

# Comparing Developmental Trajectories of Loophole Behavior in Autistic and Neurotypical Children

by

Annalisa Broski

Submitted to the Department of Brain and Cognitive Science  
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## ABSTRACT

Loophole behavior is a common strategy used by neurotypical children to avoid trouble. The use of loopholes requires pattern recognition, language understanding, rational planning, and goal alignment. A major marker of autism is difficulty with Theory of Mind and language tasks, making their engagement with loophole behavior, which has clear patterns in neurotypical development, particularly interesting. We surveyed parents of autistic children ( $N = 202$ ) and neurotypical children ( $N = 431$ ) about their children's engagement with loophole behavior. We found that loophole behavior is common in both populations, and while the onset of this behavior was significantly later among autistic children compared to neurotypical children, the peak and offset age were not. This could point to a developmental trajectory that occurs later for autistic children compared to neurotypical children, but overall demonstrates that autistic individuals have the ability to engage with loophole behavior.

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# Chapter 1

## Introduction

A child is jumping on the couch in the living room. His mother comes in and says, “Don’t jump on that couch!” The child wants to keep jumping, but understands that this could lead to trouble. To avoid this, the child stops jumping on the couch, moves to the other couch in the living room, and starts jumping on it. By jumping on this other couch, he is still technically following his mother’s wishes (he’s no longer jumping on that one), even though he understood her overarching goal of not wanting him to jump on any of the furniture.

This is an example of loophole behavior, a common behavior among elementary-aged children [4]. The use of loopholes represents an integration of complex social cognitive skills such as language understanding, rational planning, and goal alignment. When people have conflicting goals, loopholes are a possible method to achieve one’s own goals while reducing the amount of trouble that would have occurred by a method of noncompliance. The listener can weigh both sets of goals by thinking about possible outcomes in order to decide on an action. If the goals of the listener and the speaker are aligned, the listener is likely to comply. However, if the goals are not aligned and disobedient actions could result in trouble, the listener may opt to engage in a loophole. Loophole behavior demonstrates complex social-cognitive abilities as children are learning to make sense of and interact with the world around them, making it an interesting and important concept to explore.

Children with autism are thought to struggle with important aspects of socialization such as eye contact [9], shared attention [12], and thinking about others’ thoughts, or Theory of Mind [8]. In the current paper, we explore the relationship between loophole behavior and its relevance to the cognitive and social development of non-autistic and autistic populations and the implications this behavior has on both autistic and non-autistic children.

### 1.1 Loophole Behavior in Neurotypical Children and Adults

In previous work with non-autistic children concerning loophole behavior, 5-to-9-year-olds were asked how much trouble they thought they thought children would get in for compliant, non-compliant, and loophole scenarios. For example, a participant would be presented with a child whose mother asked her not to go outside alone. The compliant child would not go outside, the non-compliant child would go outside alone despite her mother’s command, and the child engaging in loophole behavior would bring her dog outside with her. Participants

would only see one of these cases (compliant, non-compliant, loophole) for each scenario. Children across all age groups indicated that scenarios where children engaged in loophole behavior would result in less trouble compared to situations where children engaged in non-compliant behavior [4]. This could point to a driving force in the prevalence of this behavior.

In another task, neurotypical 4-to-9-year-olds were asked to predict how a character would act when their goals were aligned or misaligned with the parent's goals in a story. For example, the participant would be told that the character in the story was instructed by their parent to put down the tablet. They are then informed of the child's goals, i.e. "The child is tired of looking at the tablet", "The child wants to keep looking at their tablet." They were then given three choices of action for the child, either compliant ("the child will put down the tablet"), non-compliant ("The child will keep looking at the tablet"), or loophole ("The child will put the tablet down and keep looking at it"). Across all age groups, children predicted compliance when goals were in alignment. But when goals were misaligned, prediction of noncompliance decreased with age, and predictions of the use of loophole behavior peaking when the participants were ages 7 to 8 [3].

In a separate task, neurotypical children ages 5-10 were presented with examples of loophole behavior and asked to replicate the behavior in scenarios where children commonly perform loopholes. Children were given examples of other children acting "tricky and sneaky," i.e. committing a loophole. They were then asked to generate "tricky and sneaky" actions for characters in a series of stories. For example, children would be told that a child's father said, "You need to eat your peas before you have more pizza." They were told the child doesn't want to get in too much trouble, but "really doesn't like peas and wants to eat more pizza." The child decides to be a little tricky, but doesn't know how, and needs help from the participant. The participant is then asked to generate an action for the child to be a little tricky. 5-year-olds struggled to produce any loopholes, whereas 10-year-olds had very high rates of loophole production when asked to produce a "tricky and sneaky" action for the character [3]. The ability to produce loopholes is a marker of cognitive development and understanding.

When adults were questioned about children's loophole behavior, adults were presented with multiple situations where children's behavior was either compliant, non-compliant, or a loophole, and they were asked how funny they thought the behavior would be, how upset they would be, and how much trouble the child would get into. When presented with loophole behaviors, adults reported that the child would get in less trouble, they would be less upset, and they would find the situation funnier [4]. When looking at loophole behavior in adult subjects, 63% of adults cited that they had used loopholes themselves, but only 44% cited others using loopholes around them [5]. Loopholes were used more often when the subject's social partner was of equal or higher power than the subject [5]. When asked to predict how a character would act in a story depending on if their goals were aligned or misaligned with their social partner, adults overwhelmingly predicted compliance when goals were in alignment, but predicted compliance, loophole behavior, and noncompliance at fairly similar rates when the subject and their partner were misaligned [5].

## 1.2 Social and Linguistic Tasks in Autistic Children

Understanding loophole behavior and how it signals changes in the developing brain is important for understanding social and linguistic development in humans. However, extending the findings around loopholes to include neurodiverse communities that may be expected to exhibit these behaviors differently or not at all can provide key insight into if and when these developmental paths diverge, or if they diverge at all.

For example, the autistic community is thought to exhibit impairments in social-emotional reciprocity, shared attention, nonverbal communication, and understanding and initiating relationships [15]. These impairments are often exhibited or explained with the “Theory of Mind” theory and/or the “Weak Central Coherence” theory. Theory of mind (ToM) is the ability to infer information about the beliefs, intentions, and emotions of others [8]. This skill is important for developing effective communication and empathy. Compared to non-autistic children, autistic children are less successful on Theory of Mind tasks, such as the Reading the Mind’s Eye Test, the Strange Stories Test, and the Implicit False Belief Test [14].

In the Reading the Mind’s Eye Test, participants are presented with 36 photographs of eyes and asked to describe what the person in the picture is thinking or feeling between four possible descriptions of the person’s feeling [2]. Autistic individuals are less likely to correctly interpret the individual’s feeling from the photo of their eyes than non-autistic individuals.

In the Strange Stories Test, participants are told a story in which the protagonist does something most would not expect, such as telling a white lie or persuading another character. Participants are scored on how well they can differentiate between what the protagonist says and what they actually mean [6]. Participants with autism were less successful at differentiating between what was said and what was meant than neurotypical participants [10].

The Implicit False Belief Test is a nonverbal method of testing an individual’s ToM ability. One such test presented participants with familiarization trials where they watched a character reach through one of two doors to grab a toy car after watching it drive between the two locations. The door that held the car was signaled to the character with a light and a chime. In the test trials, the character was distracted by a phone ringing, and the car drove away from the location it originally stopped in. Before the character picked the location of the car, the frame was frozen, and the participants’ gaze was recorded. One would expect participants to look at the door that the car originally stopped behind before the character was distracted by the phone ringing, as they anticipate that the character still thinks the car is behind that door. [14]. Additionally, autistic individuals are also less successful on Theory of Mind tasks compared to other neurodiverse groups. These non-autistic neurodiverse individuals are on-average less successful on these tasks than typically-developing groups [17].

The autistic community is also thought to have impaired central coherence, or the ability to derive meaning from a collection of detailed information. Participants with autism had difficulty comprehending phrases even when they knew the meaning of individual words, exhibiting greater reading accuracy but lower reading comprehension than their non-autistic

peers. This demonstrates a struggle to achieve coherence and/or exhibits a preference not to strive for coherence. In general, autistic individuals exhibit pragmatic deficits, such as inappropriate conversational turn-taking, abnormal prosody, inability to adjust to new communication settings, and difficulty differentiating old and new information, which could all be attributed to weak central coherence [7]. This deficit in central coherence is also thought to contribute to higher skill for autistic individuals, such as greater attention to detail, but also an inability to extend the knowledge of this detail to similar systems [11].

This presumed deficit in central coherence is evident in autistic performance on language tasks. Children with ASD have shown specific pragmatic inference deficits. They give the highest number of irrelevant answers when asked questions about a story's context and they exhibit deficits in performance on irony comprehension tasks. They struggle handling surprise and coherence aspects of humor simultaneously, and to use the less common homograph in situations where it is more applicable [8].

### 1.3 Loopholes and Autism

To engage in loophole behavior demands Theory of Mind abilities. Loophole behavior requires that participants engage in reasoning about the goals or wants of others and make inferences about their mental states. They also require that the participant has a desire to appease the person making the command/request and to work towards goal alignment. Additionally, children who engage in loophole behavior must have an understanding of the words and phrases in a request and the ability to manipulate the meaning of that request for their benefit. Given autistic children's history of less success on theory of mind, central coherence, and language tasks, we hypothesize that children with autism will engage less in loophole behavior compared to their non-autistic peers as well as experience a later onset, peak, and offset of this behavior.

# Chapter 2

## Methods

### 2.1 Neurotypical Parent Participants

Participants included 260 parents of children between the ages of 3-18. The survey took approximately 9 minutes to complete and participants were compensated \$1.43. Participants were US residents, fluent in English, and from diverse geographical regions and educational backgrounds. Participants reported on 425 children total ( $M_{age}$ : 8.7, range: 3-18 yrs; 42% female, 5% declined to state; 34% White, 10% multiracial, 4% Black, 3% Asian, 3% Hispanic or Latinx, 47% declined to state). An additional 39 participants were recruited but excluded from analysis due to failing the comprehension check ( $n = 7$ ), or not having children of relevant age ( $n = 32$ ).

### 2.2 Autistic Parent Participants

Participants included parents of children between the ages of 4-17 who are a part of the SPARK database. Supported by the Simons Foundation, SPARK works to advance the understanding of autism by connecting autistic individuals and families to research. Any U.S. citizen with a professional diagnosis is welcome to join this community and participate in research [1]. SPARK recruited participants for our team to contact, and when the participant agreed to be contacted, we would send them a link to our survey. The survey took approximately 9 minutes to complete and participants were compensated \$5.00. Participants were US residents, fluent in English, and from diverse geographical regions and educational backgrounds. Participants reported on 202 of children total ( $M_{age}$ : 11.7, range: 4-17 yrs; 20% female, 1% non-binary, 0.5% declined to state; 74% White, 14% multiracial, 4% Black, 0.5% Asian, 7% Hispanic or Latinx, 0.5% declined to state). An additional 19 participants were recruited but excluded from analysis due to not finishing the survey ( $n = 10$ ), not consenting to participate ( $n = 7$ ) or not having children of relevant age ( $n = 2$ ).

## Parent Experience Survey Structure

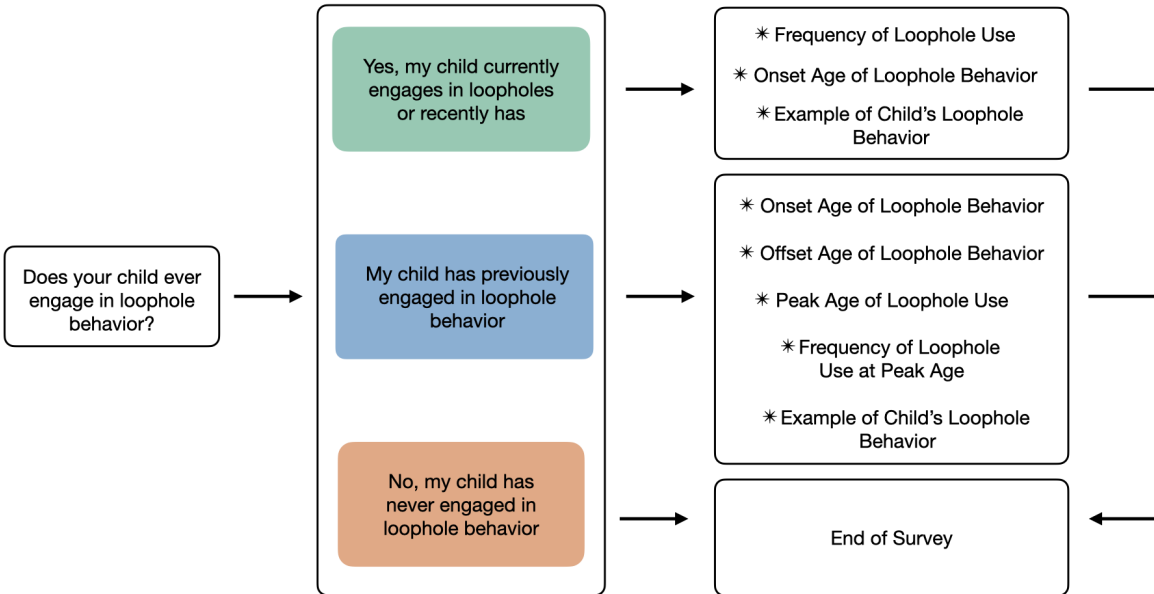


Figure 2.1: Structure of the survey.

*Participants indicated if their child ever engaged in loophole behavior. If participants indicated that their child currently engaged in loopholes, parents were then prompted to answer questions about the frequency of use, the age at which this behavior began, and invited to share an example of such behavior. If participants indicated that their child previously participated in loophole behavior, parents were prompted to answer when this behavior began, ended, peaked, the frequency of use at the age when this behavior peaked, and were also invited to provide an example of this behavior. If parents indicated their child never engaged in loophole behavior, they were directed to the end of the survey.*

## 2.3 Procedure

The survey was implemented using Qualtrics. Participants (parents of a neurotypical or autistic child) read a definition of loophole behavior (i.e., "Children (and adults) may understand the actual intended meaning of what was said to them or asked of them but choose to interpret things differently."). This definition was accompanied by examples of children finding loopholes to their parents requests, as well as examples of non-loophole behavior, such as noncompliance or genuine misunderstanding. Participants were then asked to classify loophole and noncompliant behavior in two subsequent stories. Parents were then asked to report (1) their current age and (2) whether they currently engage, used to engage, or have never engaged in loophole behavior. Parents of current children currently engaging in loophole behavior were asked to provide the age of onset of the behavior, and parents of children who previously engaged in loophole behavior were asked to provide the onset, peak, and offset age of loophole behavior. Parents of both children who currently engage and previously engaged in loophole behavior were also questioned about the frequency of



this behavior. Lastly, we asked participants to share examples of their child demonstrating loophole behavior. A visual guide to the survey procedure is shown in [Figure 2.1](#).

# Chapter 3

## Results

### 3.1 Loophole Ability by Population and Age

We found that loophole behavior is common in both autistic and neurotypical groups. A majority of children in both groups (59%;  $n = 254$  of neurotypical children and 72%;  $n = 146$  of autistic children) were reported as engaging in loophole behavior currently (44% of neurotypical children and 67% of autistic children) or previously (15% of neurotypical children and 5% of autistic children).

We found no significant difference between loophole engagement between these two groups; both groups are likely to exhibit this behavior at some point throughout their adolescence ( $\beta = 0.063$ ,  $SE = 0.05$ ,  $z = 1.17$ ,  $p < 1$ ) (Figures 3.1, 3.2). However, the mean age of current autistic loopholers (11.7) is significantly older than current neurotypical loopholers (mean age = 8.7 years,  $\beta = 11.704$ ,  $SE = 0.314$ ,  $t = 37.336$ ,  $p < 0.001$ ).

### 3.2 Age of Onset, Peak, and Offset of Loophole Behavior

Next, we sought to compare the age of onset, peak, and offset of loophole behavior between the two groups (Figure 3.3). We found that autistic children begin engaging with loophole behavior significantly later than their neurotypical peers ( $\beta = -0.614$ ,  $SE = 0.271$ ,  $t = -2.267$ ,  $p < 0.05$ ), with the mean onset for neurotypical children being 5.7 and the mean onset for children with autism being 6.2 years.

Despite a later onset of loophole engagement, there was no significant difference between the peak ages ( $\beta = -0.944$ ,  $SE = 0.919$ ,  $t = -1.028$ ,  $p < 1$ ) or offset ages ( $\beta = -1.587$ ,  $SE = 1.223$ ,  $t = -1.297$ ,  $p < 1$ ) between the two groups. The average peak age for neurotypical children was 7.4 years and 8.4 years for children with autism, and the average offset age for neurotypical children was 9.3 years and 10.9 years for children with autism.

Interestingly, while the neurotypical group exhibited a significant increase in loophole engagement as age increased ( $\beta = 0.007$ ,  $SE = 0.002$ ,  $z = 3.431$ ,  $p < 0.001$ ), the autistic group did not exhibit this same age effect ( $\beta = 0.002$ ,  $SE = 0.004$ ,  $z = 0.473$ ,  $p < 1$ ).

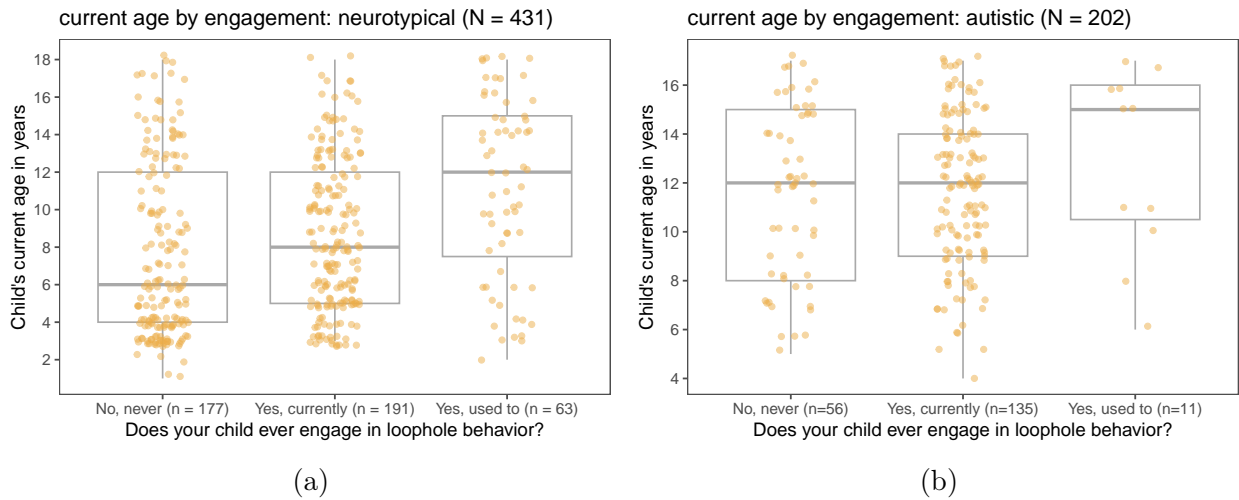


Figure 3.1: Age distribution and median age split by loophole engagement and population (a) current age of neurotypical children who have never engaged (median age = 6), are currently engaging (median age = 8), or previously engaged (median age = 12) (b) current age of autistic children who have never engaged (median age = 12), are currently engaging (median age = 12), or previously engaged (median age = 15).

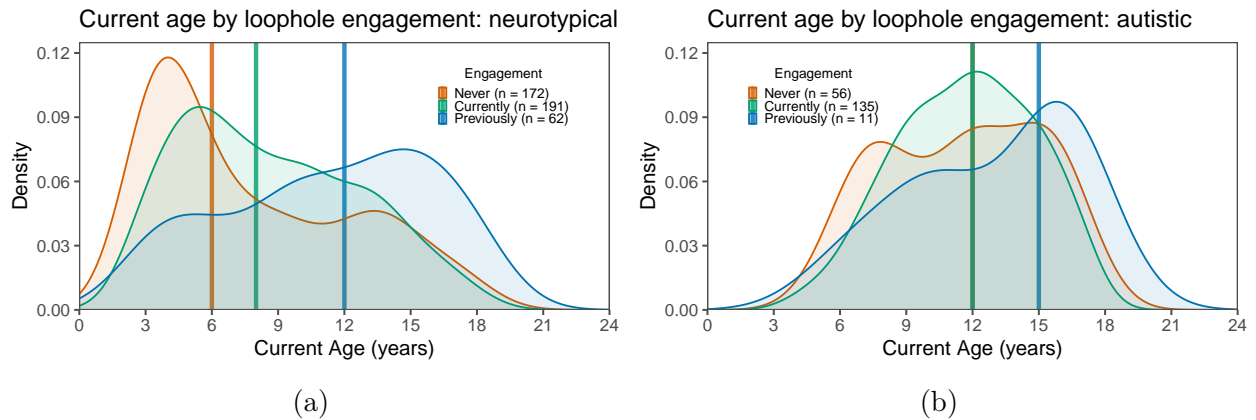


Figure 3.2: Age distribution and median age of loophole engagement split by population (a) current age of neurotypical children who have never engaged (orange; median age = 6), are currently engaging (green; median age = 8), or previously engaged (blue; median age = 12) (b) current age of autistic children who have never engaged (orange; median age = 12), are currently engaging (green; median age = 12), or previously engaged (blue; median age = 15).

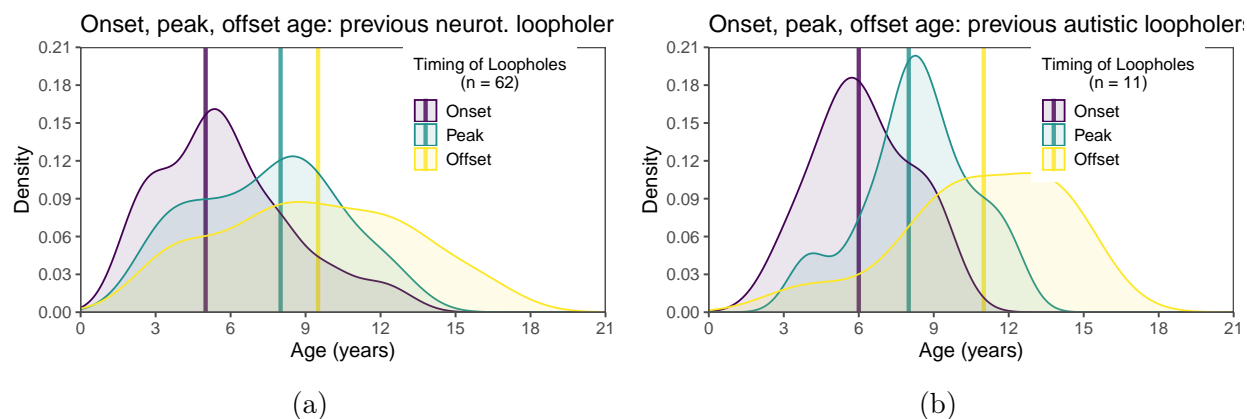


Figure 3.3: Density, median age of onset, offset, peak for previous loopholers by population (a) Density of age in years of the onset (purple; median age = 5), peak (blue; median age = 8), and offset (yellow; median age = 10) for previous neurotypical loopholers; (b) Density of age in years of the onset (purple; median age = 6), peak (blue; median age = 8), and offset (yellow; median age = 11) for previous autistic loopholers.

# Chapter 4

## Discussion

The current survey builds upon prior work on both Autism Spectrum Disorder and loophole behavior. While much was previously known about neurotypical children's engagement with loopholes, we have observed that children with autism also produce loopholes at a high rate. This goes against our hypothesis that children with autism would engage in loophole behavior less than neurotypical children.

In alignment with our hypothesis, we observed a later onset age of this behavior for children with autism when compared to their neurotypical peers. For neurotypical children, loophole behavior seems to begin around 5 to 6 years, while for autistic children, loophole behavior begins around 6 to 7 years. Previous autism studies focusing on pattern recognition and language would attribute this finding to weak central coherence accompanied with hyper-systematization or general difficulties with language. Previous autism studies focused on socialization would attribute this difference to difficulty with Theory of Mind tasks. Pattern recognition, language, and socialization are all important aspects of loophole behavior, which furthers the idea that differential performance in these areas compared to neurotypicals could contribute to a later onset for autistic individuals.

However, previous work in pattern recognition, language, and socialization studies for autistic individuals claim that difficulties in pattern recognition and socialization are the main markers of autism throughout an autistic person's life. When looking at loophole behavior, however, the only significant difference in performance between autistic and neurotypical children is a later onset. Despite a significantly later onset, there was no significant difference between the peak and offset ages between these two populations. Loophole behavior in neurotypical children peaks at 7 to 8 years and tapers off between 9 and 10 years. For children with autism, this behavior peaks between 8 and 9 years and tapers off between 10 and 11 years. While we know that neurotypical adults continue to use loopholes (although perhaps less than in childhood) throughout their adult lives, further studies could explore the frequency that adults with autism engage in loophole behavior. Additionally, our sample size of children who previously engaged with loophole behavior was small, so future studies could focus on this aspect by gathering more children who previously engaged or exploring why previous engagement seems less common among autistic children.

While neurotypical children engaged with loopholes at a significantly higher rate with age, we did not see this same effect with autistic children. This could be due to a significantly later onset while not significantly later peak and offset, leading to a shorter timeline of

loophole activity.

While autistic children begin their engagement with loopholes significantly later, little else differs in the developmental trajectory of this task between these two groups. Engaging with loophole behavior requires social motivation, language understanding, theory of mind ability, and strong central coherence, all areas where autistic children have been thought to struggle. The ability to perform these tasks could imply an underestimation of ability in these areas for children with autism. Future studies could continue to explore these abilities for children with autism using loopholes and other similar tasks to further our understanding of development across a wide range of neurodiversity.

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