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A Literature Analysis of Themes in Paediatric Cochlear Implant Research

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Abstract

Research on children with cochlear implants (CI) has documented positive outcomes, but also that many still experience language delays. The aim of this article is to explore how research on children with cochlear implants cover topics of early language development compared to research on children with typical hearing and children with hearing impairment without CI. Published research in the period 1990-2013 on language development was analysed with respect to frequency of selected search terms reflecting different language acquisition themes among children with typical hearing, children with hearing impairment without CI, and children with CI, respectively. Results showed a relatively lower number of articles which included themes such as pre-verbal language (imitation, joint attention and gestures), extra lingual abilities (social interaction), and later language skills (semantic, syntactic, grammar and pragmatic) in research on children with cochlear implants compared to research in children with typical hearing. A need for more research with focus on pre-lingual themes in language acquisition is discussed.

Keywords: Cochlear implant; Congenital deafness; Gestures; Hearing impairment; Language development; Language acquisition

Introduction

Twenty five years have passed since the Food and Drug-administration in the US, approved cochlear implantation (CI) for children between 2 and 17 years of age [1]. Today cochlear implantation surgery from 1 year of age, and even earlier, is standard treatment in many countries for children with severe to profound congenital hearing loss. The introduction of CI has been a breakthrough in rehabilitation and research has shown good outcomes with regard to speech production and perception. Even though CI is proven to be a step forward compared to former technologies and approaches in rehabilitation, there are still challenges [2]. The outcome variation shows that many children continue to struggle with delay in language development. Niparko, et al. [3] reported that differences in spoken language abilities between children without hearing impairment and children with CI were not closed 3 years after implantation. Others have reported a large variation of language outcomes for children with CI [4,5]. The explanation of and mechanisms behind, this delay and variation remain poorly understood.

Language is one of our most adaptive (generative) cognitive tools [6], without language, communication, cognition society, and culture, life would have been restricted. Therefore, language support to children with congenital hearing impairment is crucial. Short and long term negative effects of hearing loss on language development have frequently been reported [7-11]. Children with congenital hearing loss do not develop, for instance, vocabulary in the same speed as typical hearing children [7,10-13] and long-term negative impacts on educational outcomes have also been documented [14-18]. A third example of the consequences of hearing loss on language development is that delay in language development has also been found to be associated with a higher prevalence of psychosocial difficulties [19].

In research and practice a controversy is ongoing between the uses of signed languages versus uses of oral languages in deaf education. It has been debated whether or not sign language in general, and more specifically following cochlear implantation, should be used [20]. Some researchers have argued for the unnecessary or even negative effect of using sign language when the child has received a CI [21-23]. Even though recent research concluded that there is no evidence that sign language has any negative effects [24], it continues to be the rehabilitation focus in some settings [25,26]. Ruffin et al. [26]. showed in their study a negative correlation between use of sign language and the outcome of a spoken language test, "Speech perception scores were negatively associated with a meningitic etiology of hearing loss, older age at implantation, poorer preimplant unaided pure-tone average thresholds, lower family income and the use of 'total communication'", (p. 289). But their study, similar to others, did not take into account that children and their parents might choose to use sign language if their child cannot hear. Using sign language is then an outcome variable, not a predictor of lower oral language abilities.

Language development

Researchers have used a variety of approaches to understand how children learn language. The classical theories of language development are often grouped into three: Learning theories [27], nativist theories [28] and interactionist theories [29] for an overview see Gleason et al. [30]. The interactionist approach underlines the role of social interaction between the child and the caretaker in language acquisition and stresses that language is not merely an outcome of development but also a precursor of cognitive and social development [29,31]. Bohannon et al. [31], outline three different interactionist approaches: cognitive competition, socialization, and usage-gestural based. The first focuses on how cognitive development is linked to language development [32], the second on how social interaction skills develop and lead to language acquisition [33] and the third on how symbols and words develop from natural iconicity and gestures [34,35].

Deaf children's language development has been studied from all the above approaches. The natural development of sign language among deaf children has supported the nativist theories [36] and also the interactionist approaches, which have been intensively researched with respect to deaf children [37,38].

Early stages of language development

Early language development reflects the language used in the family, regardless of the specific language or modality used [39]. Deaf children's sign language development follows, in general, the same milestones as children with typical hearing [40,41]. It has been studied how deaf parents of deaf children naturally support their deaf child's early language development by engaging visually in social interaction and communication with their child involving social smiles, play dialogue, gestures, turn-taking, and greetings [42]. The social and communicative interaction becomes more and more complex and dynamic as the child develops. At 12 months of age children often produce their first word (and/or sign) [30,43]. These first words/signs are followed quite quickly by more words, two words, longer sentences, and increased pragmatic understanding.

A special interest in deaf children's language acquisition has been the use of gestures and signs [44]. Similar to children without hearing impairment deaf children use gestures in early communication. Later the gestures are combined with oral words or sign language signs [44]. The pre-lingual phases in language development are, in general, equal for children with and without hearing impairment with regard to social interaction and use of gestures [45]. Both language modalities share a common pre-lingual background and the exposed language in the child's environment enhances development of the specific language modality/-ies.

Typical researched topics in the pre-lingual period of language development are imitation [46-48], social interaction [30,39,47-49], joint attention [39,47-49] and gestures [38,46,48]. These topics are studied among different disciplines such as linguistics, psychology, and speech-language pathology. Further, language development, irrespective of language modality, has been studied from a linguistic approach including vocabulary, semantics, syntactic, grammar, and pragmatics [30,43,47,49,50].

Research question

Research and practice in early intervention and education of children with hearing loss has undergone changes due to introduction of new technologies. Language acquisition is a complicated developmental process for the individual child, and a broad range of language perspectives are of relevance in both practice and research. Interdisciplinary and cross-domain approaches are needed. The research question asks to what extent the field of hearing impairment and CI research, compared to research in children with typical hearing, take into account different aspects of the child's language development?

Method

A systematic citation analysis of selected terms used in scientific publications from 1990 to 2013 was completed. The year 1990 was decided because the US Food and Drug Administration approved the use of the first cochlear implant system for children two to 17 years of age this year [1]. Scopus was used for the citation analysis, which is one of the largest abstract and citation databases containing peer-reviewed research literature and quality web sources. Scopus includes documents from technical, medical, and social sciences fields as well as from fields in arts and humanities.

Three different groups were searched: (a) Research in language development excluding individuals with hearing impairment by using the search terms language development AND child AND NOT cochlear implant, hearing aid, or hearing loss/impairment. This group can be characterized as typical hearing children. Typical hearing does not mean typical language development because it also includes children with different language disorders but without hearing loss. (b) Research in children with hearing impairment without CI using the search terms language development AND child AND hearing impairment AND NOT cochlear implant. (c) Research in children with CI using the search terms language development AND child AND cochlear implant.

Across the three groups a search for publications including the following 12 terms reflecting different approaches/fields of research in children's language development were completed: Imitation, Babbling, Social interaction, Joint attention, Gesture, Speech, Sign language, Vocabulary, Semantic, Syntactic, Grammar, and Pragmatic. The article titles, abstracts, and keywords were included in the search and the search was completed in October 2014.

Analysis was carried out using descriptive statistics of number and frequency of publications and further Chi square statistics for comparisons between the three groups: Research in children without hearing impairment compared to research in children with hearing impairment without CI and research in children with CI, respectively.

Results

In total 12,020 hits on Scopus correspond to the search terms. A majority, 10,752, within research on children without hearing impairment, 567 in research on children with hearing impairment without CI, and 701 on research in children with CI.

Overall, we found all the searched terms represented in all three groups. Table 1 shows the number and per cent of studies for the 12 search terms. As a first analysis we found fewer studies on pre-verbal language terms in the CI group compared to the group with typical hearing. For example, we found only 3% of the studies addressed Social interaction in the CI research compared to 8% in typical hearing research.

Search term	Typical hearing group N=10752, n (%)	Hearing impaired without CI group N=567, n (%)	CI group N=701, n (%)
Imitation	767 (7)	21 (4)	31 (4)
Babbling	296 (3)	15 (3)	52 (7)
Social interaction	896 (8)	41 (7)	24 (3)

Joint attention	624 (6)	15 (3)	12 (2)
Gesture	873 (8)	63 (11)	35 (5)
Speech	7464 (69)	407 (72)	634 (90)
Sign language	271 (3)	136 (24)	92 (13)
Vocabulary	3808 (35)	139 (25)	243 (35)
Semantic	1754 (16)	42 (7)	22 (3)
Syntactic	1731 (16)	45 (8)	45 (6)
Grammar	2085 (19)	50 (9)	87 (12)
Pragmatic	984 (9)	28 (5)	12 (2)

Table 1: Number and per cent of studies for each of the 12 search terms on language development for each of the three groups.

	Typical hearing	**Hearing impairment**			**Cochlear implant**		
	N=10752	**N=567**			**N=701**		
Search term	N	n	$\chi 2$	P	n	χ^2	p
Babbling	296			ns	52	48.61	<0.001
Gesture	873	63	6.35	<0.05			ns
Speech	7464			ns	634	140.42	<0.001
Sign language	271	136	715.9	<0.001	92	241.1	<0.001
Note: Chi-square 2 x 2 outcome; n, χ^2 and p, df=1							

Table 2: Statistical comparison of studies covering terms that were more frequent in research in children with CI and hearing impairment compared to research in children with typical hearing.

	Typical hearing	**Hearing impairment**			**Cochlear implant**		
	N=10752	**N=567**			**N=701**		
Search term	N	n	χ^2	P	n	χ^2	p
Imitation	767	21	9.78	<0.01	31	7.46	<0.01
Social interaction	896			ns	24	21.47	<0.001
Joint attention	624	15	10.08	<0.01	12	21.01	<0.001
Gesture	873			ns	35	8.81	<0.01
Vocabulary	3808	139	28.18	<0.001			ns
Semantic	1754	42	32	<0.001	22	87.18	<0.001
Syntactic	1731	45	27.13	<0.001	45	47.06	<0.001
Grammar	2085	50	39.34	<0.001	87	20.87	<0.001
Pragmatic	984	28	11.75	<0.001	12	45.74	<0.001
Note: Chi-square 2x2 outcome; n, χ^2 and p, df=1.							

Table 3: Statistical comparison of studies covering terms that were less frequent in research in children with CI and hearing impairment compared to research in children with typical hearing.

To investigate if these differences were significant we conducted a Chi square comparison. Terms that are significantly more researched among children with hearing impairment with and without CI, respectively, compared to children with typical hearing, were Babbling (for research in children with CI), Gesture (for research in children with hearing impairment without CI), Speech (for research in children with CI), and Sign language, (for research in both groups) (Table 2).

Terms significantly less represented in research on children with hearing impairments with or without CI compared to research in typical hearing children were Pragmatic, Grammar, Syntactic, Semantic, Vocabulary (for research in children with hearing impairment without CI), Gesture, Joint attention, Social interaction (for research in children with CI), and imitation, (for research in both groups) (Table 3).

Discussion

The research question concerned, to what extent the fields of hearing impairment and CI research take into account the different aspects of children's language development? Significant differences on the selected research terms were found. Most search terms, except for Sign-language and Speech, were significantly less researched. These results may indicate that research on hearing impairment and CI are less varied than research on language development among children without hearing impairment. The more frequent focus on sign-language in research on children with CI compared to research on typical hearing children might reflect that more aspects of pre-lingual language development are associated to sign language. But as introduced, early language acquisition involves more than gestures and sign-language.

With respect to the fact that language outcomes vary for children with cochlear implants and hearing impairment, this study's findings may be of concern. First, some important aspects of the language acquisition process may be overlooked, there may be a need for more research on, for instance, usage-based, multimodality, social interaction, and non-verbal aspects in CI research. Second, with less diversity in research there is less of a basis for the development of cross-disciplinary research. The potential may be illustrated by the role gesture plays in language development for children in general, and more specifically, for children with hearing loss.

Gestures

Over the last decades there have been a growing number of research projects looking at the role of gesture in language development. This is, according to the results of this study, also the case for research on children with hearing impairment, but not for research on children with cochlear implants, where it seems to be overlooked. Research has found gestures to be an important part of children's language development [51-54], both in oral and signed languages [45,55]. One difference between deaf and hearing children, with respect to early use of gestures, is that deaf children develop modulated universal gestures into iconic gestures. They use more specific visual gestures and signs as referents corresponding to how words are used among hearing children.

Hearing children with deaf relatives develop both speech and sign language after initial use of gestures [56,57], and gestures, speech, and sign language seem to share essential linguistic features rather than separate [58]. If gesture in early language development is responded to, they will continue to be used and become a natural part of communication [59]. Even without natural language models (deaf signing parents), gestures can develop into a sign language structure for congenitally deaf children [57,60,61].

Gesture use may play an important part in language learning. Early gesture use has been found to be important for language processing [62], attention control in early word learning [63], and early pointing gestures have been found to be connected to both word and sign development [64]. Gesture use is suggested to be an early connection between language and thought, in that infants from their earliest pointings share common conceptual contexts with their parents [33,53,65]. Gestures do not just reflect thought but have an impact on thought [65], without gestures thought would be altered or incomplete [53]. Gestures bridge the transition from pre-linguistic to more symbolic communication [66]. Alibali et al. [67] found that gestures among students seem to serve both speaker-internal and communicative functions. In their study they found that gestures were used both in face to face communication and in communication when listeners could not see each other.

The impact of gesture use has been researched among different groups of children with language difficulties. Children with Down syndrome, who used signs, were able to express more utterances compared to if they only used oral speech [68]. Children with late language development who used gestures and signs showed faster language development than similar children who did not use gestures and signs [57].

Gestures seem to occur as a bridge from early language exposure to speech and/or sign language. Early gesturing can predict later language development [69] and support language development [70]. Further on in language development for normal hearing children gestures, batonic (non-representational) and iconic (representational), continue to be natural parts of communication [47]. Gestures might have an important role to play for the development of young children with hearing loss - with and without CI. Therefore, we recommend future research to take early aspects of language development such as gestures into account when conducting research among children with hearing loss and CI.

Conclusion

Pre-verbal themes in research among children with hearing impairment and CI were found to be significantly less focused upon compared to research among children with typical hearing. This may be an issue of concern since the delay some children with cochlear implants experience with regard to language development might start in the early and pre-verbal steps of language acquisition. Important themes in early language development, which could support congenital deaf children's language development, may be overlooked in current research. Gestures, social interaction, joint attention, and imitation, to mention a few, need more attention in research on early language development for children with hearing impairment and cochlear implants.

References

1. Stinson A (1996) Cochlear Implantations in Children. AORN Journal 64: 561-571.
2. Archbold S, O'Donoghue GM (2009) Cochlear implantation in children: current status Paediatrics and Child Health 19: 457-463.

3. Niparko JK, Tobey EA, Thal DJ, Eisenberg LS, Wang NY, et al. (2010) Spoken language development in children following cochlear implantation. JAMA 303: 1498-1506.
4. Lyness CR, Woll B, Campbell R, Cardin V (2013) How does visual language affect crossmodal plasticity and cochlear implant success? Neurosci Biobehav Rev 37: 2621-2630.
5. Tait M, Lutman ME, Robinson K (2000) Preimplant measures of preverbal communicative behavior as predictors of cochlear implant outcomes in children. Ear Hear 21: 18-24.
6. Corballis, M. C. (2002). From hand to mouth, the origins of language. Princeton, NJ: Princeton University Press.
7. Blamey PJ, Barry JG, Jacq P (2001) Phonetic inventory development in young cochlear implant users 6 years postoperation. Journal of Speech, Language, and Hearing Research 44:73-79.
8. Campbell R (2008) Insights into language structure and function: some consequences of prelingual hearing loss. In K. Dodd, R. Campbell, & L. Worralk (Eds.),Evaluating Theories of Language: Evidence from Disordered Communication pp: 74-96. London: Whurr
9. Lederberg AR, Schick B, Spencer PE (2013) Language and literacy development of deaf and hard-of-hearing children: successes and challenges. Dev Psychol 49: 15-30.
10. McGowan RS, Nittrouer S, Chenausky K (2008) Speech production in 12-month-old children with and without hearing loss. J Speech Lang Hear Res 51: 879-888.
11. Vohr BR, Topol D, Watson V, St Pierre L, Tucker R (2014) The importance of language in the home for school-age children with permanent hearing loss. Acta Paediatr 103: 62-69.
12. McGowan RS, Nittrouer S, Chenausky K (2005) Preliminary comparison of infants speech with and without hearing loss. The Journal of the Acoustical Society of America 117: 2377-2377.
13. Vohr B, Pierre LS, Topol D, Jodoin-Krauzyk J, Bloome J, et al. (2010) Association of maternal communicative behavior with child vocabulary at 18-24 months for children with congenital hearing loss. Early Hum Dev 86: 255-260.
14. Hendar O (2008) Måluppfyllelse för döva och hörselskadade i skolan. Örebro, Sweden: Specialskole myndigheten.
15. Hendar O (2012) Elever med hørselshemming i skolen: En kartleggingsundersøkelse om læringsutbytte. Oslo, Norway: Skådalen Resource Centre.
16. Powers S (1999) The educational attainments of deaf students in mainstream programs in England: examination results and influencing factors. Am Ann Deaf 144: 261-269.
17. Thoutenhoofd E (2006) Cochlear implanted pupils in Scottish schools: 4-year school attainment data (2000-2004). J Deaf Stud Deaf Educ 11: 171-188.
18. Traxler CB (2000) The Stanford Achievement Test, (9thedn) National Norming and Performance Standards for Deaf and Hard-of-Hearing Students. J Deaf Stud Deaf Educ 5: 337-348.
19. Dammeyer J (2010) Psychosocial development in a Danish population of children with cochlear implants and deaf and hard-of-hearing children. J Deaf Stud Deaf Educ 15: 50-58.
20. Knoors H, Marschark M (2012) Language planning for the 21st century: revisiting bilingual language policy for deaf children. J Deaf Stud Deaf Educ 17: 291-305.
21. Borchgrevink HM (2009) Effects of shift work and intermittent noise exposure on hearing: mechanisms and prophylactic potential. Noise Health 11: 183-184.
22. Percy-Smith L, Cayé-Thomasen P, Breinegaard N, Jensen JH (2010) Parental mode of communication is essential for speech and language outcomes in cochlear implanted children. Acta Otolaryngol 130: 708-715.
23. Sparreboom M, Langereis MC, Snik AFM, Mylanus EAM (2015) Long-term outcomes on spatial hearing, speech recognition and receptive vocabulary after sequential bilateral cochlear implantation in children. Research in Developmental Disabilities, 36:328-337.
24. Kunnskapssenteret (2011) Kommunikasjonsformer for barn med cochleaimplantat. Systematisk oversikt. Rapport fra Kunnskapssenteret nr 15–2011. Norway, Oslo: Kunnskapssenteret.
25. Brennan-Jones CG, White J, Rush RW, Law J (2014) Auditory-verbal therapy for promoting spoken language development in children with permanent hearing impairments. Cochrane Database Syst Rev 3: CD010100.
26. Ruffin CV, Kronenberger WG, Colson BG, Henning SC, Pisoni DB (2013) Long-term speech and language outcomes in prelingually deaf children, adolescents and young adults who received cochlear implants in childhood. Audiol Neurootol 18: 289-296.
27. Skinner BF (1957) Verbal behavior. New York: Appleton-Century-Crofts.
28. Chomsky N (1968) Language and mind. New York: Harcourt Brace & World.
29. Bruner J (1983) Child's Talk: Learning to Use Language. New York: Norton.
30. Gleason JB, Ratner NB (2013) The development of language. Boston, MA: Pearson
31. Bohannon III J, Bonvillian J D (2013) Theoretical approaches to language acquisition. In J. B. Gleason, & N. B. Ratner (Eds.),The development of Language. Boston, MA: Pearson pp:190-240. Boston, MA: Pearson.
32. Piaget J (1955) The Language and Thought of the Child. London: Routledge & Kegan Poul.
33. Tomasello M, Carpenter M, Liszkowski U (2007) A new look at infant pointing. Child Dev 78: 705-722.
34. Tomasello M (2009) The usage-based theory of language acquisition. In E. L. Bavin (Ed.),Cambridge Handbook of Child Language (pp. 69-88). Cambridge, MA: Cambridge University Press.
35. Tomasello, M. (2003) Constructing a Language: A Usage-Based Theory of Language Acquisition. Cambridge, MA: Harvard University Press.
36. Kegl J, Senghas A, Coppola M (1999) Creation through contact: Sign language emergence and sign language change in Nicaragua. In M. DeGraff (Ed.), Language Creation and Language Change: Creolization, diachrony, and development. Cambridge, MA: MIT Press pp: 179-237.
37. Janjua F, Woll B, Kyle J (2002) Effects of parental style of interaction on language development in very young severe and profound deaf children. Int J Pediatr Otorhinolaryngol 64: 193-205.
38. Preisler G (1999) The development of communication and language in deaf and severely hard of hearing children: implications for the future. International Journal of Pediatric Otorhinolaryngology 49: 39-43.
39. Berk L E (2006) Child development. Boston, MA: Pearson.
40. Bonvillian JD, Orlansky MD, Novack LL (1983) Developmental milestones: sign language acquisition and motor development. Child Dev 54: 1435-1445.
41. Marschark M, Schick B, Spencer P E (2006) Understanding Sign Language Development of Deaf Children. In B. Schick, M. Marschark , P. Spencer (Eds.),Advances in the Sign Language Development of Deaf Children. NY: Oxford.
42. Spencer P E, Harris M (2006) Patterns and effects of language input to deaf infants and toddlers from deaf and hearing mothers. In B. Schick, M. Marschark, & P. E.Spencer (Eds.), Advances in the Sign Language Development of Deaf Children. NY: Oxford University Press pp. 71-101.
43. Traxler M J (2012) Introduction to psycholinguistics, understanding language science. Oxford: Wiley-Blackwell.
44. Volterra V, Iverson JM, Castrataro M (2006) The development of gesture in hearing and deaf children. In B. Schick, M. Marschark, & P. E. Spencer (Eds.),Advanges in the Sign Language Development of Deaf Children. New York, NY: Oxford University Press pp. 46-70.
45. Volterra V, Erting CJ (1990) From Gestures to Language in Hearing and Deaf Children. Heidelberg, Germany: Springer-Verlag
46. Meltzoff AN, Moore MK (1977) Imitation of facial and manual gestures by human neonates. Science 198: 75-78.
47. Harley TA (2014) The Psychology of language, from data to theory. London: Psychology Press.

48. Reed VA (2014) An introduction to children with language disorders. Harlow, Essex: Pearson.
49. Oller JW, Oller SD, Oller SN (2014) Milestones, normal speech and language development across the life span. San Diego, CA: Plural Publications.
50. Davidson K (2013) The nature of the semantic scale: Evidence from sign language research. Sign Language, 16:106-110.
51. Gullberg M, de Bot K, Volterra V (2008) Gestures and some key issues in the study of language development. Gesture 8: 149-1475.
52. Liszkowski U (2008) Before L1: A differentiated perspective on infant gestures. Gesture 8:180-196.
53. McNeill D (2005) Gesture and thought. Chicago, IL: University of Chicago Press.
54. Vallotton CD (2011) Sentences and conversations before speech? Gestures of preverbal children reveal cognitive and social skills that do not wait for words. In G. Stam., & M. Ishino. (Eds),Integrating Gestures. The interdisciplinary nature of gesture. Amsterdam: John Benjamins Publishing Company, pp. 105-120.
55. Guidetti M, Colletta JM (2010) Gesture and multimodal development. Gesture 10: 123-128.
56. Cramér-Wolrath E (2012) Attention interchanges at story-time: a case study from a deaf and hearing twin pair acquiring Swedish sign language in their deaf family. J Deaf Stud Deaf Educ 17: 141-162.
57. Goldin-Meadow S (2005) The resilience of language, what gesture creation in deaf children can tell us about how all children learn language. New York : Psychology Press.
58. Meier RP (2002) Modality and structure in signed and spoken languages. Cambridge: Cambridge University Press.
59. Hoskin J, Herman R (2001) The communication, speech and gesture of a group of hearing-impaired children. International Journal of Language and Communication Disorders 36: 206-209.
60. Morford JP, Hänel-Faulhaber B (2011) Homesigners as late learners: Connecting the dots from delayed acquisition in childhood to sign language processing in adulthood. Linguistics and Language Compass 5: 525-537.
61. Morgan G, Kegl J (2006) Nicaraguan Sign Language and Theory of Mind: the issue of critical periods and abilities. J Child Psychol Psychiatry 47: 811-819.
62. Fais L, Leibowich J, Hamadani L, Ohira L (2010) Infant movement as a window into language processing. Gesture 10: 222-250.
63. Rader N, Zukow-Goldring P (2012) How the hands control attention during early word learning. In J. M. Colletta, & M. Guidetti (Eds.), Gesture and multimodal development. Amsterdam, Holland: John Benjamin Publishing Company, pp. 79-98.
64. Morgenstern A, Caëta S, Collombel-Leroyb M, Limousinc F, Blondel M (2010) From gesture to sign and from gesture to word pointing in deaf and hearing children. Gesture 10: 172-201.
65. Goldin-Meadow S, Alibali MW (2013) Gesture's role in speaking, learning, and creating language. Annu Rev Psychol 64: 257-283.
66. Longobardi E, Rossi-Arnaud C, Spataro P (2012) Individual differences in the prevalence of words and gestures in the second year of life: developmental trends in Italian children. Infant Behav Dev 35: 847-859.
67. Alibali MW, Heath DC, Myers HJ (2001) Effects of visibility between speaker and listener on gesture production: Some gestures are meant to be seen. Journal of Memory and Language 44:169-188.
68. Stefanini S, Recchini M, Caselli MC (2008) The relationship between spontaneous gesture production and spoken lexical ability in children with Down syndrome in a naming task. Gesture 8: 197-218.
69. Crais ER, Watson LR, Baranek GT (2009) Use of gesture development in profiling children's prelinguistic communication skills. Am J Speech Lang Pathol 18: 95-108.
70. Goldin-Meadow S (2009) From gesture to word. In E. L. Bavin (Ed.), The Cambridge Handbook of Child Language Cambridge, MA: Cambridge University Press.145-160.