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ARTICLE

Parental use of causal language for preterm and full-term children: A longitudinal study

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Abstract

Parents are often a good source of information, introducing children to how the world around them is described and explained in terms of cause-and-effect relations. Parents also vary in their speech, and these variations can predict children's later language skills. Being born preterm might be related to such parent-child interactions. The present longitudinal study investigated parental causal language use in Turkish, a language with particular causative morphology, across three time points when preterm and full-term children were 14-, 20-, and 26-months-old. In general, although preterm children heard fewer words overall, there were no differences between preterm and full-term groups in terms of the proportion of causal language input. Parental causal language input increased from 20 to 26 months, while the amount of overall verbal input remained the same. These findings suggest that neonatal status can influence the amount of overall parental talk, but not parental use of causal language.

Keywords: causal language; parental input; preterm development; early vocabulary

Introduction

Causal cognition is a fundamental aspect of children's early cognitive development (Muentener & Bonawitz, 2017), and expressions of causality in language can support children's causal reasoning (e.g., Butler & Markman, 2012; Ger et al., 2021). Parents are often a good source of information for children's early causal understanding, introducing children to and guiding them on how the world around them is described and explained. Parents, however, vary in terms of the quantity and quality of their language input, and these variations can predict children's later language skills (Anderson et al., 2021). The use of specific linguistic structures, such as causal language, may lead to better acquisition of those structures. Individual characteristics of a child, such as neonatal status, can influence parent-child interactions, and thus be related to the properties of the input children receive (e.g., Adams et al., 2017). For example, children born preterm (before 37 weeks of gestation period), being at risk of language and cognitive delays in development, have differences in their interactions with their parents compared to full-term born peers (e.g., Barra & Coo, 2023; Salerni et al., 2007). However, the development of specific linguistic structures has not been investigated thoroughly with a preterm sample. The present study investigates parental use of causal language in Turkish, a language with particular causative morphology, during free-play sessions across three time points when children were 14-, 20-, and 26-months-old. We examined whether causal language input differs among preterm and full-term groups and across time, alongside whether earlier and concurrent causal language input relates to children's later causal verb vocabulary.

Parental language input and preterm development

The quantity and quality of early parental language input can be a predictor of children's language development (Anderson et al., 2021). In general, children of parents who speak more words have better vocabulary (e.g., Rowe, 2012). Moreover, not only parental use of total words, but also the use of specific structures of language can support children's vocabulary knowledge, especially their acquisition of those specific types of words (Goodman et al., 2008). To name some, the frequency of verbs (Naigles & Hoff-Ginsberg, 1998), adjectives (Blackwell, 2005), auxiliaries (Theakston & Lieven, 2005), number words (Levine et al., 2010), spatial words (Pruden et al., 2011), and causal verbs (Aktan-Erciyes & Göksun, 2023) in parental language input have been associated with children's acquisition of such structures. In that regard, parent-child playtime provides fruitful opportunities to observe parental language input (Soderstrom & Wittebolle, 2013). Additionally, parents' use of such specific structures can be associated with children's individual characteristics. For instance, children's early spatial word comprehension skills are related to parents' use of spatial words (Kısa et al., 2018).

One such individual characteristic that can influence parent-child communication is being born preterm (e.g., Salerni et al., 2007). Preterm birth is operationalized as being born before 37 weeks of pregnancy, with 5% to 18% of births being preterm across varying countries (Blencowe et al., 2012). Preterm birth may lead to language, cognitive, motor, auditory, and visual delays and problems in children (see Sansavini et al., 2011). Moreover, negative experiences surrounding premature birth such as admission to neonatal intensive care units, and continuous psychosocial adversities such as low maternal education or poverty, can influence preterm children's neurobiological and cognitive developmental trajectories (Barra & Coo, 2023), as well as their interactions with their parents. Due to these possible developmental issues, preterm children are at risk of displaying long-term problems in language outcomes (e.g., Putnick et al., 2017; Sansavini et al., 2014). Longitudinally, from 5 months to 8 years of age, both moderately and very preterm children consistently performed worse in language measures than full-term children (Putnick et al., 2017).

In the early years of life, parent reports of very preterm children's vocabulary at 1;0 to 1;6 (Sansavini et al., 2011) and 2;0 (Foster-Cohen et al., 2007) show delays in language. However, between low-risk preterm children and full-term peers, there might not be differences in vocabulary, grammar comprehension, and executive functions (Pérez-Pereira & Cruz, 2018; Pérez-Pereira et al., 2019). Cognitive problems preterm children face may also show cascading effects where issues in one domain may lead to issues in another domain (Oakes & Rakison, 2019). For example, comparing preterm and full-term infants, visual processing mediated the contributions of motor skills to vocabulary development, a cascading effect that was more pronounced in the preterm group (Kobaş et al., 2022).

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Preterm children, however, vary in their cognitive developmental trajectories, with some being at similar levels to their full-term peers and others falling behind, even in terms of language development (Guarini et al., 2019; Sansavini et al., 2014). This variability in cognitive development is similar to other atypical populations (see Demir-Lira & Göksun, in press). Considerable proportions of preterm children show performances similar to those of full-term children (e.g., Marchman et al., 2015; Pérez-Pereira et al., 2019). The variability observed in preterm children's language development might be related to multiple factors such as earlier individual cognitive skills (e.g., Rose et al., 2009), motor skills (e.g., Kobaş et al., 2022), environmental conditions such as parent-child synchrony (e.g., Foster-Cohen et al., 2010; Sansavini et al., 2015), and more critical to the current paper, parental input (e.g., Adams et al., 2017).

Early social and communication patterns might be different for preterm and full-term parent-child interactions (e.g., Gatta et al., 2017; Gueron-Sela et al., 2016). These differences could be due to preterm children having poorer preverbal and verbal skills (De Schuymer et al., 2011), being less active or responsive in their interactions with their mothers (Bozzette, 2007; Salerni et al., 2007), alongside having worse co-regulation quality (Sansavini et al., 2015). For instance, at 6 months of age, during free-play sessions, parents of preterm infants may show more controlling patterns than parents of full-term infants, which was related to parent reports of behavioral symptoms at 1;6 (Forcada-Guex et al., 2006). However, a meta-analysis of 34 studies indicates that the behaviors of mothers of preterm children do not differ from mothers of full-term children in terms of sensitivity and responsivity (Bilgin & Wolke, 2015).

It is currently controversial whether there are group differences between preterm and full-term children in early parent-child interactions. Differences between these groups that are observed in language or cognitive domains might influence how children respond to parental input, even though parents of these children might not differ in their behavior. In terms of language input, no difference between preterm and full-term groups was found in the amount of caregiver talk during play (Salerni et al., 2007), book reading sessions (Suttora et al., 2020), and all-day recordings (Adams et al., 2017). With preschoolers, multimodal spatial input during puzzle sessions did not differ between preterm and full-term children (Clingan-Siverly et al., 2021). However, an investigation of multimodal (i.e., verbal and gestural) input with the current preterm sample indicates that preterm infants have received fewer pointing gestures and have heard fewer utterances at 14 months (Doğan et al., 2021). It can also be argued that preterm children might gain more from parental input compared to their full-term peers, even though their parents may approach them similarly, talk similar amounts, or use similar structures in their speech. In that regard, specific language input toward preterm children has not received much attention other than spatial language (Clingan-Siverly et al., 2021). Thus, the present study is novel in examining possible differences in causal language input between preterm and full-term groups and whether causal input can predict children's causal verb knowledge.

Causal language in Turkish

All languages have ways of expressing causality, with considerable variation in terms of their lexicalization and morphology (Shibatani & Pardeshi, 2002). While some languages lack causative morphology and make use of lexical causatives (e.g., English), some have both morphological and lexical causatives (e.g., Turkish). Causality can also be expressed with causal conjunctions such as "because." Turkish, as an agglutinative language with particular causative morphology, allows speakers to express causality using morphological causatives without relying on inherent causal semantics (i.e., as in lexical causatives) or causal conjunctions (Ketrez, 2012).

As it is in other languages such as English, lexical causal verbs convey an action of an agent that entails a change in state or a change in location of a patient (Shibatani & Pardeshi, 2002; Wolff, 2003). For example, verbs such as "to break" or "to throw" are lexical causatives, indicating respectively a change in state, and a change in location. Lexical causal verbs are generally in transitive form (i.e., can take an object), but not all transitive verbs are lexical causatives. To categorize a verb as lexically causal, that verb should evoke the meaning of an agentive action that causes a change. Similarly, agentive verbs (i.e., include an agent that performs the action) can be but are not necessarily causal. For example, in the sentence "Ali discussed politics," "to discuss" is a transitive and agentive verb, but it is not causal as it does not entail a change in state or location. To extract causal information from lexical causatives, Turkish learning children can make use of the number of noun phrases in a sentence and accusative morphology (Göksun et al., 2008). Moreover, idiosyncratic properties of child-directed speech like repetition can allow children to infer causal meaning without relying on syntactic cues (You et al., 2021a).

Morphological causal verbs in Turkish are formed by the attachment of a causative suffix to a verb stem. These verbs can be formed from both lexical causal verbs (e.g., *kır* "break" becomes *kır-dır* "cause to break, make someone break something") and non-causal verbs (e.g., *gül* "laugh" becomes *gül-dür* "cause to laugh, make someone laugh"). As exemplified above, *-DIr* is the most frequent causative suffix, and can be attached to the majority of monosyllabic verbs and some multisyllabic verbs. The second most frequent suffix is *-t*, which is attached to multisyllabic verbs ending in a vowel, /r/, or /l/ (e.g., *uyu* "sleep" becomes *uyu-t* "cause to sleep, put someone to sleep"). The other causative suffixes *(-Ir, -Ar, -It)* apply to fewer verbs in Turkish (Nakipoğlu & Üntak, 2008) and appear less in children's productions (Ketrez, 1999). Acquisition of the causal morphemes also follows differential developmental trajectories (Nakipoğlu et al., 2021). In general, morphological causal verbs can easily be categorized as causal, as these causal suffixes are mostly regular and transparent. Therefore, a causal interpretation can be elicited when a listener spots one of the causative suffixes. In addition to these suffixes, there are some suppletive (i.e., irregular) verbs in Turkish that appear frequently as causativized forms of non-causal verbs. For example, *getir* "bring, cause to come," is the suppletive form of *gel* "come." It is worth noting that lexical causal verbs (e.g., *ye* "eat") and morphological causal verbs (e.g., *ye-dir* "feed, make someone eat") are different from multiple-clause periphrastic causative sentences (e.g., *bebeğin yemesine sebep ol* "make the baby eat") (e.g., Wolff, 2003). Periphrastic causative verbs require the explicit expression of an embedded clause (e.g., make, let, cause), which lexical or Turkish morphological causal verbs do not require.

Other than verbs, conjunctions can connect a cause and an effect, often by joining two clauses. In Turkish, there are coordinating conjunctions like "because" or "but," and subordinate conjunctions in the form of suffixes. For instance, in the sentence *Bardak düşer*SE *kırılır* "*If* the glass drops, it breaks," the suffix *-SE* is equivalent to an English "if" (Ketrez, 2012). Parents' use of both conjunctions and *why*-questions can scaffold children's own use of conjunctions (e.g., van Veen et al., 2013). Children are also actively involved in the amount and type of linguistic input they receive, with their own use of *why*-questions eliciting causal conjunction use from their parents.

Are lexical and morphological causal verbs different in expressing causality? Verbs with distinct causal morphemes might be considered to be more transparent (Shibatani & Pardeshi, 2002). Still, whether Turkish morphological causatives are more salient cues of causality than lexical causatives is a question that is yet to be answered. Few studies have investigated the associations between lexical and morphological causatives with Turkish learning children. In terms of children's reasoning about untypical causal events, novel lexical and morphological causal descriptions were equally influential in facilitating causal understanding with children aged 2;6 to 3;6 (Ger et al., 2021). In mapping causal language to causal events, Turkish morphological causatives were as causally informative as lexical causatives for 3- and 4-year-olds (Ger et al., 2022). Notably, the influence of the causal morpheme was apparent even when the syntactic structure offered a non-causal meaning (i.e., without the object in a sentence): children still assigned a causal meaning when faced with a causal morpheme. Additionally, in terms of parental input, a recent longitudinal study has shown that morphological causal verb input, but not lexical causal verb input during free-play at 1;2 and 1;8 predicted later causal verb comprehension at 2;11 (Aktan-Erciyes & Göksun, 2023). Overall, both lexical and morphological causal verbs seem to convey causation to a similar extent, with differences being possible in terms of parental use.

For Turkish learning children, the production of specific causal verbs may emerge early, starting from age 1;2 (Furman et al., 2010), with morphological causal verbs emerging later than lexical causal verbs, around age 1;9 (Ketrez, 1999). There is also variation in Turkish-learning children's acquisition of the morphological causative suffixes, with errors occurring in terms of overregularizations and irregularizations (Nakipoğlu et al., 2021). Moreover, children's ability to communicate causality seems to increase with age, showing a "non-causal to causal" developmental trajectory in speech and gestures (Göksun et al., 2010). By preschool age, children can selectively use causal language (Kanero et al., 2016; Muentener & Lakusta, 2011). Together, research from different languages and modalities shows an increase in the expression of causality as children get older. Therefore, the first years of life can be important in establishing the groundwork for causal language, where parental input has critical relations with later language outcomes (e.g., Anderson et al., 2021), which might differ between preterm and full-term children (e.g., Gueron-Sela et al., 2016).

Parental causal language input has been investigated by only a limited number of studies that mostly focused on a single type of causal structure. For instance, parental use of *why*-questions has been shown to scaffold children's acquisition of causal conjunctions such as "because" or "but" (e.g., van Veen et al., 2009). Longitudinally, the amount of lexical causal verbs such as "break" in child-directed speech shows increasing trends similar to children's own use of such verbs from around 2;0 to 3;0 (You et al., 2021b). Critically, parental use of Turkish-specific morphological causal verbs, but not lexical causal verbs during free-play, can predict later causal verb comprehension (Aktan-Erciyes & Göksun, 2023). The present study aims to fill a gap in the budding literature on parental causal language input by investigating not only causal verbs but also causal conjunctions in naturalistic child-directed speech. Moreover, investigating possible differences in causal linguistic input with preterm and full-term children can provide novel and valuable insight into the role of causal language in different developmental trajectories. The wide variability we get from preterm children can help answer questions regarding child- and parent-related cascading effects on children's specific language outcomes (Demir-Lira & Göksun, in press).

Considering that preterm children can show delays in their language development (e.g., Sansavini et al., 2014), specific linguistic structures have not been thoroughly investigated with preterm vs. full-term groups other than spatial language (Clingan-Siverly et al., 2021). A fundamental structure of all languages, causal language has been

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shown to facilitate children's causal cognition in languages such as English, Turkish, and Japanese (e.g., Ger et al., 2021; Kanero et al., 2016; Muentener & Lakusta, 2011). For instance, using causal language to describe complex events can enable 2-year-olds to understand the event and guide their actions to intervene (Bonawitz et al., 2010). Therefore, investigating causal language input within the context of neonatal status might shed light on both the specific outcomes of causal input and the probable differences between preterm and full-term children.

The present study

The present longitudinal study examined parental causal language input in Turkish-learning preterm or full-term children during 10 minutes of free-play sessions. Across three time points, when children were 14-, 20-, and 26-months-old, frequencies of Turkish causal language structures (lexical causal verbs, morphological causal verbs, and causal conjunctions) within the parental input were analyzed.

We have three main questions and hypotheses. First, did parents of children born preterm and full-term differ in terms of the language input they provided to their children? We expected full-term children to receive more causal language input than preterm children when we examined specific input, due to findings from the current sample showing that full-term infants have received more multimodal input (Doğan et al., 2021), and due to previous research showing preterm children to lag behind in language development (e.g., Putnick et al., 2017), with potential impairments in parent-child interactions (Salerni et al., 2007). However, some research found no differences between preterm and full-term groups in parental language input (e.g., Adams et al., 2017; Suttora et al., 2020). Thus, alternatively, patterns in overall language input might be reflected in specific types of input and there may not be differences in the amount of causal input preterm and full-term children receive.

Second, how did parental causal language input occur across time? We expected the frequency of causal language input to increase with time due to parental input becoming gradually more causal over time (e.g., You et al., 2021a), as children also show a "non-causal to causal" trajectory in their language development (e.g., Göksun et al., 2010). Additionally, as shown in previous work on Turkish parental language input (Aktan-Erciyes & Göksun, 2023), we expected lexical causal verbs to be more frequent in the input than morphological causal verbs.

Third, were tokens and types of causal verb input associated with children's causal verb vocabulary? We expected causal language input from previous time points to predict children's causal vocabulary at later time points due to previous research showing that parents' use of both general and specific linguistic structures can facilitate children's vocabulary of those structures (e.g., Goodman et al., 2008; Pruden et al., 2011).

Method

Participants

The present study was the first three time points of a longitudinal study that investigates preterm and full-term children's cognitive and language development across four time points. The fourth time point took place online, with no in-person play sessions, or assessments of input or vocabulary. Thus, data from then is not included. The project was approved by Koç University's Institutional Review Board with protocol number 2018.118.IRB3.083. Data was collected between May 2018 and March 2020.

Participants were recruited from a local hospital's pediatric services database, a health-care center, and through posts on social media platforms. We obtained informed written consent forms from all parents. Children born before 37 weeks of gestational age (GW) were considered preterm. The ages of children born preterm were corrected referring to the presumed date of birth (see Sansavini et al., 2011). We did not include preterm children who displayed extreme medical symptoms such as cerebral palsy or visual problems. All children were Turkish-learning monolinguals. Table 1 displays descriptive statistics of the sample.

In total, across three time points, 105 parent-child dyads (52 preterms, 50 females) participated in this study. At the first time point (T1), 77 parent-child dyads participated. At the second time point (T2), 63 of them continued the study (18% attrition). At T2, 28 new parent-child dyads started the study. In total, 91 dyads participated at T2. At the third time point (T3), 42 dyads who continued from T1 to T2 continued the study. Of the new dyads who started the study at T2, 16 continued to T3. One dyad from T1 did not participate in T2 but participated in T3. There were no new parent-child dyads starting the study at T3. In total, 59 dyads participated at T3 (36% attrition). One dyad was excluded at T1 due to both the mother and the father playing together with the child. One dyad was excluded at T2 due to the play session lasting too short – around two minutes. Two dyads at T3 were excluded due to the father playing with the child when in previous time points it was the mother who was playing. Thirteen dyads only participated at T1. Twelve dyads only participated at T2. Twenty-one dyads participated at only T1 and T2. Due to the global outbreak of COVID-19 in 2020, data collection was paused mid-way, resulting in a high rate of attrition at T3.

Preterm children had significantly lower gestational ages and birth weights than full-term children (see Table 2). Moreover, the preterm sample of the present study included children from a wide spectrum of gestational ages and birth weights across the time points. Out of 105 children, 17 were extremely preterm (GW < 29), 17 were very preterm ($29 \leq$ GW < 33), 18 were moderately preterm ($33 \leq$ GW < 37), and 53 were full-term ($37 \leq$ GW). Based on cranial ultrasound, within our preterm sample, 14 children in T1, 11 children in T2, and 10 children in T3 displayed symptoms of minor complications staying in intensive care after birth. Before merging the data, we checked whether atypical and typical preterm children differed on our dependent variables (i.e., language input and vocabulary measures). Kruskal-Wallis analyses showed that the preterm children with medical complications were not different from typical preterm children with all of our measures at all time points (all ps $> .05$). Thus, we merged the two preterm groups for the rest of the analyses.

Participants of the present study were of mid- to high-socioeconomic status with an average of 16 years of maternal education (i.e., having a university undergraduate degree).

Table 1. Sample Sizes and Ages of Preterm (PT) and Full-Term (FT) Groups Across Time Points

	Sample Size					Age (in months)	
Time	Total	F	M	PT	FT	M (SD)	Range
T1	77	34	43	40	37	13.71 (1.42)	10.09-17.68
T2	91	45	46	41	50	19.93 (1.40)	16.95-23.75
T3	59	28	31	24	35	26.08 (1.29)	24.08-30.00

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Table 2. Gestational Ages and Birth Weights of Preterm (PT) and Full-Term (FT) Groups Across Time

		Gestational age (weeks)				Birth weight (grams)			
Time	Group	M (SD)	Range	χ^2	ε^2	M (SD)	Range	χ^2	ε^2
T1	PT	30.30 (3.01)	23–36	57.63*	.758	1528 (527)	800–2600	56.93*	.749
	FT	38.86 (1.38)	37–44			3293 (395)	2800–4650		
T2	PT	30.51 (3.52)	23–36	67.57*	.751	1570 (592)	610–3000	65.82*	.731
	FT	39.12 (1.39)	37–44			3342 (390)	2575–4650		
T3	PT	29.67 (3.39)	23–35	42.87*	.739	1456 (546)	800–2560	42.01*	.724
	FT	39.34 (1.39)	37–44			3350 (415)	2575–4650		

Note. Kruskal-Wallis tests concurrently compared preterm and full-term groups, *$p < .001$. Epsilon-squared (ε^2) denotes effect sizes.

However, mothers of preterm children ($M = 15.20$, $SD = 2.70$) had fewer years of education than mothers of full-term children ($M = 16.83$, $SD = 2.38$), $t(99) = 3.21$, $p < .05$.

Measures and procedure

Free-play sessions

At all three time points, parent-child dyads were given 10 minutes in a quiet room with several toys and were asked to play with their child as they would at home, with no other instructions. These sessions were conducted either in the playroom of the Metin Sabancı Healthcare Center in İstanbul, or in the playroom of Koç University's Laboratory.

At T1 and T2, during the free-play sessions, there were two short books, two animal plushies, four cubes with their attachable platform, a soft ball, and an abacus in the room. At T3, there were several wooden wheels, an animal puzzle, a detachable train, a toy phone, a toy cooking set, and an abacus in the room. None of the toys or instructions were intended to elicit causal language. The reasoning behind providing different toys at T3 was to avoid parents' and children's familiarity with the toys and to avoid stagnant language input. These free-play sessions were videotaped. See Appendix A for pictures from the free-play sessions of T2 and T3 showing the toys being used.

TCDI-1 & TCDI-2

Turkish versions of the MacArthur-Bates Communicative Development Inventory (MB-CDI) were used to assess children's receptive and expressive vocabulary (TCDI; Aksu-Koç et al., 2019). These are reliable parent-report questionnaire measures used with children from 0;8 to 3;1. At T1, TCDI-1 was used, which has 418 items that measure early receptive and expressive vocabulary, 95 of which are for verbs, and 44 of which are for causal verbs. In TCDI-1, parents mark whether their child "understands" (i.e., receptive) or "understands and says" (i.e., expressive) a given word. At T1, in terms of causal verb vocabulary, only 24 children out of 72 who had a TCDI-1 measure had an expressive causal verb vocabulary score, with an average expressive causal verb vocabulary of 1.11 verbs. Most of those expressive markings were coming from *aç* "open," *at* "throw," and *ver* "give." Therefore, for causal verbs in TCDI-1, "understands and says" markings were added with "understands" markings, giving a composite measure of early receptive causal

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verb vocabulary. At T2 and T3, TCDI-2 was used, which has 711 items that measure expressive vocabulary, 146 of which are for verbs, and 64 of which are for causal verbs. In TCDI-2, parents mark whether their child "says" a given word. Both MB-CDI and TCDI have previously been used with preterm children (e.g., Foster-Cohen et al., 2007; Kobaş et al., 2022). TCDI-1 and TCDI-2 were either filled during the visits or were emailed to the parents where they printed the forms out and later sent the experimenters pictures of them. See Supplementary Materials A for the list of causal verbs in TCDI-1 and TCDI-2. TCDI scores were calculated by taking the percentage of words a child knows within the total number of words in that category. For instance, if a child speaks 32 of the 64 causal verbs in TCDI-2, they had a score of 50%. Kruskal-Wallis tests revealed that preterm and full-term children's vocabulary scores differed only at T1, but not at T2 or T3 (see Table 3).

Coding and data preparation

Parents' speech from video recordings of the free-play sessions was transcribed. Each word or speech sound distinct with pauses in between was considered to be an utterance. The transcribed speech was separated into clauses (i.e., units of speech that contain only one verb or one gerundial). Therefore, all conversations were converted into a form based on Berman and Slobin (1994), with one "verbed clause" per line. These clauses were then coded for whether they contained any lexical causal verbs (e.g., "break"), morphological causal verbs (e.g., *çık* "get out" becomes *çık-Ar* "make it get out, take out"), or causal conjunctions (e.g., "because"). Due to having only one verb or one gerundial, each clause can only contain a lexical causal verb or a morphological causal verb. This coding process has been adapted from Aktan-Erciyes and Göksun (2023). See the "Causal Language" subsection in this paper's introduction for more details about these structures. Verbs were categorized as lexical, morphological, or non-causal by referring to a document that lists all causal verbs in Turkish (see Supplementary Materials B), which was based on the complete verb lexicon of Turkish (Nakipoğlu & Üntak, 2008).

Token input was defined as the number of times a causal word was used (i.e., quantity). Type input was defined as the number of different causal words used by the parent (i.e., quality). While token input takes repetitions of the same word into account, type input does not take repetitions into account. For example, consider this string of parental speech: *Onu çıkar. Çıkar oradan. Çıkardın mı? Getir şimdi.* "Take it out. Take it out of there. Did you take it out? Now bring it." Here, the verb *çıkar* "cause to take out" was used three times, and *getir* "bring, cause to come" was used once. Therefore, in this string, a total of four tokens of morphological causal verbs, and only two types of morphological causal verbs were used.

Dividing the number of both the tokens and types of each causal structure by the number of clauses gave proportional scores of how frequent the causal constructions were in the parental speech input. As each clause contains only one verb or gerundial, the proportions of causal structures cannot exceed 100%. Transcriptions from video recordings and causal language coding were conducted by trained research assistants who were blind to preterm or full-term group belonging. Twenty percent of the data from each time point were re-coded by another research assistant to check for reliability. At T1, intraclass correlation values were .971, .981, and .811 for lexical causatives, morphological causatives, and causal conjunctions respectively. At T2, the values were .876, .998, and .571. At T3, the values were .876, .911, and .809. Differences mostly stemmed from some assistants failing to spot some words or suffixes and were resolved afterward. All coded data were

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Table 3. TCDI Scores of Preterm (PT) and Full-Term (FT) Groups Across Time

			Total Words				Verbs				Causal Verbs			
		N	Mean% (SD)	χ^2	ε^2	*p*	Mean% (SD)	χ^2	ε^2	*p*	Mean% (SD)	χ^2	ε^2	*p*
T1: TCDI-1 (Receptive + Expressive)	PT	35	27.53 (25.83)	6.061	.085	.014	27.25 (28.17)	5.007	.071	.025	30.39 (29.65)	4.519	.064	.034
	FT	37	37.78 (19.95)				37.24 (22.13)				40.60 (23.45)			
T2: TCDI-2 (Expressive)	PT	38	17.94 (19.93)	1.565	.018	.211	14.31 (18.91)	0.054	.001	.817	15.37 (21.01)	0.233	.003	.630
	FT	50	20.81 (18.06)				15.05 (16.03)				17.00 (19.96)			
T3: TCDI-2 (Expressive)	PT	23	57.51 (39.33)	0.060	.001	.806	55.30 (41.06)	0.156	.003	.693	56.45 (41.85)	.020	.001	.887
	FT	31	58.18 (33.41)				59.61 (40.15)				58.67 (38.36)			

Note. Kruskal-Wallis tests concurrently compared preterm and full-term groups. Epsilon-squared (ε^2) denotes effect sizes.

also controlled by the first author. Supplementary Materials C shows all the types of causal structures used in the current data. The present data is available at Open Science Framework: https://osf.io/ayj5b/?view_only=cb5883225c3249388e4a07ea2ee502dc.

Results

To investigate how parental language input occurred across the three time points and among preterm and full-term groups, we performed linear mixed model analyses first with general linguistic measures, then with specific causal linguistic structures. Last, we performed hierarchical linear regressions to assess whether there are longitudinal or concurrent relations between input and vocabulary outcome. All analyses were performed using the statistical analysis software jamovi (version 2.3; The jamovi project, 2022). The linear mixed model analyses were run with jamovi's general analyses for linear models module (GAMLj; Gallucci, 2019), using restricted maximum likelihood estimation and the optimizer *bobyqa* (Powell, 2009). These types of analyses can account for missing data at separate time points. Therefore, all 227 observations at various time points from all of the 105 parent-child dyads were included in these analyses.

Parental general language input

To assess whether the amount of general language input changed between preterm and full-term children, we performed linear mixed model analyses with parents' utterances per second and clauses (linguistic units containing only one verb or gerund) per second as the dependent variables, time (simple contrast coded) and neonatal status as factors, and participants as random intercepts. Figure 1 shows distributions of both general language measures. These mixed model analyses are reported below.

In terms of utterances per second, there was significant variability in parental input, $\sigma^2 = 0.059$, $p < .001$. The number of parental utterances differed significantly between preterm

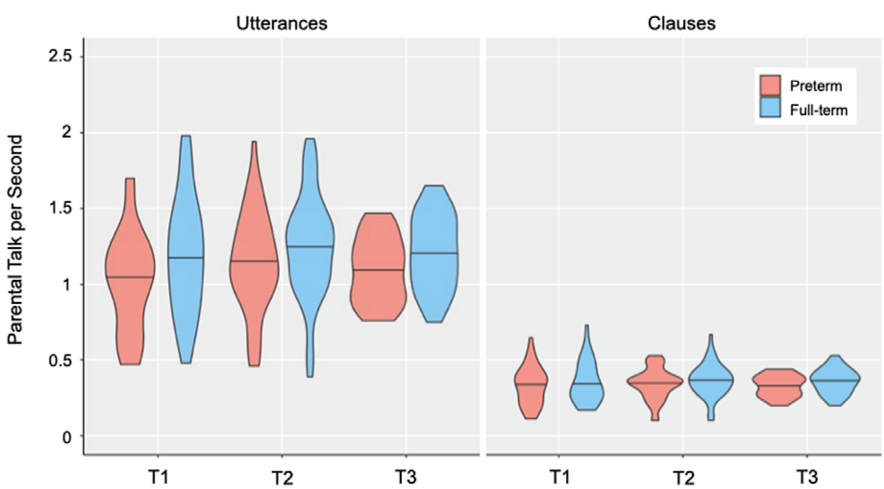

Figure 1. Violin plots of parental use of utterances and clauses (verbs and gerunds) per second across the three time points and among preterm and full-term groups. The horizontal lines indicate 0.5 quantiles.

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and full-term children, $F(1, 103.609) = 5.070$, $p = .026$; with preterm children receiving less input per second than full-term children. The number of parental utterances also significantly differed among time points $F(2, 134.246) = 5.354$, $p = .006$. Post-hoc analyses indicated that from T1 to T2, utterances per second increased by 0.11%, $t(138.478) = 3.264$, $p_{bonferroni} = .004$. There were no differences between T1 and T3, $t(137.947) = 1.745$, $p_{bonferroni} = .250$; and between T2 and T3, $t(129.882) = -1.189$, $p_{bonferroni} = .750$. There was no interaction between neonatal status and time points, $F(2, 134.246) = 0.486$, $p = .616$. In sum, full-term children heard more parental talk than preterm children, and parents' utterances increased from 14 to 20 months, but did not change from 20 to 26 months.

In terms of clauses per second, there was significant variability in parental input, $\sigma^2 = 0.006$, $p < .001$. Contrary to utterances, the number of clauses used per second did not differ between preterm and full-term children, $F(1, 98.925) = 1.435$, $p = .234$. Moreover, the number of clauses per second did not differ among time points, $F(2, 134.983) = 0.840$, $p = .434$. There was no interaction between neonatal status and time, $F(2, 134.983) = 0.019$, $p = .981$. In sum, unlike utterances per second, parental use of clauses per second did not change by neonatal status or time.

Overall, we found that preterm children heard less parental talk than full-term children, although they did not hear fewer clauses. Furthermore, while parents' utterances per second increased from 14 to 20 months, their use of clauses per second did not change over time. These results indicate that neonatal status and child age can influence parents' overall amount of speech, but might not influence parents' use of clauses. Next, we analyzed the proportions of causal structures within clauses across time and among preterm and full-term groups.

Parental causal language input

Token analyses

Similar to how we analyzed general language measures, we performed three linear mixed model analyses using proportions of lexical causal verbs, morphological causal verbs, and causal conjunctions as dependent variables, with time (simple contrast coded) and neonatal status as factors, and participants as random intercepts. Figure 2 shows the token input for each structure of causal language.

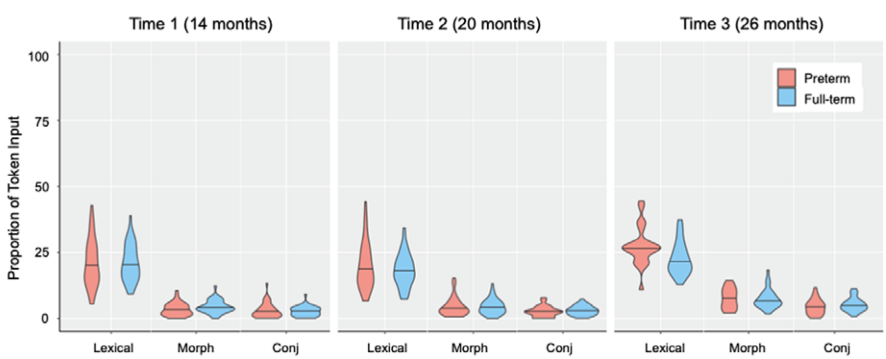

Figure 2. Violin plots of proportions of token input of lexical causal verbs (Lexical), morphological causal verbs (Morph), and causal conjunctions (Conj) across three time points and among preterm and full-term groups. The horizontal lines indicate 0.5 quantiles.

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In terms of tokens of lexical causal verbs, there was significant variability in parental input, $\sigma^2 = 15.456$, $p < .001$. Children born preterm and full-term did not differ in terms of the tokens of lexical causal verb input they received, $F(1, 109.341) = 3.178$, $p = .077$. The proportion of lexical causal verbs in the input changed among time points, $F(2, 155.396) = 14.362$, $p < .001$. Post-hoc analyses indicated that between T1 and T2, there was no significant change, $t(149.308) = 1.696$, $p_{bonferroni} = .276$. However, at T3, on average, children received 4.15% more lexical causal verb input than T1, $t(155.174) = 3.600$, $p_{bonferroni} = .001$, and 5.86% more lexical causal verb input than T2, $t(142.269) = 5.324$, $p_{bonferroni} < .001$. There was no interaction between neonatal status and time, $F(2, 155.396) = 1.776$, $p = .173$.

In terms of tokens of morphological causal verbs, there was no significant variability in parental input, $\sigma^2 = 0.419$, $p = .537$. Children born preterm and full-term did not differ in terms of the tokens of morphological causal verb input they received, $F(1, 108.625) = 0.285$, $p = .595$. The proportion of morphological causal verbs in the input changed among time points, $F(2, 171.062) = 25.196$, $p < .001$. Post-hoc analyses indicated that between T1 and T2, there was no significant change, $t(156.812) = 0.968$, $p_{bonferroni} = .999$. However, at T3, on average, children received 3.57% more morphological causal verb input than T1, $t(170.596) = 6.623$, $p_{bonferroni} < .001$, and 3.11% more morphological causal verb input than T2, $t(155.008) = 5.963$, $p_{bonferroni} < .001$. There was no interaction between neonatal status and time, $F(2, 171.062) = 0.874$, $p = .419$.

In terms of tokens of causal conjunctions, there was significant variability in parental input, $\sigma^2 = 1.760$, $p < .001$. Children born preterm and full-term did not differ in terms of the tokens of causal conjunction input they received, $F(1, 105.870) = 0.904$, $p = .344$. The proportion of causal conjunctions in the input changed among time points, $F(2, 149.104) = 19.266$, $p = .004$. Post-hoc analyses indicated that between T1 and T2, there was no significant change, $t(147.464) = 0.004$, $p_{bonferroni} = .999$. However, at T3, on average, children received 1.86% more causal conjunction input than T1, $t(151.790) = 5.391$, $p_{bonferroni} < .001$, and 1.86% more causal conjunction input than T2, $t(139.743) = 5.676$, $p_{bonferroni} < .001$. There was no interaction between neonatal status and time, $F(2, 149.104) = 1.004$, $p = .369$.

Type analyses

Similar to the analyses reported above, we performed three linear mixed model analyses with types of causal words parents used.

In terms of types of lexical causal verbs, there was no significant variability in parental input, $\sigma^2 = 0.396$, $p = .092$. Children born preterm and full-term did not differ in terms of the types of lexical causal verb input they received, $F(1, 82.222) = 0.690$, $p = .408$. The proportion of the number of different types of lexical causal verbs in the input changed significantly among time points, $F(2, 139.431) = 4.926$, $p = .009$. Post-hoc analyses indicated that between T1 and T2, there was no significant change, $t(153.188) = 0.497$, $p_{bonferroni} = .999$. However, at T3, children heard more types of lexical causal verbs than T1, $t(162.918) = 2.468$, $p_{bonferroni} = .044$; and than T2, $t(148.369) = 3.022$, $p_{bonferroni} = .009$. There was no interaction between neonatal status and time, $F(2, 139.431) = 0.200$, $p = .819$.

In terms of types of morphological causal verbs, there was no significant variability in parental input, $\sigma^2 = 0.041$, $p = .622$. Children born preterm and full-term did not differ in terms of the types of lexical causal verb input they received, $F(1, 86.942) = 0.225$, $p = .637$. The proportion of the number of different morphological causal verbs in the input changed significantly among time points, $F(2, 154.068) = 26.713$, $p < .001$. Post-hoc analyses indicated that between T1 and T2, there was no significant change, $t(156.838) = 0.521$, $p_{bonferroni} = .999$. However, at T3, children received more types of morphological causal verbs than T1, $t(170.651) = 6.637$, $p_{bonferroni} < .001$, and than T2, $t(155.058) = 6.384$, $p_{bonferroni} < .001$. There was no interaction between neonatal status and time, $F(2, 154.068) = 1.789$, $p = .171$.

In terms of types of causal conjunctions, there was significant variability in parental input, $\sigma^2 = 0.283$, $p < .001$. Children born preterm and full-term did not differ in terms of the types of causal conjunction input they received, $F(1, 102.440) = 0.767$, $p = .383$. The proportion of the number of different causal conjunctions did not change significantly among time points, $F(2, 149.872) = 2.735$, $p = .068$. There was no interaction between neonatal status and time, $F(2, 149.872) = 1.796$, $p = .170$.

In sum, there were no neonatal group differences in terms of the causal language input (lexical causal verbs, morphological causal verbs, causal conjunctions) with both tokens and types. This indicates that neonatal status was a significant factor in changing overall parental speech, but not for specific properties of the input. Furthermore, causal language input analyses revealed a consistent increase from T2 to T3 in all causal language measures with both tokens and types. This indicates that while the amount of talk children heard did not change between 20 and 26 months, the causal structures within their input increased; meaning that although parents talked the same amount from 20 to 26 months, their talk became proportionally more causal. Additionally, as visible in Figure 1 (also see Supplementary Materials C), lexical causal verbs were used the most, followed by morphological causal verbs, and causal conjunctions the least in parental input.

Longitudinal and concurrent predictors of causal verb vocabulary

To investigate whether children's causal verb vocabulary at T3 (expressive) is associated with longitudinal or concurrent measures, we performed two hierarchical linear regressions. In these analyses, as the vocabulary measures (TCDI-1 and TCDI-2) assessed children's knowledge of causal verbs but not causal conjunctions, causal verb input scores for each time point were calculated by adding the proportion of lexical causal verbs and morphological causal verbs. First, longitudinally, we assessed whether causal verb vocabulary scores at T1 (receptive) and T2 (expressive), alongside composite standardized scores of causal verb inputs at T1 and T2 were associated with later causal verb vocabulary at T3. For both token and type inputs, we calculated standardized scores from T1 and T2, and took their average as composite scores of earlier causal verb input. Second, concurrently, we assessed whether causal verb inputs at T3 were associated with causal verb vocabulary at T3. We took T3 causal verb vocabulary as the outcome measure in both regressions because it was the most adequate variable to investigate both longitudinal and concurrent relations. As linear regression analyses cannot account for missing data at various time points, the first model was performed with only the 42 who participated at all time points. The second model was performed with the 57 who had TCDI-2 scores at T3 (two participants from T3 did not have TCDI-2 scores). We added children's ages at T3 into these models as covariates since there was a 6-months age range within T3. Appendix B shows variance inflation factors (VIF) and tolerance statistics for both models showing no violation of collinearity.

In Model 1 (Table 4), we investigated longitudinal predictors of T3 causal verb vocabulary. Predictor variables were neonatal status, children's age at T3, children's causal verb vocabulary at T1, causal verb vocabulary at T2, and composite scores from T1 and T2 of both tokens and types of parental causal verb input. In the first step, we included neonatal

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Table 4. Model 1: Longitudinal Predictors of T3 Causal Verb Vocabulary

Predictors	β	p	R^2	ΔR^2
Step 1			.071	–
Neonatal status	.001	.998		
Age at T3	.265	.101		
Step 2			.374	.304
Neonatal status	.198	.478		
Age at T3	.173	.227		
T1 Causal Verb Vocabulary (Receptive)	.114	.465		
T2 Causal Verb Vocabulary (Expressive)	.507	.002		
Step 3			.452	.078
Neonatal status	.185	.504		
Age at T3	.152	.280		
T1 Causal Verb Vocabulary (Receptive)	.237	.150		
T2 Causal Verb Vocabulary (Expressive)	.411	.016		
T1 + T2 Causal Verb Input (Token)	–.099	.508		
T1 + T2 Causal Verb Input (Type)	–.267	.061		

status and age at T3. The model was not significant in the first step, $F(2, 39) = 1.479, p = .240$. Age at T3 and neonatal status were not associated with T3 causal verb vocabulary. In the second step, upon inclusion of children's causal verb vocabulary at T1 and at T2, the model was significant, $F(4, 37) = 5.534, p = .001$. While T1 causal verb vocabulary did not predict T3 causal verb vocabulary, T2 causal verb vocabulary positively predicted T3 outcome. In the third step, we included T1 and T2 composite causal verb input scores of both tokens and types. The model, although significant, did not improve from the second step, $F(6, 35) = 4.811, p = .001$. Earlier token and type inputs did not predict T3 causal verb vocabulary, but T2 causal verb vocabulary remained significant.

In Model 2 (Table 5), we investigated concurrent predictors of T3 causal verb vocabulary. Predictor variables were neonatal status, children's age at T3, and parental causal verb input of tokens and types at T3. In the first step, we included neonatal status and age at T3. The model was not significant in the first step, $F(2, 54) = 1.106, p = .338$. Age at T3 and neonatal status were not associated with T3 causal verb vocabulary. In the second step, we included parental causal verb input scores of both tokens and types at T3. The model did not improve and was not significant, $F(4, 52) = 1.518, p = .211$. Concurrent token and type inputs were not associated with T3 causal verb vocabulary.

Overall, the regression analyses showed that children's expressive causal verb vocabulary at T2 was the only significant predictor of their expressive causal verb vocabulary at T3. Receptive causal verb vocabulary at T1, and parental causal verb input from earlier or concurrent time points did not predict causal verb vocabulary. These indicate that parental input was not longitudinally or concurrently associated with children's knowledge of causal verbs. Nonetheless, children's expressive vocabulary of causal verbs at 20 months can predict their expressive vocabulary of causal verbs at 26 months.

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Table 5. Model 2: Concurrent Predictors of T3 Causal Verb Vocabulary

Predictors	*β*	*p*	R^2	ΔR^2
Step 1			.039	–
Neonatal status	–.025	.854		
Age at T3	.200	.143		
Step 2			.105	.065
Neonatal status	–.115	.428		
Age at T3	.177	.199		
T3 Causal Verb Input (Token)	–.254	.088		
T3 Causal Verb Input (Type)	–.073	.591		

Additionally, we investigated correlations between measures of general language input (utterances and clauses per second) with measures of general vocabulary (all words including verbs and verbs only) (see Supplementary Materials D). Significant correlations BETWEEN input and vocabulary were only evident concurrently at T1. Utterance per second at T1 positively correlated with receptive word and verb vocabularies at T1: $r(70) = .324$, $p = .006$, and $r(70) = .286$, $p = .015$ respectively. There were no other concurrent or longitudinal associations between input and vocabulary (*ps* > .05). However, there were significant correlations WITHIN input and vocabulary measures, indicating that parental input and child vocabulary were consistent in time. Parents' use of utterances was highly and positively associated between T1 and T2, T2 and T3, and T1 and T3: $r(61) = .593$, $p < .001$; $r(56) = .611$, $p < .001$; $r(41) = .578$, $p < .001$. Similarly, children's total word vocabulary was positively associated between T1 and T2, T2 and T3, and T1 and T3: $r(58) = .449$, $p < .001$; $r(58) = .680$, $p < .001$; and $r(43) = .436$, $p = .003$ respectively.

Discussion

In the present study, we asked (1) whether parents of children born preterm and full-term differed in terms of the language input they provide to their children, (2) how parental causal language input occurred across time for young children, and (3) whether tokens and types of causal verb input were associated with children's causal verb vocabulary. Parental causal language input was measured in free-play sessions at three time points when preterm and full-term children were 14, 20, and 26 months of age. First, we found that preterm children heard fewer utterances per second than full-term peers. However, the proportion of clauses, or the proportion of causal language in the input did not differ between preterm and full-term groups. Second, from 14 to 20 months, while the amount of parental talk increased, causal language input did not change. However, from 20 to 26 months, while the amount of parental talk remained the same, causal input increased. Lexical causal verbs constituted the most of causal language input, followed by morphological causal verbs, and causal conjunctions the least. Third, we found that expressive causal verb vocabulary at 20 months was the only longitudinal predictor of expressive causal verb vocabulary at 26 months. Parental causal verb input had no longitudinal or concurrent associations with expressive causal verb vocabulary at 26 months. Overall, our findings indicate that while neonatal status can be an influential factor for general

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parental language input, it did not influence the causal properties of the input. Moreover, the amount of parental talk and the proportion of causal language showing different increasing patterns across time indicates that parents changed the way that they speak as their children aged, with causal structures taking a bigger proportion within the input as children got over the age of two.

Neonatal differences in general but not specific language input

Our findings show that in all time points, parents of full-term children used more utterances per second than parents of preterm children. However, when we investigated more specific and causal properties of the input, we did not observe any differences between preterm and full-term groups. Parents' use of clauses (verbs or gerunds) per second did not change. Proportions of causal structures (lexical causal verbs, morphological causal verbs, and causal conjunctions) by token or type also did not differ between preterm and full-term groups. Why did parents of preterm children talk less? How come there were no differences in specific language input?

Parents using fewer utterances towards preterm children could be due to an awareness of preterm children's tendency to lag behind their full-term peers in several areas such as motor development and preverbal skills (De Schuymer et al., 2011; Kobaş et al., 2022). Parents might be reluctant to overuse words that could disrupt their scaffolding ability during play instances. Another possibility might be that preterm parents might have uttered fewer words but focused on crucial verbalizations to keep their children on task, without disrupting their attentional processes. Together with these, finding no differences in the proportion of causal language input might indicate that parents did not omit causal structures when talking less to preterm children. Causal language structures were deemed to be fundamental, having a consistent proportion in parental speech input regardless of neonatal status.

Previous research comparing parental language input between preterm and full-term children has mostly found no differences from infancy to preschool ages. During 15 minutes of semi-free-play, Italian-speaking parents of preterm and full-term 6-month-olds did not differ in their utterances per minute (Salerni et al., 2007). During day-long home observations, English-speaking parents of preterm and full-term 16-month-olds did not differ in their word count per hour (Adams et al., 2017). During 10 minutes of book reading, Italian-speaking parents of 30-months-old low-risk preterm and full-term late talkers did not differ in their number of utterances, verbs, nouns, and adjectives (Suttora et al., 2020). Similarly, during puzzle play, English-speaking parents of 4-years-old preterm and full-term preschoolers did not differ in their use of words, gestures, and spatial words (Clingan-Siverly et al., 2021). However, an earlier investigation of the present sample found that at 14 months (T1), parents of preterm children used fewer pointing gestures alongside having fewer utterances (Doğan et al., 2021). Comparably, while there is extensive literature documenting preterm children's delays in language development (e.g., Guarini et al., 2010; Putnick et al., 2017), some findings indicate no differences (e.g., Pérez-Pereira & Cruz, 2018; Pérez-Pereira et al., 2019).

Looking at our language measures, we found that preterm children had lower receptive vocabulary scores at T1 than full-term children. There were no differences in expressive vocabulary measures at T2 and T3. The difference we observe at T1 is similar to previous research on comprehension (e.g., Putnick et al., 2017; Sansavini et al., 2011) and production (e.g., Foster-Cohen et al., 2007). Nonetheless, some reports indicate that differences due to environmental factors and differences in vocabulary production may become more apparent after 24 months and onwards (e.g., Fasolo et al., 2010; Sansavini

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et al., 2011; but see Clingan-Siverly et al., 2021). Even in light of previous research, our findings showing neonatal differences in parental utterances but not in clauses or causal structures are puzzling. Future longitudinal research with longer and denser data collection would be required to see if the present null findings in parental causal language input continue at later time points.

Language input changed across time

We found that parents' utterances per second increased between 14 and 20 months, but remained the same between 20 and 26 months, while clauses per second did not change over time. Conversely, parental use of causal language remained the same between 14 and 20 months, but increased between 20 and 26 months. This increase was present not only for the tokens of lexical and morphological causal verbs or causal conjunctions, but also for the types of different verbs. At 26 months, compared to earlier points, parents used a more diverse range of both lexical and morphological causal verbs. These indicate that parents not only increased the quantity of the proportion of causal language they used with their children, but they also gave children better quality causal input. However, why did utterances and causal structures show different increases over time? Parents might have increased their general talk from 14 to 20 months in response to their children's developing language capabilities. Nonetheless, the increase in causal language from 20 to 26 months while the number of utterances or clauses remained the same indicates that parents might not only respond to general developmental patterns, but also are sensitive to their children's developing sense of causation.

Children's understanding of the causal relations around them has long been considered to be a crucial aspect of their development (e.g., Gopnik & Schulz, 2007; Piaget, 1954). The increase we found in causal input at 26 months could be reflective of how children show a "non-causal to causal" trajectory of development in their own speech and gestures (e.g., Göksun et al., 2010). This increase in causal input at 26 months is also similar to previous longitudinal research on causal language use in other languages. English child-directed speech and child speech show increase in the use of lexical causal verbs (e.g., "break") after 24 months of age (You et al., 2021b). The probability of German causal conjunctions (e.g., *weil* "because") occurring in parental speech also gets higher around the same time (van Veen et al., 2009). However, these studies were limited in scope due to either excluding causal conjunctions or the whole range of lexical causal verbs (You et al., 2021b), or excluding verbs altogether (van Veen et al., 2009). The present study is among the first that included all types of causal language in the input of a language that has particular causative morphology.

Properties of causal language input

We found that each causal structure appeared with differing levels in the input. Lexical causal verbs had the biggest proportion, followed by morphological causal verbs, which were followed by causal conjunctions. These replicate previous results on the distribution of causal structures within parental input in Turkish (Aktan-Erciyes & Göksun, 2023). Moreover, all three structures showed significant increases at 26 months, albeit to different degrees. Except for types of different causal conjunctions, all structures were produced more at 26 months in both token and type measures. These particular and overall increases in causal language input could indicate that change in parental speech is not limited to a set of expressions, but is observed in all levels of causal language.

The higher frequency of lexical causal verbs could be due to how simple causal interactions with the environment can lead to the use of basic forms of causal expressions that refer to them (Shibatani & Pardeshi, 2002; Wolff, 2003). Parents' simple directives like "*Throw* the ball!" or descriptions like "I *caught* it!" during free-play sessions constituted a considerable amount of this lexical causal input. Although less than lexical causal verbs, morphological causal verbs were not infrequent in the current data (see Supplementary Materials C). Causal morphemes are not among the most used suffixes in Turkish, yet irregular forms such as *getir* "bring" and *göster* "show" (suppletions of *gel* "come" and *gör* "see") appear very frequently in both writing and speech (Aksan et al., 2017). Parents used common suppletive forms such as *getir, götür, göster, kaldır* alongside regular morphological causal verbs such as *çık-ar* "bring out," or *uyu-t* "put to sleep."

While by nature all lexical causal verbs differ by phonology and semantics, morphological causal verbs have common phonological indicators (i.e., the causal morphemes) that could allow easier causal categorization. Therefore, morphological causal verbs can be considered to be more transparent about causation (see Shibatani & Pardeshi, 2002). Noticing a causal suffix at the end of a verb would inform the listener that this verb is causativized. Coupled with less frequent usage, the causal morpheme could trigger heightened awareness about those verbs. Hearing them during the early years of life could point the child to pay attention to particularly causal instances, more clearly communicating the causal nature of the relations. In that vein, Aktan-Erciyes and Göksun (2023) have found that early input of morphological causal verbs at 14 and 20 months, but not of lexical causal verbs, predicted later causal verb understanding at 35 months of age. Regardless, compared with lexical causal verbs, previous research is inconclusive about the nature of the Turkish morphological causative on language development. Less exposure in input to causal morphemes could explain the lack of differences between lexical and morphological causal verbs in eliciting causal understanding with children (Ger et al., 2021, 2022).

Input was not associated with vocabulary

We investigated associations of children's expressive causal verb vocabulary at 26 months with longitudinal and concurrent measures of causal verb input. We found that expressive causal verb vocabulary at 20 months was the only longitudinal predictor of expressive causal verb vocabulary at 26 months. However, parental causal verb input was not longitudinally or concurrently associated with expressive causal verb vocabulary at 26 months. Contrary to previous research showing how parents' use of specific linguistic structures can predict children's vocabulary of those structures (e.g., Blackwell, 2005; Pruden et al., 2011), we have not found consistent associations between earlier parental causal verb input and children's later causal verb vocabulary. However, vocabulary at 20 months predicting vocabulary at 26 months is similar to how early vocabulary growth can predict later vocabulary skills (Rowe et al., 2012). Given extensive literature connecting input to vocabulary, why could parental causal verb input fail to predict children's causal verb vocabulary?

One reason we could not find associations between input and vocabulary could be due to how TCDI is an indirect, parent-report measure of children's vocabulary, in which we only focused on a section of that contained causal verbs. TCDI may not be sufficient to detect associations between language input and vocabulary outcome. Moreover, expressive causal verb vocabulary is not the sole representative of children's causal language capabilities, where children's use of *why*-questions or explanations could also be at play.

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Another possibility could be due to parental causal verb input we assessed during free-play sessions not being adequately reflective of the actual input children receive at home. The structure of play can influence the amount of causal input, as parents use more causal verbs during guided-play compared to free-play (Aktan-Erciyes & Göksun, 2023). Future research should incorporate both receptive and expressive causal language from different contexts, such as naturalistic and longer home observations, storytelling or book reading sessions, and experimental settings.

Limitations and future directions

One of the limitations of the current research was the methodological decision to change the toys in free-play sessions at T3. We acknowledge that the higher proportion of lexical causal verbs such as *ye* "eat" and morphological causal verbs such as *pişir* "cook" and *karıştır* "mix" can be a result of the toy cooking set given at the 26-months play session that was absent in previous time points. Nonetheless, although to a lesser degree, words such as *ye* or *pişir* were present in earlier time points as well. Similar to Aktan-Erciyes and Göksun's study (2023), the reasoning behind providing different toys at T3 was to avoid parents' and children's familiarity with toys that could elicit similar language input. This decision was also made to achieve better external validity by providing a range of toys across the time points at the expense of internal validity. Conversely, at T1 and T2, but not at T3, there was a toy ball in the sessions. Parents often used lexical causal directives such as *At!* "Throw!" or *Tut!* "Catch!" while playing with the ball and these verbs appear more at T1 than at T3. Additionally, we observed an increase in utterances from T1 to T2, but not from T2 to T3, and no time changes in clauses. We argue that if toys influenced input to such a degree, we would have seen a larger increase in utterances and clauses from T2 to T3. Therefore, although the toys might have influenced the content of the speech, specific toys were not the only reason for the increased quantity and quality of input at T3. We argue that the increased use of causal language is reflective of children's developing sense of causality, language, and cognition as they pass the age of two, rather than being a byproduct of the toys that were present. Nonetheless, a careful interpretation of the present results about the increase in T3 is necessary. Previous research has shown that the toys being used in parent-child interactions can influence input. For instance, playing with blocks or puzzles may increase spatial talk (Ferrara et al., 2011). Compared to such studies, here, no toy was given to specifically elicit causal language. Another limitation at T3 was the outbreak of COVID-19 and consequent government-issued lockdown measures starting from March 2020. Around 36% of participants from the previous time point could not participate at T3.

The current findings could also be limited in terms of "direct output" measures of causal verbs and conjunctions, although we investigated causal input thoroughly and included parent reports of child vocabulary at all time points. The current play sessions were not rich enough in child production data where their coding and analysis would be justified. Future research should elicit more child language production during play or include experimental assessments of causal language to see whether direct output measures are related to parental input. Considering our participants were from a mid- to high-socioeconomic status with educated mothers, our findings can be limited in representing the general population. Moreover, we cannot draw conclusions about children's causal cognition, which is shown to be facilitated by causal language (e.g., Bonawitz et al., 2010; Ger et al., 2021). Future research on causal language and parental input should also include measures of causal learning, reasoning, and counterfactual thinking.

Conclusion

In conclusion, the present study investigated parental causal language input during three time points when preterm and full-term children were 14, 20, and 26 months of age. In general, although preterm children heard fewer words overall, there were no differences between preterm and full-term children in terms of the proportion of causal language input. Parental use of causal language increased from 20 to 26 months, while the amount of overall verbal input remained the same. Only children's expressive causal verb vocabulary at T2, rather than earlier or concurrent causal verb input, predicted their expressive causal verb vocabulary at T3, These findings suggest that neonatal status can influence the amount of overall parental talk, but not parental use of causal language. Moreover, parents might be increasing the proportion of causal language input as children grow, sensitive to children's developing constructions of the causal world around them.

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Appendix A

Parental Use of Causal Language for Preterm and Full-Term Children: A Longitudinal Study

Toys

Sample screenshots from the video recordings of free-play sessions of T2 (left) and T3 (right) showing the setting and the toys being used. Toys were the same in T1 and T2.

Appendix B

Parental Use of Causal Language for Preterm and Full-Term Children: A Longitudinal Study

VIF and Tolerance Values

Model 1 (Table 4) – Step 3			Model 2 (Table 5) – Step 2		
Variable	VIF	Tolerance	Variable	VIF	Tolerance
Age at T3	1.220	0.820	Age at T3	1.079	0.927
Neonatal Status	1.190	0.840	Neonatal Status	1.194	0.838
T1 Causal Verb Vocabulary	1.649	0.607	T3 Causal Verb Token	1.243	0.805
T2 Causal Verb Vocabulary	1.684	0.594	T3 Causal Verb Type	1.070	0.935
T1+T2 Causal Verb Token	1.404	0.712			
T1+T2 Causal Verb Type	1.165	0.858			

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