years). The four groups did not differ in age, $F(3, 79) = 2.334, p = 0.10, \eta^2 = 0.29$.

The autistic children’s non-verbal intelligence (or else, performance IQ; PIQ) scores were above clinical levels of intellectual impairment, as measured through the percentile scores on the Greek version of the Wechsler Intelligence Scale for Children-Revised (WISC-III) (Wechsler, 1992; adapted in Greek by Georgas, Paraskevopoulos, Besevegis, Giannitsas, & Mylonas, 2003). Besides PIQ scores, between-group analyses were run on the core
Coding and Symbol search subtests of the PIQ scales. These time-sensitive subtests have been deployed in the current study as measures of the autistic children’s processing efficiency, since they have been designed to measure processing speed, visual selective attention, vigilance, perceptual speed, and visual–motor ability (Koyama et al., 2009; Mayes & Calhoun, 2006). This way, we looked for possible differences between monolingual and bilingual children with autism in cognitive efficiency that could have affected their performance in the pronoun comprehension task. Fluency in L2 production, which is perceived as the production of communicatively accepted utterances in the L2, has been associated with several cognitive operations responsible for performing fluently in L2, including speed of lexical access, and speed and processing efficiency of attentional control (Segalowitz, 2016; Segalowitz & Freed, 2004). The processing speed data obtained from the Coding and Symbol search subtests of the WISC-III tool allowed us to detect differences between ASDmono and ASDbi children’s attention and perceptual speed skills that could have confounded their performance in the pronoun task. There were no significant differences in PIQ, $F(1, 39) = 0.036, p = 0.850, \eta^2 = 0.03$, Coding, $F(1, 39) = 2.956, p = 0.104, \eta^2 = 0.27$, and Symbol search scores, $F(1, 39) = 0.226, p = 0.637, \eta^2 = 0.05$, between the two groups (see Table 1). The finding that the two groups with autism did not significantly differ in processing efficiency allowed us to observe direct effects of bilingualism on pronoun comprehension.

Besides children’s intelligence and cognitive profiles, we wanted to assess comorbidity of Developmental Language Disorder (DLD) in both the monolingual and the bilingual autistic groups. Many autistic children demonstrate language difficulties, even if fluent language has been achieved, such as difficulties with grammar which are similar to the syntactic difficulties detected in children with DLD (Tager-Flusberg, 2003; Wittke et al., 2017). To examine whether the autistic children in the current study had a grammatical deficit, we have used the Greek version of the sentence repetition task which was developed within the COST Action IS0804 (Chondrogianni et al., 2013; Marinis et al., 2015). The particular test includes 32 sentences in total, but we focused on two types of sentences, namely, those involving clitics in clitic left dislocation and clitic doubling contexts ([N]umber of sentences = 4) and object wh-questions ([N] of sentences = 4). We assumed that the autistic children’s performance in the specific structures would reliably reflect a syntactic deficit across the two groups, since pronominal clitics and structures involving phrasal movement, like wh-questions, have been found to be particularly problematic for children with a primary language impairment, such as DLD (for clitics see Arosio et al., 2014; Tsimpli et al., 2017; for wh-questions see Marinis & van der Lely, 2007; Friedmann & Novogrodsky, 2011). During the sentence repetition task, the child listened to each sentence only once and repeated it as accurately as possible. Any mistake in the repetition of a word or any omitted word was counted as an error. Each child listened to the eight sentences via headphones and her/his responses were recorded. Regarding scoring, the child scored three points for each sentence repeated correctly, while two points and a single point were awarded in case s/he made one and two errors, respectively. In case the child made more than two errors while repeating a single sentence, s/he received zero points. The highest possible score was 24 points.

A $2 \times 2$ (Group: TD, autism; Language status: monolinguals, bilinguals) ANOVA was conducted for the sentence repetition scores (see Table 1). There was a main effect of Group, $F(1, 79) = 17.396, p < 0.001, \eta^2 = 0.18$, as well as a main effect of Language status, $F(1, 79) = 6.666, p = 0.012, \eta^2 = 0.08$. The interaction between Group and Language status was not significant, $F(1, 79) = 1.267, p = 0.264, \eta^2 = 0.02$. The results indicate that both autistic groups scored lower in repeating clitic and wh-question structures than the TD groups, which implies a syntactic deficit. Specifically, 25% of the monolingual autistic children and 35% of the bilingual autistic children scored at or below chance level in the specific structures. Furthermore, bilingualism had a detrimental effect on the children’s accuracy scores, which agrees with previous research that reports similar sentence repetition performances between TD bilingual children and bilingual children with a language disorder (Meir et al., 2016; Meir & Novogrodsky, 2020).

Children with autism were recruited from schools, public and private diagnostic centers. They had received a

| Table 1 | Groups’ mean PIQ, coding, symbol search mean scores (SDs) in WISC-III, and ADI-R total scores |
|---------|------------------------------------------------|
|         | ASDmono | ASDbi | TDmono | TDbi |
| PIQ     | 92.2 (12.6) | 92.9 (8.6) | - | - |
| Coding  | 8.5 (2.3) | 9.6 (1.5) | - | - |
| Symbol search | 9.6 (1.8) | 9.3 (2.2) | - | - |
| ADI-R total scores | 36.0 (4.8) | 34.9 (3.7) | - | - |
| Sentence repetition (max. Score) | 15.8 (4.3) | 14.6 (3.3) | 19.7 (1.8) | 16.9 (3.6) |

Abbreviations: ADI-R: Autism Diagnostic Interview-Revised; ASDmono, monolingual children with autism spectrum disorder; ASDbi, bilingual children with autism spectrum disorder; max.: maximum; PIQ: performance IQ; TDmono: monolingual children with typical development; TDbi: bilingual children with typical development; WISC-III: Wechsler Intelligence Scale for Children-Revised.
language preference in everyday life with family members or
age of four) and current language use (i.e., literacy and lan-
child
questionnaire identified the home language history (i.e., the
was documented through a comprehensive language history
M
ASDbi:
language children with and without autism came from bilingual
households with at least one parent being an immigrant,
thus participants were simultaneous bilinguals, that is,
exposed to both languages from the time of birth. All the
bilingual children were Albanian-Greek speakers and they
were all dominant in Greek. Children’s language experience
was documented through a comprehensive language history
questionnaire (see Andreou, 2021, for more details). The
questionnaire identified the home language history (i.e., the
child’s exposure to each language from birth time up to the
age of four) and current language use (i.e., literacy and lan-
guage preference in everyday life with family members or
friends) (Home language history: TDbi: M = 20.9 (13.7);
ASDbi: M = 27.8 (12.3), Current Language Use: TDbi: M = 36.3 (9.0); ASDbi: M = 24.5 (12.6)). The two biling-
gual groups did not differ in Home Language History, F
(1, 39) = 2.770, p = 0.10, η² = 0.33, yet, they differed in
Current Language Use, F(1, 39) = 9.447, p = 0.004, η²
= 0.45, since the TDbi children showed higher rates of cur-
rent use of Greek than their bilingual peers with autism.

General procedure

All groups of children completed the following tasks in a
fixed order: an expressive vocabulary task and an online
task that tested ambiguous pronoun comprehension. The pronoun comprehension task was run on a computer using E-Prime software (Schneider et al., 2012). Due to the lack of the authors’ knowledge of Albanian, that could have otherwise allowed the administration of the online pronoun task in Albanian, the pronoun task was administered in Greek only. Children were tested individually at school or in a quiet area of their home. Participants completed the tasks in a single testing session. Data collection took place over a period of 24 months (from March 2017 to March 2019). The study was approved by the Research Ethics Committee of the Greek Ministry of Education and parental consent was required for participation in the study.

Experimental tasks

Expressive vocabulary task

The children’s expressive vocabulary was assessed with an expressive vocabulary test, which has been adapted from the Renfrew Word Finding Vocabulary Test (Renfrew, 1995). This test has been standardized for 3- to 10-year-old Greek-speaking monolingual children. The bilingual children with and without autism were adminis-
tered both the Greek adaptation and the Albanian trans-
lation of the expressive vocabulary test to see whether their lexical retrieval skills would differ across the two languages. The test includes 50 black-and-white pictures of common objects that each child was asked to name individually. Each correct answer earned one point, with a maximum score of 50. The test was terminated when the participant failed to respond correctly to five consecutive trials. It should be noted that within the framework of researching bilingualism effects in the language abili-
ties of children with disorders in Greece, vocabulary skills have been largely investigated in the L2/Greek, with lim-
ited attention to measuring vocabulary in the bilingual children’s heritage language, mainly due to the lack of both standardized tests for bilingual children and lan-
guage tests adapted to Albanian. The Greek adaptation of the Renfrew task (Vogindroukas et al., 2009) has so far been used with many bilingual children living in Greece (e.g., Andreou & Tsimpli, 2020; Andreou, Tsimpli, et al., 2021; Dosi, 2019). Despite its extensive use with bilingual child populations, the expressive
vocabulary scores of the bilingual groups should be treated with caution.

Picture verification pronoun comprehension task

We implemented an online listening sentence picture veri-
fication task, based on Marinis (2007, 2008), Marinis and
Saddy (2013) and Papadopoulou et al. (2015). The task
consisted of pictures that appeared on the computer screen. While the picture remained on the screen, a pre-
recorded sentence was provided acoustically in a phrase-
by-phrase fashion to the participants, who could control the reproduction of the segments with a press of a button on a push button box. The presentation of the sentential segments was therefore self-paced. During the time the sentence unfolded, the relevant picture-probe was continu-
ously shown at the center of the screen and stayed there until the end of the entire sentence. Therefore, the partici-
pants were presented with the visual scene and the audio recording of each experimental sentence simultaneously. After the end of the recorded sentence, the picture was replaced by a question mark (“?”), that was shown in the center of the screen for 2 s, during which the participant should reach a decision as to whether the sentence was congruent to the visual scene or not. Two pre-specified buttons on the push button box were available to the partici-
ants for making their responses (✓ for a match response; x for a mismatch response). Participants were instructed to press the button in order to listen to the sen-
tences. They had 10 practice sentences for familiarization
with the task. Participants’ (mis)matching responses were measured, in order to examine the pronoun resolution preferential choice at the end of the sentence. The task was designed and run with E-prime software (Schneider et al., 2002).

**Materials**

This task consists of 10 practice sentences, 20 experimental sentences (half with a null subject pronoun and the rest with an overt pronoun), 60 experimental pictures (each sentence being accompanied by three pictures having the subject/object/other referent as the agent of the action of the subordinate verb), and 20 filler sentences. Specifically, the experimental sentences included a matrix clause, where two characters were introduced, one of which was in the subject position and the other in the object position, succeeded by an adverbial clause with a null pronoun as the subject position (see [4]).

(4) O pàpuć / miılüse / ðìnàtä / ston egono6 tu / òtan / Ø / aftòsδ
djàvaze / èna vivlió.

“The old-man.SING.MASC.NOM. / speak.3P.SING.PST.PROGR./ loudly / to grandchild.SING.MASC.ACC. his.PR.SING.MASC. GEN./ when / Ø / he.PR.SING.MASC.NOM. read.3P.SING. PAST.PROGR. / a book. SING.NEUT.ACC.”

The old man was speaking loudly to his grandchild when he was reading a book.

Abbreviations: 3P, 3rd person; SING, singular; PST, past tense;
PROGR, progressive; Ø, null pronoun; ACC, accusative; NOM, nominative; MASC, masculine; PR, overt pronoun; GEN, genitive; NEUT, neuter.

The slashes in (4) demonstrate the segments the sentence was divided into. A female native speaker of Greek did the recordings of the sentences with a normal speaking pace, by maintaining a neutral intonation style in order to eliminate any prosodic bias on the participants’ preferred perception. Cool Edit was later used to segment the recorded sentences. Each experimental sentence was paired with three different pictures. The pictures showed the action described in the adverbial clause and each picture allowed for a different interpretation: the first picture demonstrated an agent that was the subject of the main clause (the old man, for (4)), the second picture showed an agent that was the object of the main clause (the grandchild, for (4)), and the third picture, an agent that was a third character (e.g., a young man for (4)). It should be mentioned, that for a sentence such as (4) all three references are grammatically acceptable. The attribution of the null pronoun to the subject or the object or a third referent reveals a strategy of the pronoun resolution instead of a grammaticality judgment (see Dimitriadis (1996), Carminati (2002) and Papadopoulou et al. (2015) for similar arguments). Both conditions had therefore no correct or incorrect responses; rather, the children’s antecedent choices reflected different degrees of discourse appropriateness, for example, linking the overt pronoun to the entity in object position would be more pragmatically appropriate than linking it to the entity in syntactic subject position. The filler items consisted of 20 unambiguous, true or false sentences that either matched or mismatched the corresponding picture (see Examples 5 and 6 below). They were all simple transitive or relative structures. Half of the filler items required a mismatch response to avoid a “match” bias. Both autistic and TD children’s accuracy performance in the filler items reached ceiling level.

(5) Iparhi / lijo psomi / pano / sto trapezi / ke / katholu/ jala

There is some bread on the table and no milk (match response)

(6) O kathiritis /pu /ësosë/ ta vivlia /sti fititria /forai /
yialia

The professor who gave the books to the student wears glasses (mismatch response)

Three lists were created, each containing the 20 experimental sentences (10 with a null subject pronoun and 10 with an overt pronoun) and the 20 filler sentences. The experimental sentences were paired with one of the three pictures in each list. Each participant was administered all three lists.

**RESULTS**

Expressive vocabulary task

Table 2 below shows the groups’ mean performances and standard deviations (SD) in the Greek and Albanian version (for the bilingual groups, only) of the expressive vocabulary task.

| TABLE 2 Groups’ mean scores (SDs) in the Greek and the Albanian version of the expressive vocabulary task |
|-----------------------------------------------|
|                                      | TDmono | TDbi | ASDmono | ASDbi |
| Expressive vocabulary-Greek (maximum score: 50) | 44.7 (2.1) | 36.8 (5.1) | 37.7 (4.9) | 29.8 (8.2) |
| Expressive vocabulary-Albanian (maximum score: 50) | - | 39.4 (4.7) | - | 32.5 (5.4) |

Abbreviations: ASDmono, monolingual children with autism spectrum disorder; ASDbi, bilingual children with autism spectrum disorder; TDmono, typically developing monolingual children; TDbi, typically developing bilingual children.
There was a main effect of Disorder, $F(1, 79) = 31.427, p < 0.001, \eta^2 = 0.29$, as well as a main effect of Language status, $F(1, 79) = 40.060, p < 0.001, \eta^2 = 0.35$. The main effect results indicate that both monolingual and bilingual autistic children scored lower in vocabulary than the TD groups, while the bilingual children with and without autism scored lower than their monolingual peers. For the Albanian version of the expressive vocabulary task, there was a main effect of Disorder, $F(1, 39) = 18.885, p < 0.001, \eta^2 = 0.33$, which stemmed from the fact that the ASDbi children scored lower than their TDbi peers. Furthermore, differences between scores in the Greek and the Albanian version of the expressive vocabulary task were tested separately for the TDbi and the ASDbi group through paired t-tests. The difference was nonsignificant for both the TDbi, $t(19) = 1.264, p = 0.222$, and the ASDbi group, $t(19) = 1.496, p = 0.151$.

### Picture verification pronoun comprehension task

The output of the picture verification task included behavioral responses of both (mis)matching preferences and reaction times (RTs), yet, RTs were not included in the analysis due to the fact that the standard deviations of the speed of responses (i.e., variability in the time to launch a decision) were very variable across the monolingual and the bilingual autistic children. A further reason for not using RTs is that the latter reflect a series of processes, like scanning the images and parsing the sentence at the same time, as well as doing syntactic re-analyses following interpretive difficulties; given this chain of events, it is difficult to say whether RTs reflect the processes involved in pronoun resolution or/and domain-general cognitive factors.

Table 3 below shows groups’ mean performances in the matching decision (%) of the picture verification pronoun comprehension task.

We first present the results on the null pronoun trials. A $2 \times 2$ (Group: TD, autism; Language status: monolingual, bilingual) repeated measures ANOVA was conducted for Referent (subject, object, other) preferences. There was a main effect of Disorder, $F(1, 76) = 88.351, p < 0.001, \eta^2 = 0.54$, and a main effect of Language status, $F(1, 76) = 5.613, p = 0.020, \eta^2 = 0.07$. The main effect results indicate that the autistic children had higher mismatching decision rates than the TD groups, while the bilingual children had higher matching rates than their monolingual peers. There also was a significant three-way interaction among Disorder, Language status and Referent, $F(2, 152) = 3.655, p = 0.028, \eta^2 = 0.05$.

To unpack the significant interaction, we ran separate repeated measures analyses for each group. For the TDmono group, there was a significant Referent effect, $F(2, 38) = 60.640, p < 0.001, \eta^2 = 0.76$, which was due to the fact that both the subject and the object referent were preferred significantly more often than the other referent ($p < 0.001$ for the subject vs. other comparison; $p < 0.001$ for the object vs. other comparison). The difference between the subject and the object referent was not statistically significant ($p = 0.216$). For the TDbi group, there was a significant Referent effect, $F(2, 38) = 73.179, p < 0.001, \eta^2 = 0.79$, which was due to the fact that the subject referent was significantly more preferred than the object, while both the subject and object referents were preferred significantly more than the other referent ($p < 0.001$ for all comparisons). For the ASDmono group, there was a significant Referent effect, $F(2, 38) = 13.832, p < 0.001, \eta^2 = 0.42$, which was due to the fact that the other referent was selected significantly more than both the subject and the object referent ($p < 0.001$ for the subject vs. other comparison; $p = 0.001$ for the object vs. other comparison). The difference between the subject and the object referent was not found to be statistically significant ($p = 0.748$). Finally, for the ASDbi group, there was a significant Referent effect, $F(2, 38) = 6.272, p = 0.004, \eta^2 = 0.25$, which was due to the fact that the other and the subject referents were selected significantly more than the object referent ($p = 0.002$ and $p = 0.007$, respectively). There was no significant difference between the subject and the other referent matching decision rates ($p = 0.239$).

We now present the results on the overt pronoun trials. There was a main effect of Disorder, $F(1, 76) = 32.232, p < 0.001, \eta^2 = 0.29$, which stemmed from the fact that that the autistic children had higher mismatching decision rates than the TD groups. The Language status effect was non-significant, $F(1, 76) = 1.481, p = 0.227, \eta^2 = 0.02$. There also was a

### Table 3

Groups’ mean matching decision rates (%) and SDs in the picture verification pronoun comprehension task

| Group  | Null pronoun trials | Overt pronoun trials |  |
|--------|---------------------|----------------------|--|
|        | Subject | Object | Other | Subject | Object | Other |
| TDmono | 86.6 (12.7) | 76.3 (17.4) | 11.7 (16.3) | 71.6 (16.3) | 86.2 (15.3) | 25.0 (18.4) |
| TDbi   | 96.6 (14.9) | 80.0 (10.8) | 28.3 (11.1) | 68.2 (10.2) | 82.5 (14.8) | 25.0 (15.6) |
| ASDmono | 13.2 (19.8) | 20.0 (17.3) | 50.1 (15.1) | 26.5 (15.3) | 26.6 (13.2) | 56.3 (17.9) |
| ASDbi  | 34.9 (16.0) | 23.8 (18.9) | 43.3 (10.3) | 26.6 (13.2) | 43.3 (14.5) | 70.0 (16.4) |

Abbreviations: ASDmono, monolingual children with autism spectrum disorder; ASDbi, bilingual children with autism spectrum disorder; TDmono, typically developing monolingual children; TDbi, typically developing bilingual children.
significant two-way interaction between Disorder and Referent, $F(2, 152) = 74.856$, $p < 0.001$, $\eta^2 = 0.49$. To unpack the significant interaction, we ran repeated measures analyses separately for the TD and the autistic children. The autistic children tended to prefer subject and object referents significantly fewer times than their TD peers ($p < 0.001$ for both comparisons), while the reverse pattern was found for the other referent, that is, the autistic children tended to prefer other referents significantly more than TD children ($p < 0.001$).

**Interim summary**

The analyses of the pronoun comprehension data showed significant disorder and bilingualism effects on the groups’ referential choices in the null pronoun trials, while no bilingualism effect was observed for the overt pronoun trials. More specifically, in the null pronoun trials, the other referent was robustly preferred by the ASDmono group, while the ASDbi children tended to oscillate between the other and the subject referent. The TDmono group oscillated between the subject and the object referent, while the TDbi children exhibited a robust preference towards the object referent. In the overt pronoun trials, the other referent was the dominant choice across the autistic (both monolingual and bilingual) children, in contrast to the TD children that tended to prefer the subject and the object referent.

**Links between referent preference rates, expressive vocabulary, age, current language use, and home language history**

The linear regression analysis tested the links between each group’s preference for the subject, object and other referent across null and overt pronoun trials, expressive vocabulary in Greek and age. Also, bilingual children’s referent matching decisions were also examined in relation to their home language history, current language use and expressive vocabulary in Albanian. Table 4 below presents the significant predictive relations which emerged for each experimental group.

For the TDmono group, age uniquely predicted null pronoun-subject antecedent preference rates, while the regression model was non-significant for the TDbi group. Age and expressive vocabulary in Greek in the ASDmono group emerged as significant predictors of the null pronoun-subject antecedent preference rates. Finally, for the ASDbi group, age and current language use were inversely associated with the variance in the null pronoun-other antecedent preference rates, while current language was inversely associated with the overt pronoun-other antecedent preference rates.

**DISCUSSION**

Research in neurotypical children has described the influences of bilingualism on their language development at various levels of language processing (e.g., Kroll & Bialystok, 2013; Nicol, 2001; Sorace, 2016). However, an understanding of the influence of bilingualism in the language performance of children with autism is lacking, which both obscures our knowledge of how bilingualism and autism intersect and strengthens the fear of parents that the use of two languages may hinder the child’s language development. Bilingualism’s growing prevalence leads to an increasing clinical and practical need to understand how bilingualism manifests in language outcomes in children with autism. The current study addresses this need by examining bilingual ASD children’s ambiguous pronoun resolution preferences in a null subject language (i.e., Greek) and comparing these preferences to those of age- and PIQ-matched monolingual autistic children, as well as TD monolingual and bilingual children. According to the study’s findings, both monolingual and bilingual children with autism showed consistent bias towards the other, extra-sentential referent across both null and overt subject pronouns, while subject and object referents tended to take priority in the referential preferences of the TD children only, since the ASDbi children preferred subject and other referents to an equal extent in the discourse contexts with an ambiguous null pronoun, in contrast to

| Group    | Pronoun-referent matching condition | Predictor(s)       | $\beta$ | $R^2$ | $F$  |
|----------|-------------------------------------|--------------------|--------|-------|------|
| TDmono   | Null pronoun-Subject                 | Age                | 0.342  | 0.12  | 5.146** |
| ASDmono  | Null pronoun-Subject                 | Age                | -0.699 | 0.48  | 9.796** |
|          |                                     | Vocabulary in Greek| 0.351  |       |      |
| ASDbi    | Null pronoun-Other                   | Age                | -0.497 | 0.22  | 4.278*  |
|          |                                     | Current language use| -0.381  |       |      |
|          | Overt pronoun-Other                  | Current language use| -0.476  | 0.20  | 4.143*  |

*p < 0.05; **p < 0.01.
their monolingual autistic peers wherein the identification of extrasentential entities as the preferred referents was observed robustly. The overall pattern of results suggests that bilingualism is not detrimental to autistic children’s referential processing in ambiguous pronoun comprehension contexts.

The monolingual and bilingual children with autism that have participated in the current study were matched on autism severity, and were also matched with TD children on age and PIQ. Both bilingual groups with and without autism scored lower than their monolingual peers with and without autism, as revealed through their performance in the repetition of structures involving clitics and wh-questions, while both groups scored significantly lower than their monolingual peers on expressive vocabulary in L2/Greek. This is not surprising since the vocabulary knowledge of bilinguals is distributed across the two languages, thus, single-language assessments tend to underestimate a bilingual child’s total conceptual vocabulary knowledge (Bedore & Peña, 2008). In the current study, bilingual children’s vocabulary skills were also measured in Albanian through the translational equivalent of the expressive vocabulary task. The lack of standardized language ability tests in Albanian did not allow us to compare the bilingual children’s standard scores with monolingual scores for each language, that is, Greek and Albanian. We speculate that single-language assessment of vocabulary is the main reason for not finding significant relationships between the bilingual groups’ referent preferences across pronoun types in the pronoun comprehension task and their expressive vocabulary scores.

Our first research question concerned the effect of bilingualism on the autistic children’s pronoun comprehension ability. Regarding referent choices in null pronoun trials, matching decision rates indicated distinct patterns across groups. More specifically, TDmono children seemed to oscillate between the subject and the object referent, which were both preferred significantly more than the other referent. This is in line with Papadopoulou et al.’s (2015) finding that 10-year-old TD monolingual Greek-speaking children do not manifest subject preference for the null pronouns, which implies that the null subject pronoun is underspecified as far as its discourse features are concerned. Papadopoulou et al.’s (2015) study shows that TD Greek-speaking monolingual children actually exhibit a drop in subject preference at age 10 because of discovering exceptions to the null pronoun-subject co-indexation rule, and then an increase after year 11 because of the maturation of their pronoun comprehension system, thus, resulting in U-shaped development. On the other hand, TDbi children went for a clear subject preference, which is in line with theoretical models that postulate a strong connection between null pronouns and referents in syntactic subject/topic position for discourse prominence reasons (Carminati, 2002; Dimitriadis, 1996; Miltsakaki, 2007). The use of null pronouns in discourse in null subject languages is influenced by preceding context, and more specifically, by how the antecedent is linguistically realized. Work on syntactic subjects’ discourse status reveals that first-mentioned antecedents in subject position are more available than antecedents in object position for null pronoun reference (Filiaci et al., 2014; Kaiser, 2010). For example, in a sentence like Ana is cleaning up with Liz. O needs the broom, the null subject tends to pick the syntactic subject, or topic (i.e., Ana). These findings fit with syntactic subjects’ reputation as discourse salient, that is, as guiding listeners’ attention and memory for subsequent anaphoric reference. We speculate that TDbi children’s strong bias towards the subject referent in null pronoun trials may have been the result of a transfer effect between the two languages, that is, Albanian and Greek; since the two language systems behave similarly in terms of the discourse features of their subject pronouns, this typological proximity may have strengthened the children’s underlying parsing biases towards the subject referent. Interestingly, Andreou et al. (2016) also found that TD Albanian-Greek children tended to produce higher rates of null subject pronouns in topic-continuity contexts relative to TD monolingual Greek-speaking children in a narrative production task. Although the ASDbi group showed stronger preference for the subject over the object antecedent in the null pronoun trials, the subject and other referent rates were very similar. Regarding ASDmono children, there was a clear preference for the other referent which was significantly stronger relative to both the subject and the object referent.

The presence of an overt subject pronoun in the referentially ambiguous sentences gave rise to a robust disorder effect that distinguished between TD and autistic children regardless of bilingualism. More specifically, both TD groups preferred the subject and the object relative to the other referent, while both autistic groups picked the other referent to a significantly greater extent as compared to the sentential entities in subject and object position. The pattern of performance in the TD groups aligns with Papadopoulou et al.’s (2015, 2020) research finding that topic-shift driven by the use of overt pronouns in discourse is a computationally demanding operation that is acquired in null subject languages after late childhood, at least not until the age of 10. Crucially, both the ASDmono and ASDbi children exhibited a strong preference for the other referent only, which was not linguistically expressed in the experimental sentences. This pattern suggests that the autistic children had difficulty linking the ambiguous overt pronoun to entities whose reference was established through language, while they judged the extrasentential referents to be more suitable antecedents.

The finding that both autistic groups showed a preference for the other referent is intriguing. We speculate that this bias stems from the cognitive processing style that characterizes individuals within the spectrum, and more
specifically, their over-attention to detail and insistence on
sameness. Individuals with autism have been extensively
reported to exhibit excellent attention to detail (Baron-
Cohen et al., 2009; Ropar & Mitchell, 2001), which has
also been recognized to contribute to feeling overwhelmed
with integrating local features into a global framework
(see Robertson & Baron-Cohen, 2017, for a review). Fur-
thermore, rigidity and insistence on sameness are core
symptom domains in autism that prevent individuals from
adapting to unexpected situations (Leekam et al., 2011;
Uljarević et al., 2020). We consider the possibility that the
children with autism tracked the extra-sentential entity in
the visual stimuli of the picture verification task, also
noticing the lack of sameness between the three visual pro-
tagonists of the pictures (e.g., the old man, the child and
the young man/other) and the two sentential entities in the
trial, e.g., ‘The old man spoke loudly to his grandchild
when he read a book’. The incongruency between the
visual and the auditorily presented entities may have
forced children with autism to pick the other referent in an
attempt to reconcile linguistic and extra-linguistic informa-
tion. Although research between the cognitive processing
style in autism and language outcomes is limited, we
believe that the robust local conceptualization and insis-
tence on sameness that characterize the perceptual skills of
individuals with autism may partially explain their bias
towards the extra-sentential entity.

The fact that the ASDbi children exhibited a signifi-
cant bias towards the subject and the other referent in the
null pronoun trials hints at a difference between the
ASDmono and the ASDbi children in the way the two
groups perceived the discourse prominence of referents
appearing in syntactic subject position. As already men-
tioned, (agentive) subjects are prominent in discourse due
to their high topicality, and tend to be linked to null pro-
nouns based on principles of topic continuity, mainly
akin to discourse coherence-based accounts of pronoun
resolution (Chafe, 1976; Givón, 1983; Kehler, 2002). The
finding that the other and the subject referent were
equally plausible antecedents for the null pronoun trials
in the ASDbi (vs. ASDmono) group suggests that bilingual-
ism had an impact on the referential assignments
strategies of the bilingual autistic group, at least for the
null pronoun contexts. We speculate that bilingualism
strengthened the topicality of the noun phrases in syntac-
tic subject position, which, in turn, may have enhanced
the null pronoun-subject co-indexation processing strat-
edy for the autistic children.

The second research question addressed possible fac-
tors, more specifically, age, expressive vocabulary and
language input in the bilingual groups only, underlying
the children’s performance in the pronoun comprehen-
sion task. Subject preference in the null pronoun trials
was found to be inversely related to the age of the
ASDmono children, which means that older children
tended to pick the subject less frequently than their youn-
ger peers. This pattern suggests that the older ASDmono
children became less target-like in processing referentially
ambiguous contexts than their younger peers. Although
we cannot ascertain the factors triggering this pattern,
this finding supports the idea of an atypical maturational
time course of referential processing in the monolingual
children with autism. On the other hand, the ASDmono
children with higher expressive vocabulary scores in
Greek tended to exhibit stronger null pronoun-subject
bias than their peers with lower expressive vocabulary.
Vocabulary has been acknowledged to be supportive of
language development at multiple levels of linguistic
structure, including reference, in children with autism
(Kelty-Stephen et al., 2020; Naigles et al., 2016). The
finding that a larger vocabulary in the ASDmono relates
to more target-like resolution of null pronouns suggests
that vocabulary skills may promote autistic children’s re-
ferential processing skills in discourse contexts with com-
peting referents.

Regarding the language input factors, the regression
analyses of the current study showed that the use of the
Greek language was inversely related to ASDbi children’s
preference for extrasentential referents in both null and
overt pronoun trials, which further suggests that the more
the autistic bilingual children were exposed to input in
Greek, the weaker their other referent biases were. Cru-
ically, there is evidence that pronoun resolution bias is
modulated by language experience, suggesting that it
may be learned from exposure to the more frequent pat-
terns of pronoun reference. For example, Arnold
et al. (2021) exposed readers to stories with unambiguous
pronouns that either always referred to the subject or
always referred to the object, and people adapted to this
pattern when interpreting ambiguous pronouns (for simi-
lar effects see Contemori, 2019; Kaiser, 2009). This dem-
onstrates a causal link between exposure and pronoun
comprehension. These findings fit with the tendency of
the ASDbi children of the current study having longer
exposure to Greek to dismiss null/overt pronoun-other
co-indexation, which represents a pragmatically infelici-
tous choice and the least dominant pronoun interpreta-
tion pattern in TD children (Papadopoulou et al., 2015).
Furthermore, ASDbi children’s preference to link null
pronouns to other referents was inversely correlated with
age, which suggests that this tendency became weaker as
children grew older.

The overall results show that bilingualism had no det-
rimental effect on the autistic children’s ambiguous pro-
noun resolution skills. In fact, the ASDbi children
showed greater sensitivity than their monolingual peers
to the topicality of the linguistic expressions in syntactic
subject position, with the latter being considered as suit-
able referents for the ambiguous pronoun. However, it
should be noted that both autistic groups faced general
difficulty in processing the topic-shift feature encoded in
overt pronouns, which was reflected in low preference for
object referents in the overt pronoun trials. Besides shed-
ding light into bilingualism effects in the language
processing skills of children in the spectrum, the findings of the current study have potential implications for parents and carers of children with autism who are sometimes advised to keep to a single language (Lim et al., 2018). Parents, therapists and educators around the world lack sufficient evidence to support their language decisions and policies for children with autism. These choices hold consequences for the treatment, education and formation of ethnic identities for children in the spectrum. We can infer from the results of the current study that bilingualism does not negatively impact pronoun resolution skills in children with autism. Finally, this work raises questions to be addressed in future studies on the role of other factors that may have affected bilingual autistic children’s performance in pronoun resolution, such as literacy skills and language dominance.

There are several limitations to the present study. First, the single-language administration of the pronoun comprehension task may have masked subtle processing differences between the experimental groups that could have affected children’s referential preferences. ASDbi and TDBi children’s performance in the Albanian version of the pronoun task is worthy of exploration in future research. In addition, it is possible that bilingual children’s referent bias might be modulated by their total vocabulary scores, which the current study failed to capture due to the lack of standardized language tools in the children’s heritage language, that is, Albanian. Finally, it is possible that the groups’ reference performance might be influenced by other factors to language, such as executive functions, including inhibition and working memory. It might be of interest in future research to examine monolingual and bilingual autistic children’s executive functions skills and investigate the extent to which they contribute to pronoun comprehension in these populations.

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ETHICS STATEMENT

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. Research involving human participants and/or animals. The study was approved by the Research Ethics Committee of the Greek Ministry of Education (Ref. No.: HAA37HAA87). Informed consent Written informed consent was obtained from the parents. The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

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