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WHORFIAN POTENTIAL IN CHILD LANGUAGE

As toddlers begin the language acquisition process, event memory and the capacity for dead-reckoning are developing in the cognitive domain, providing the potential to think about the relative location of events in time and objects in space. While the language they happen to be learning varies in structure, every language has a way of coding the location of events / objects in time / space. We can think of the toddler as a code breaker who arrives at the acquisition problem with a set of language information processing abilities. Depending how temporal and / or spatial location is coded in the language, it will make the toddler's code-breaking problem more or less difficult, providing the potential to facilitate acquisition. Benjamin Whorf argued that the structure of a child's language influences the course of conceptual development within the realms of temporal and spatial thinking. If the structure of a particular language matches the toddler's processing capacities in either the temporal or spatial domain, then the resulting precocious acquisition in that domain provides the potential to influence conceptual development. This paper investigates such a potential in child language, i.e., a developmental Whorfian hypothesis.

Key words: linguistic relativity, child language, cognitive development, time, space

Introduction and Purpose.

Benjamin Whorf (1956 p. 138) conjectured, "Are our own concepts of 'time', 'space', and 'matter' given in substantially the same form by experience to all men, or are they in part conditioned by the structure of particular languages?" In contrast to surface differences in vocabulary (e.g., the number of words for geometric concepts (see Newcombe & Uttal, 2006)), Whorf focused on language differences at the deeper morpho-syntactic level where time-space

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structural differences are found[1]. There is a related reason to emphasize the time and space dimensions which concerns habitual thinking (see Lucy, 1992). The successful outcome of a conversation depends on temporal and spatial deictic relations, i.e., the listener needs to know the speaker's time-space coordinates. Hence, the child has to penetrate the morpho-syntactic structure of their language to understand and to be understood. In order to investigate this potential interaction of language with conceptual development, we need to know how the capacity to locate events in time and objects in space emerges, and how the structural variations in language might influence this process. The purpose of this paper is to review some of the most informative research within the areas of cognitive development and language acquisition in order to shed light on a developmental version of the Whorfian Hypothesis. In this paper, I review pertinent research in the temporal domain followed by research in the spatial domain. Within each section, I will consider the developmental process from the cognitive and the linguistic perspective.

Temporal Development: the Conceptual Domain

Infant-toddler Memory

We want to know when/how an infant-toddler develops the capacity to remember an event in their life within some sense of personal context. While there have been variations on this theme (e.g., Bauer 2007, Table 11.1, p. 354), Tulving's (1985) distinction between "procedural" and "episodic" memory remains fundamental. According to Tulving, procedural memory, "provides a blueprint for future action without containing information about the past" (p. 387), and episodic memory (i.e., a type of declarative/explicit memory) contains, "information about the relations of represented events to the rememberer's personal identity as it exists in subjective time and space" (p.388). For example, at 2;0, when reminded of a ride on her uncle's back earlier that day, Christy said, *I cri**ed*** (Bowerman, 1981). Christy's memory of her experience with her uncle demonstrates "episodic" memory and the integration of a functional morpheme with the verb, locating that experience prior to speech time, indicates "procedural" memory (i.e., the "blueprint" for this functional application). Christy's choice of the verb *to cry* and not the verb *to laugh* demonstrates another kind of declarative memory that Tulving called "semantic memory" where representations "describe the world without prescribing any particular action" (p. 388).

[1] Evidence supporting the Whorfian hypothesis has been found in areas of language other than time and space, such as grammatical number marking. Lucy and Gaskins (2001) reviewed their research relating nominal number marking patterns with classification preferences in American English and Yucatec Mayan. The structure of these languages guided English speakers to a preference for "shape-based" classification and Yucatec speakers to a preference for a "material-based" classification, and this cultural difference was evident developmentally by nine years of age.

At one time, Piaget's (e.g., 1952) theory was the most influential theory of cognitive development, and according to Piaget, the infant's representations were limited to "action schemas" throughout the first five sub-stages of the "sensorimotor" period, i.e., memory was limited to procedural memory prior to 18-24 months. Within this historical/theoretical context, most of the contemporary research projects concerning infant-toddler memory were designed to determine when/how episodic memory emerges (see Bauer's 2007 review). Utilizing many diverse experimental procedures, the answer was/is well before Piaget had imagined while observing his own children. Rovee-Collier's (e.g., 1997, 1999) research program was the most sensitive to the developmental process. Her conjugate reinforcement procedure involved linking a leg movement (or lever depression) to the movement of a mobile (or train) and then testing for recognition memory (i.e., a type of declarative memory) with the link deactivated. For infants-toddlers ranging in age from 2 to 18 months there was a linear increment in the length of the retention interval (see Rovee-Collier, 1997, Figure 4, p. 475). Considering a wide range of data, she argued that "implicit and explicit memory follow the same developmental course" (p. 467). Within a quite different experimental paradigm, Meltzoff (e.g., 2005 review) used deferred imitation to evaluate retention. In one study, 14-month-old infants saw a novel action whereby a model leaned forward to touch his/her forehead on a rectangular box which lit up. After a one week delay 67% of the infants duplicated the action in contrast to none of the control participants in the study (Meltzoff, 1988). In this experimental context, the infants had remembered the arbitrary event. The research programs of Rovee-Collier, Meltzoff, Bauer, and others were particularly sensitive to the development of memory because their methodology did not require a verbal response. These studies show that toddlers have a kind of declarative memory. The argument can be (has been) made that the acquisition of language provides the child with a new way of encoding representations in memory.

Toddler & Early-Childhood Memory

When the experimental methodology requires a verbal response, the evidence for episodic memory will (obviously) be linked to language acquisition. For example, Peterson and Rideout (1998) evaluated children's memory for a medical emergency. Asking a battery of questions about the trauma and the emergency room experience, they interviewed three groups of children: young toddlers (13 – 18 months), older toddlers (20 – 25 months), and 2-year-olds (26 – 34 months). The children were interviewed at retention intervals of 6, 12, and 18 or 24 months. The children in the young toddler group failed to recall their experience, the older toddlers gave some details or partial accounts even at extended retention intervals, and the 2-year-olds related partial or full accounts after 18 to 24 months (see Peterson & Rideout,

Appendix, p.1072). Peterson and Rideout (p. 1068) argued, as language became part of the toddler's conceptual framework, the child's capacity to "consolidate those experiences linguistically" was emerging, and this innovation facilitated memory. Even though the children in the young toddler group failed to narrate their experiences, some revealed their memory in other ways, e.g., identifying a photo of their doctor (i.e., recognition memory). In summary, the infant-toddler has the capacity to construct representations of their experience, and during the initial phases of language acquisition, those representations obtain a linguistic code enabling the older children to reveal the details of their emergence room experiences. The Peterson and Rideout study provides a good developmental example of language-thought interaction (see also Simcock and Hayne, 2003 regarding non-verbal versus verbal representations)[2]. However, in reference to a Whorfian hypothesis, this research does not show us how structural variation in languages might influence conceptual development differently.

Early-Childhood Future Thinking

While there has been considerable research on the child's capacity to think about the past, there has been minimal exploration into their capacity to think about the future. In the temporal domain, it is just as possible that the structure of language will influence the child's capacity to think about future events as those in the past. Recent research by Atance (e.g., 2008 review) focused on the future. Making reference to Tulving's concept of episodic memory, Atance (2008, p. 99) defined "episodic future thinking" as "the ability to project the self into the future to preexperience an event." Whereas episodic memory involves re-experiencing an event, episodic future thinking involved pre-experiencing an event. Atance and O'Neill (2005) designed two experiments to evaluate this kind of pre-experiencing in 3- ½ -year-old children. While packing for an imaginary trip with their parents, the children were instructed to choose three out of eight items for the trip and to explain their choice. Within the refined methodology of Experiment 2, the choices were categorized as future, uncertain future, and present depending on the authors' criteria as follows: 1) future: *will, gonna, could, should, & when*+, 2) uncertain future: *might, if, in case, maybe, probably*, and 3) present: *want to, need to, have to, like (it)*. The following exemplifies the children's explanations for their choices: 1) juice for future, *I will drink it*, 2) Band-Aids for uncertain future, *In case someone has an owie*, and 3) book for present, *I've got to read some of the book*. The likelihood that the children's response fell into the three categories was as follows: 1) future 18%,

[2] Research concerning the manner in which narrative structure changes autobiographical memory representations is beyond the scope of this paper. In her brief review of this issue, Fivush (1995, p. 102) concluded that, "Narratives provide cohesion and meaning to event memories, and memories that conform to canonical narratives will be stable and resistant to suggestion." I would argue that narrative structural integration transforms the memory representation (cf. Newcombe, 2017 on episodic memory).

2) uncertain future 32%, and 3) present 30%. Atance and O'Neill (2005 p. 15) concluded that, "by 3 years of age children's language is already reflecting an ability to anticipate future situations that involve the self." This conclusion supports the findings of Gee and Savasir's (1985) child language research project. In the historical/theoretical context of Piagetian theory, the capacity to think about the future was predicted to emerge during the "pre-operational" stage (i.e., 2 to 7 years) rather than at the beginning of this hypothetical period of development. In fact, the cross-linguistic data on future reference described below indicate a much more precocious development of future thinking.

Temporal Development: The Linguistic Domain.

Tense and Deixis

When tense morphology is detected in a toddler's language, e.g., Christy (2;0), *I cri**ed***, one's interpretation of the functional properties of the past tense morpheme will depend in part on assumptions made about conceptual development. For example, when interpreting the Turkish child's early use of the past tense plus direct experience particle *–di*, Slobin and Aksu (1982, p. 191) claimed: "As Piaget has pointed out (1927 [1969 p. 284]), temporal thought for a very small child is characterized by 'living purely in the present and assessing the past exclusively by its results.'" Hence, for Slobin and Aksu, the function of *–di* was limited to aspect, devoid of the fluent speaker's deictic meaning until 3 years of age and missing the evidential direct-versus-indirect experience contrast with the *-miş* particle. As documented in the previous section, however, the claim that the toddler (i.e., pre-three years old child) is limited to speech time thinking is (in hind-sight) obviously incorrect. Extensive reviews of the emergence of the deictic attribute of past and future tense can be found in Weist (2002 for past) and Weist (2014 for future). This paper is focused on the general impact of language on conceptual development and the comparative research with potential Whorfian implications.

Language and Memory: General Potential

Weist and Zevenbergen (2008) investigated how the acquisition of the morpho-syntactic properties of past reference is linked to the emergence of autobiographical memory. Bauer's (2007, pp. 350-355 and Table 11) concept of autobiographical memory represents a variation on Tulving's (1985) episodic memory containing the additional property "expressed verbally" and emphasizing "a sense of 're-living' the event" (p. 354). Utilizing data from the Child Language Data Exchange System (CHILDES), Weist and Zevenbergen studied the emergence of past reference within discourse context in 10 children acquiring English during the period from

2 to 5 years of age. Pertaining to the morpho-syntactic properties of past reference, the following forms were included: 1) simple past tense (regular and irregular), 2) past progressive, and 3) "sentences with an adverbial clause having the subordinate conjunction *when* and past temporal reference" (past-*when* sentences) (p. 295). For control purposes, the study also included present progressive and non-past-*when* sentences. The discourse context for these target utterances was analyzed for the following properties: 1) establishment of reference time context by child or interlocutor, 2) reference to a secondary-supporting event, and 3) relevance to the child. These three criteria were intended to reflect the notion of re-experiencing the episode.

Within the linguistic temporal system, there was a definite sequence in the average age of acquisition as follows: 1) simple past, 2;4, 2) past progressive, 2;10, and 3) past *when*-sentences, 3;6. The acquisition of some present-orientated linguistic forms preceded those with past time semantic function. Present progressive was five months ahead of past progressive and non-past *when*-sentences were two months before past *when*-sentences. The number of discourse segments that contained the discourse criteria (i.e., reference-time context, supporting event, and self-relevance) increased together with the emergence of linguistic forms as follows: 1) 1.2 for simple past, 2) 2.2 for past progressive, and 3) 3.4 for past *when*-sentences. Hence, the discourse contextual evidence for the development of autobiographical memory is associated with the linguistic evidence. Obviously, this linguistic and cognitive developmental process takes place within (i.e., was analyzed within) a conversational context, and Weist and Zevenbergen provide examples, e.g., a discourse segment begins with Nina's mother's question: *Did you have a splinter yesterday?*, Nina's reply (2;11): *I wasn't crying when you did it*, Nina's clarification: *When you did take my splinter out*. Nina's mother establishes a specific past reference time context for the interaction. Nina has the cognitive capacity to re-experience the episode and the linguistic capacity to express her memory. She used a subordinate clause to match her mother's past reference time, and she used the past progressive to take an internal perspective on the ongoing event within the past self-relevant episode. The conversational context provides a mechanism for a symbiotic relationship between linguistic and cognitive development creating the opportunity for language structure to enable the restructuring of autobiographical memory. The concept of "restructuring" a mental representation involves a transformation with the potential to be long lasting (see also Fivush, Haden, and Adam (1995) concerning narrative structure and "childhood amnesia").

Language and Memory: Precocious Polish

Given the possibility that the acquisition of the child's linguistic temporal system introduces innovations in the representations in memory, this raises

the possibility the structural differences in temporal systems across languages may have the potential to influence memory. In fact, children learning some languages acquire their tense-aspect system earlier than children learning a structurally different language. In two studies involving Polish and American research teams (Weist, Pawlak, & Carapella, 2004; Weist Pawlak, & Hoffman, 2009) the investigators found evidence that children learning Polish acquire their tense-aspect system ahead of children learning English. Utilizing longitudinal data from Polish and American children, the methodology in these studies involved tracking the emergence of verb morphology within a set of predicates (i.e., determining a developmental history for the functional morphology of predicates within a child's lexicon). Variations on the Shirai and Andersen (1995) categorization scheme were applied to categorize predicates as telic versus atelic (see also Van Valin, 2005 on lexical structure). In the Weist et al. (2004) study, three dependent measures were analyzed for each predicate being tracked for each individual child as follows: 1) the first occurrence of a tense-aspect form, 2) the likelihood of occurrence, and 3) three types of contrast. The types of contrasts were as follows: 1) tense (holding aspect constant), e.g., Polish perfective past versus perfective non-past (future meaning), 2) aspect (holding tense constant), e.g., English past progressive versus past non-progressive (i.e., simple-past), and 3) tense-aspect, e.g., English present progressive versus past non-progressive. Regarding the acquisition patterns in these languages, the results of two analyses involving the age of emergence are particularly salient: 1) the interaction language by telicity (i.e., lexical aspect) by grammatical aspect summing over tense, and 2) the interaction of language by type of contrast. Table 1 (Weist et al., 2004, Table 7b) demonstrates that the sematic structure of predicates shapes the acquisition pattern in these two structurally different languages. Telic predicates emerge early in the aspectual form having external perspective (e.g., Polish perfective, e.g., Inka (1;4) *spadła*, 'she fell') and atelic predicates emerge relatively early in the aspectual form having internal perspective (e.g., English progressive, e.g., Nina (2;4) *That lady's crying*). This interaction is significantly more pronounced in the Slavic language of Polish. When tracking the emergence of the functional morphology within a predicate in the child's lexicon, morphological contrast provides a strong measure of acquisition. Table 2 (Weist et al., 2004, Table 9) contains the results of the contrast analysis. In general, contrasts within the temporal systems emerge earlier in Polish than in English. In both languages, contrasts in tense are acquired before contrasts in grammatical aspect. Hence, because of the structure of their language, Polish children are capable of locating the time of episodes relative to speech time before children learning English. The capacity to express temporal deictic relations makes the child a relatively successful conversational partner, leading to interactions about events in his/her life. Such interactions provide the

opportunity to restructure episodic memories, yielding the potential to facilitate memory. In the Weist et al. (2009) study, the research team extended the scope of the predicate tracking methodology to include subject-verb agreement as well as tense-aspect morphology. Once again, contrast was the basic dependent measure of acquisition. They found that, "In general, the children learning Polish acquired finite morphology more rapidly than children learning English …" (p. 1342) supporting the earlier Polish-English cross-linguistic study.

Table 1. The Average Age of Emergence for Interaction of Language by Aspect by Telicity

	Polish		**English**	
	Perfective	**Imperfective**	**Non-Progressive**	**Progressive**
Atelic	3;0	2;4	2;11	3;0
Telic	2;2	2;11	2;7	3;1

Note. Table adapted from Weist et al. (2004), Table 7b.

Table 2. The Average Age of the Emergence of Tense-Aspect, Tense, and Aspect Contrasts in Polish and English

	Tense-Aspect	**Tense**	**Aspect**
Polish	2;10	2;4	2;11
English	3;0	3;0	3;5

Note. Table adapted from Weist et al. (2004), Table 9.

Language and Knowledge: Korean Evidentials

Korean has a subject-object-verb sentence structure creating the likelihood that predicate suffixes will be sentence final inflections (i.e., "sentence-ending (SE) suffixes"). In Korean, in addition to the past/non-past distinction, the SE-suffixes are obligatory. Choi (1991) focused her study of the acquisition of SE-suffixes on the following six modal forms: -TA, -E (descriptive), -CI, -TAY, -LAY, and KKEY. The first four are epistemic (more specifically evidential) modals and the last two are deontic modals, with –LAY expressing desire and –KKEY intention. In contrast to conventional wisdom (e.g., Stephany, 1986), the deontic modals were acquired after the evidential modals. Choi's study was concerned primarily with the first four evidentials having the following meaning: -TA new/unassimilated information, -E assimilated information, -CI certainty of information, and –TAY indirect source of information. Three children from 1;8 to 2;11 acquiring Korean were included in the investigation. The children's use of the target evidentials was analyzed within the linguistic (i.e., preceding and

following utterances) and non-linguistic (i.e., referent present versus absent) conversational context. The order of acquisition was relatively similar for the three children, and the ages of productivity were as follows for one of the children: (1st) -TA 1;8.2, (2nd) -E descriptive 1;11.2, (3rd) -CI 2;0.3, and (4th) –TAY 2;1.2 (see Choi 1991, Tables 2 & 3, pp. 99-101). The suffix –TA was used to encode events/states that were directly experienced (e.g., TJ (1;9.3) *chaca-ss-TA*, find-Past-TA, '(I) found (it)'). The suffix –E "denotes assimilated information which is well established in the child's knowledge system" (p. 107) (e.g., PL (1;11.2) *polami meli ippukey hay-ss-E*, hair prettily do-Past-E, 'PL had her hair done. It was pretty'). The suffix –CI expresses certainty or checking on certainty of some information (e.g., PL (2;2) *kweymwul Tibi-ey-na iss-CI*?, monster TV-Loc-only exist-CI?, 'Monsters exist only on TV?'). The suffix –TAY encodes indirect knowledge such as reporting on another person's experience or speech (e.g., HS (2;5.4) *ung, enni-ka saykchil hay cwun-TAY*, yes, Sister-SM color do give-Tay, 'Yes, Sister says she will color for me'). Choi evaluated the relationship between the order of acquisition and the input frequency in the caregivers' speech, finding that they are not correlated. Choi (1991, p. 115) concluded that, "the evidence suggests that the early acquisition of epistemic meanings is at least partly the result of children's conceptual development as it relates to different status of information in their knowledge system." The structure of Korean places these obligatory morphemes in verb final and sentence final position in the utterance, making them salient for information processing and acquisition. From the Whorfian perspective, the Korean language requires children at an early age to think about the nature of their knowledge, e.g., new versus old information and/or directly versus indirectly experienced information, potentially functioning as a pacesetter for conceptual development.

In a set of four experiments, focusing on the Korean *-e/-tay* ("direct evidence/hearsay") contrast, Papafragou, Li, Choi, and Han (2007) investigated this Whorfian-like hypothesis. Their research included an evaluation of linguistic competence in the comprehension and production of the *-e* versus *-tay* evidential morphemes in 3- and 4-year-old Korean-learning children and a non-linguistic test of the source monitoring ability of Korean-learning versus English-learning children. In the Comprehension task of Experiment 1, the children were presented with a scenario whereby one actor looked at an object in a box versus a second actor who was told about the object. The children had to match a *-e* or *-tay* sentence with the direct (looker) versus indirect (hearer) experienced actor. In spite of the fact that 2-year-old children make this distinction in caregiver-child interaction (Choi, 1991), 3-year-olds did not deviate from chance (Papafragou et al. Figure 1, p.268). In the Source Monitoring component of Experiment 1 and the "Self" task, the children either looked at the contents of a hiding

place in a dollhouse or they were told about the contents. They were then asked, how they knew (i.e., Did you look?/Did I tell you?). In the Source Monitoring "Other" task, one of two characters either looked or was told of the hidden contents and the other character kicked the hiding place. The children were asked to identify the character who knows the contents (i.e., the looker/hearer versus the kicker). Both 3-and 4-year-olds performed above chance on both the "Self" and "Other" tasks (i.e., Self, 3-yrs. 81% & 4-yrs. 96% and Other, 3-yrs. 64% & 4-yrs. 85%). Furthermore, the "look/tell" source monitoring performance was significantly better than the *-e/-tay* comprehension (Figure 3, p. 270). Experiment 3 resembled Experiment 1 with two production tasks replacing the previous comprehension task. The children, at both ages, were relatively successful in production tasks that required the transformation of an erroneous *-tay/-e* puppet statement into the correct *-e/-tay* sentence. The developmental advantage of performance on the source monitoring tasks over the language competence task was diminished. In Experiment 4, English-learning 3- and 4-year-old children were compared to similar aged Korean-learning children on the source monitoring tasks, and there were no language differences (i.e., no Korean advantage). The authors surmised that, "contrary to relativistic expectations, children's ability to reason about sources of information proceeds along similar lines in diverse language-learning populations and is not tied to the acquisition of linguistic markers of evidentiality in the exposure language" (p. 254). Hence, contrary to Choi's (1991) expectation, the Papafragou, et al. (2007) research made the argument that language acquisition could not have a pacesetting function in this domain, providing counter-evidence to the developmental Whorfian hypothesis (see also Ozturk and Papafragou, 2016 on Turkish).

Is it the case that, "linguistic evidentiality is not, and **could not**, be a pacesetter for cognition" [emphasis mine] (Papafragou, et al., 2007, p. 293) because the source monitoring task performance was more developmentally sensitive than evaluations of linguistic competence? Choi (1991) has shown that 2-year-old Korean children demonstrate considerable understanding of evidential contrasts in the natural setting with a more fine-grained understanding than just direct-looking versus indirect-hearing/telling. Can 2-year-old children learning any language discriminate finding an object from being told about an object or the experience of looking/hearing versus kicking? To rule out pacesetting, what is needed is an application of source monitoring tests with children having the 2-year-old understanding of evidentiality that is found in the natural caregiver-child interactive setting. Furthermore, Choi's 2-year-olds behaved as if they understood more than just the *-e/-tay* (direct evidence/hearsay) contrast. Choi (1991) observed that 2-year-old Korean children demonstrate an understanding of the distinction between new/unassimilated, assimilated, and certain information as well

as indirect sources of information. How might children learning English demonstrate an understanding of the complete Korean system?

Language and Future Thinking: Remote Tenses

In her review of the child language data taken from a number of different languages with a past/non-past split, Swift (2004, p. 103) found that present and past forms appear first between 1;6 and 2;0, and "Overt marking of future time reference is not reported until later, starting around age 2;5." Swift studied temporal reference in the Eskimo-Aleut language Inuktitut (see also Allen, 1997). Inuktitut has a basic future/non-future temporal split and a system of remote tenses with four distinctions in the future and five in the past (see Table 3.2, p. 74). The future suffixes were labeled: 1) near future, 2) same day future, 3) distant future, and 4) far future, and the past suffixed were labeled: 1) recent past, 2) same day past, 3) yesterday past, 4) distant past, and 5) long ago. Swift analyzed the data from eight children between the ages of 1;0 and 3;6 using contrast as her measure of productivity. In general, Swift (p. 153) found that, "Inuit children develop competence with overtly marked future time reference before overtly marked past time reference." Early past reference was expressed in the "zero-marked verb", combining telicity and grammatical aspect. The first temporal suffixes to emerge were prospective aspect *–si-* and near future *–langa-*, with near future appearing at 1;8 in one child, 2;1 in others, and all children by MLU (i.e., mean length of utterance) 3.5 or greater. Same day future and distant future (tomorrow or later) followed relatively soon after (see Tables 9.3-9.5 pp. 222-231). In contrast, "Most instances of past temporal remoteness suffixes occur in the speech of children with MLU of at least 4.0" (p. 240). The structure of the Inuktitut language has the potential to promote the precocious development of "future episodic thinking" at 2 years of age, which is a full year earlier than predicted by Atance and O'Neil (2005). Regarding degrees of remoteness, obviously other languages have a means to make these distinctions, e.g., English adverbs such as *already* and *soon* or *tomorrow* and *yesterday*, but the temporal adverbial support emerges later in at least some past/non-past languages (see Weist & Buczowska, 1987 for Polish, and Weist's 2014 review). Once again, from the Whorfian perspective, the linguistic capacity to make reference to refined future locations may facilitate conceptual time travel into the future.

Tillman, Marghetis, Barner, and Srinivasan (2017) utilized a non-linguistic spatial tool to investigate the developmental relationship between deictic status, event ordering, and degrees of remoteness. In this study, children learning English, ranging in age from 3 to 8 years, located deictic words (e.g., tomorrow) and events (e.g., next week) along a bidirectional, left-to-right "time line" anchored by infancy on the left and adulthood on the right with a dividing line ("right now") in the middle. Deictic status and

order were acquired relatively rapidly while degrees of remoteness continued to develop in the 8-year-olds. If the developmental Whorfian hypothesis is correct, we would expect to find facilitated understanding of the remoteness dimension in children learning languages with a remote tense system such as Inuktitut.

Spatial Development: Conceptual Domain

Spatial cognitive development

According to Spelke (2000) some aspects of cognitive development including spatial cognition are built on "core knowledge systems", i.e., "mechanisms for representing and reasoning about particular kinds of ecologically important entities and events" (Spelke, 2000, p. 1233) and not dependent on Piagetian notions of sensory and motor experiences. The rapid development of spatial representations is supported by the extensive research of Newcombe and Huttenlocher (2003) with children learning English. Newcombe and Huttenlocher (2003 p. 23) proposed that infants are equipped with the following four types of spatial coding: 1) cue learning involves forming an association between the "to-be-located" (or primary) object and perceptually identifiable landmarks, 2) place learning involves "using a system of distance and direction" relative to landmarks, 3) response learning involves establishing a relationship between a set of motor movements and a to-be-located object, and 4) dead-reckoning involves monitoring one's own position in space, i.e., "coding distance and direction of one's own movement to update self-referenced location knowledge." The four types of spatial coding (i.e., cue, place, response, and dead-reckoning) were proposed to change in relative importance (i.e., re-weighted) during development[3]. In their study of the combined utilization of place learning and dead-reckoning, Newcombe, Huttenlocher, Drummey, and Wiley (1998) presented children ranging in age from 16 to 36 months with a hide-and-seek task to be played in a 1' X 5' sand box. In the experiment, the child saw an object buried in the sand, and then the child's attention was diverted from the search environment. At this point, the child conducted a search under one of the following conditions: 1) same location or 180 degree alternative perspective, and 2) external and potentially decisive landmarks absent or present. The children were partitioned into three age groups: 1) 16 to 21 months, 2) 22 to 24 months, and 3) 28 to 36 months. When the children didn't move, their performance was uniformly accurate indicating that even the 16-month-old could process distance and direction. When the children moved to the mirror-image perspective, performance suffered at all ages but performance was still

[3] Newcombe and Huttenlocher's (2003) concept of "re-weighting" is consistent with Newcombe's (2017) concept of developmental "augmentation" (e.g., the capacity for "cue learning" is not lost when "dead-reckoning" becomes more prominent).

above chance. Hence, the children had some success monitoring their own position in space. However, the 16 to 21 month old children could not take advantage of the pivotal landmarks to reduce search errors, i.e., they were not successful in combining dead-reckoning with place learning. It could be argued that children utilize spatial coding cues to build on spatial core-knowledge-systems during cognitive development. As a result, by the time children are 2 years of age, they have the capacity to utilize a full range of cues to construct spatial representations. Spatial cognition continues to develop rapidly as young children begin to talk about spatial location.

Spatial Development: Linguistic Domain

Korean & Tight/Loose Fit

Choi and Bowerman (1991) studied the emergence of the spatial language related to motion events in English and Korean. The elements making up the structure are: 1) figure (moving object), 2) ground (referent object), and 3) path (the trajectory of the figure). For English, the concept of motion is conflated with the following: 1) manner (*fly/walk*), 2) cause (*push/pull*), or 3) deixis (*come/go*). Path is not conflated with the verb and is expressed with a set of prepositions, e.g., *into/onto*, *up/down*. In English, the structure is the same for intransitive and transitive sentences, e.g., *the golf ball rolled into the cup/the golfer rolled the ball into the cup*. The conflation structure in Korean is different for intransitive clauses expressing spontaneous motion and transitive clauses indicating caused motion: 1) intransitive clauses require three verbs: for manner, for path, and for motion together with deixis, and 2) transitive clauses require two verbs: one verb for manner and cause, and the other verb for motion, path, and ground (see Choi & Bowerman, Table 3, p. 94). Since Korean is a verb final language, the verb integrating motion, path, and ground is in clause final position. The cross-linguistic child language research has focused on the distinction between tight-fit versus loose-fit. For English, regardless of transitivity the prepositions *in/into* specify containment and *on/onto* for support. In Korean, the verbs *kkita/ppayta* mean to join/separate two objects with a tight fit, and *nehta/kkenayta* mean to put in/take out from a loose container. While the situations of putting a button in a button hole and putting a button in a bowl require *in* for English, in Korean, these situations provide a loose fit/tight fit (i.e., *nehta* versus *kkita*) contrast. Choi and Bowerman studied the emergence of motion expressions in two English learning and four Korean learning children in the 16 to 28 month age range. They found that, “from their first productive use of spatial words, children categorize spatial events language-specifically – there is no evidence that they rely on the same set of basic spatial concepts” (Choi & Bowerman, 2001, p. 488). Choi and Bowerman’s longitudinal production study was supported by Choi, McDonough, Bowerman, and Mandler’s (1999)

comprehension study. Utilizing a preferential-looking methodology with the participation of English-learning and Korean-learning children between 18 and 23 months, the investigators found that, "The target word led children to gaze at different and language-appropriate aspects of the scenes" (p. 241). Hence, the acquisition of spatial terms is guided by the structure of the language they are learning. This outcome might not appear to be surprising. However, these findings serve to reject the alternative hypothesis (i.e., the cognitive hypothesis) that, "children initially identify words, inflections, and combination patterns with meanings formulated independent of language" (Choi & Bowerman, 1991 p. 84).

The research on the acquisition of Korean versus English spatial morphology demonstrates that the structure of language shapes the acquisition process. Can we take this outcome one step further? Do these differential patterns of language learning influence cognitive development, i.e., the Whorfian question? Utilizing a variation on the preferential looking procedure, Choi (2006) investigated this possibility with children learning English and children learning Korean. The children included in the study were in the following age groups: 1) English: 18, 24, 29, and 36 months, and 2) Korean: 29 and 36 months. During the familiarization phase of the procedure, either a pair of tight-fit activities (e.g., nested-cup insertion) or a pair of loose-fit activities (e.g., putting blocks in a basket) were presented simultaneously on a split screen. In the test phase, the children were presented with a familiar containment relation contrasting with the alternative relation, i.e., tight fit versus loose fit. Choi measured looking time. The 29 and 36 month old Korean-learning children looked longer at the relation-matching program. Parental analysis revealed that *kkita* 'tight fit' was already part of their corpus at 29 months. For the English-learning children, there was a developmental trend shifting from relation-matching at 18 months to no preference at 36 months. According to parental analysis, the use of the locative *in* increased dramatically from 18 to 36 months. Choi concluded that "the results suggest that the acquisition of language-specific semantics influences nonlinguistic sensitivity in the relevant cognitive domain" (p. 225), i.e., the positive Whorfian outcome[4].

Mayan Languages: Spatial Perspective

Three kinds of relevant spatial perspectives are as follows: 1) object-centered (intrinsic), e.g., the ball is in front of the person's eyes, 2) viewer-centered (relative), e.g., the ball is on the 'right-hand' side of the person, and 3) environment-centered (absolute), the ball is "north/uphill" of the person (see Levinson, 1996, Figure 4.9, p. 139). Object-centered perspective

[4] In their review of language and cognition, Ünal and Papafragou (2016, p. 570) argue for the view that, "selectivity creates an online, highly transient change in attention and [contrary to Choi's proposal] does not lead to reorganization of the underlying perceptual-conceptual space."

is found in every language, and this perspective remains invariant with a 180 degree rotation of the speaker, e.g., if the ball is along the person's line of sight, it remains 'in front of' regardless of the speaker's position. Viewer-centered perspective is basic to many languages like English and Polish, and in contrast, environmental-perspective is basic to Mayan languages like Tzeltal and Tzotzil. A rotation of 180 degrees will change viewer-centered perspective, e.g., from viewer's right side to left side, but such a rotation does not alter the environmental-centered perspective. According to Levinson (1996 p. 145), "People who speak such language [environment-centered] … can dead reckon current location in unfamiliar territory with extraordinary accuracy."

Brown (2001) studied the acquisition of perspective within the environment-centered (or absolute) spatial system of Tzeltal. Brown explained that within the Tzeltal system, "an 'uphill/downhill' coordinate abstracted from the lay of the land is used to reckon spatial relations on the horizontal in both small-scale and long-distance space" (p. 515), and this system, "requires speakers to maintain absolute orientation at all times" (p. 516). Brown found that Mayan children master the contrasts within their absolute system by 3 years of age. The system includes the intransitive verb roots *mo/ko* 'ascend/descend', and the following example demonstrates system understanding of one of the children at 2;5: *Ya x**mo**on ek .. **ko**ixix tal*, 'I'll go up too … they have come down' [target morphemes in bold] (Brown, Table 17.2&3, pp. 519 & 521). Returning to conceptual development, Newcombe and Huttenlocher (2003) proposed four types of spatial coding that become re-weighted during development, and their research showed that 28- to 36-month-old children (2;4 to 3;0) were capable of combining the dead-reckoning with the place coding cues. It is possible that the "re-weighting" developmental process is accelerated when acquiring an environment-centered spatial language, i.e., the Whorfian potential. Furthermore, Brown's research on Tzeltal has been supported by De León's (2001) investigation of the acquisition of Tzotzil, another language with the primary environment-centered frame of reference.

Levinson (2003, Ch. 4) reviewed a series of experiments evaluating the spatial memory of fluent speakers of the viewer-centered (or "relative") language Dutch and the fluent speakers of the environment-centered (or "absolute") language Tzeltal, more specifically the Tenejapan dialect. Many different visual displays were investigated, e.g., a line of three animals presented perpendicular to the observer's line of sight (i.e., right to left/"West" to "East"). The adult participants were instructed to memorize the array, the objects were removed, and then they were asked to rebuild the array "… exactly as it was." After a delay, the participants were rotated 180 degrees, and then asked once again to rebuild the array. The relative language speakers were likely to preserve the left-to-right (or relative) organization of

the array, and the absolute language speakers preserved the "fixed bearing" (or absolute) organization (e.g., see Figure 4.12, p. 158). Levinson (2003, p. 168) concluded that if the congruence between spatial coding in language and spatial coding in non-linguistic cognition can be shown to be reliable, "it raises the possibility that some kind of 'Whorfian' view of the relation between language and thought is not as untenable as current dogma in cognitive science maintains."

In Experiment 1 of a more recent study, Haun, Rapold, Call, Jenzen, and Levinson (2006) investigated the influence of absolute versus relative frames of reference within a hide-and-seek game. The participants were adults and 8-year-old Haiom-speaking and Dutch-speaking children. Haiom is a Central Khoisan language of northern Namibia with a dominant absolute spatial system in the language. The spatial array in the hide-and-seek game was a "dice-five" arrangement of cups presented on two tables. The participants watched a block hidden under one of the cups on the "hide-table" and they were instructed, "you will go to another table with another set of cups, where you can search for the block …". Importantly, the potential experimenter "demand characteristics" (or so called "Gricean doubt") that might have been encountered by Levinson's earlier instructions to rebuild "… exactly as it was" has been removed. In general, the dominant search strategy was absolute for Haiom-speaker and relative for the Dutch-speakers, confirming prior Whorfian findings.

However, the Whorfian interpretation of the findings of the Levinson research program has been challenged. Li, Abarbanell, Gleitman, and Papafragou (2011) conducted a set of experiments with adult Tenejapan Mayan speakers which has provided an evaluation of the relativistic finding of previous research. The Li et al. experimental paradigm featured an "unambiguous" matching task under egocentric (i.e., view-centered) versus geocentric (i.e., environment-centered) conditions of rotation. In the "rotating-dots" test trials of Experiment 1, the participants viewed a two-dot card differentiated by two colors or two sizes and organized in one of four potential configurations (i.e., 2 vertical and 2 horizontal). The experiments were conducted in room with clear landmarks. The room contained two tables, an initial viewing table and a post-rotation card matching table. For every test trial, a card was viewed in a box, the box was closed, and the participants themselves rotated 180 degrees and carried the closed box to the second table. In the "egocentric" condition, the participants rotated the box 180 degrees (i.e., turned with the box), and in the "geocentric" condition, the participant maintained the original orientation of the box (see Li et al., Figure 2, p. 37). The participants were instructed to choose the card that matched the one in the closed box from the four alternatives having left-right/north-south or top-bottom/east-west orientations. While there was an 85% versus 74% correct numerical advantage favoring the egocentric

(i.e., linguistically non-preferred for Tzeltal) condition, the difference was not significant.

In maze solving task of Experiment 2, the rotational movement events that created the egocentric /geocentric conditions in Experiment 1 were the same in Experiment 2. In this experiment, in the demonstration phase, the experimenter moved a ball through a 1-, 2-, or 3-leg path within a 10 element X 10 element maze contained within a box (see Li et al., Figure 4, p. 40). As in the Experiment 1 test trials, the box was covered and then transported from presentation table to response table, following the "egocentric" (i.e. maze rotates 180 degrees) or "geocentric" (i.e., absolute orientation of the maze is maintained) trajectory. The participants were instructed to recreate the maze path (i.e., the Tzeltal equivalent, "do it, the same way I just did"). Their capacity to recreate the path completely was better in the egocentric condition than the geocentric condition and the discrepancy increased as the number of path legs increased (i.e., 1-leg 100%/92%, 2-legs 96%/60%, and 3-legs 80%/35% correct). The advantage of the viewer-centered (or egocentric) frame of reference continued through two more experiments.

Thus, the Li et al. experiments presented "essentially monolingual" Tzeltal speakers with "unambiguous" spatial tasks as contrasted with prior so called "ambiguous" task methodology (see Levinson's 2003 review and this section). The research indicates that Tzeltal speakers are "flexible" in their spatial reasoning. The acquisition of a language with a dominant frame of reference (i.e., absolute (or environment-centered) for Tzeltal) does not "shape" spatial cognition in such a way as to eliminate alterative ways of thinking/reasoning about spatial navigation. The developmental Whorfian hypothesis is supported when the structure of language in some domain (e.g., absolute frame of reference) facilitates cognitive development in a related domain (e.g., dead reckoning). In summary, the developmental Whorfian hypothesis would predict superior performance on the rotation task that matches the primary frame of reference (i.e., for Tzeltal, geocentric/ environment-centered and not egocentric viewer-centered). The Li et al. research indicates that the "Whorfian potential" of a dominant frame of reference was not realized. However, the current hypothesis, as well as other variations on the Whorfian, does not require/predict the loss of flexible spatial reasoning. In other words, a developmental advantage in conceptual dead reckoning accrued from an absolute linguistic frame of reference does not necessitate the loss of the viewer-centered aspect of spatial reasoning.

Temporal and Spatial Systems: Cross-linguistic

Systems and Innovations

During the acquisition of language, cross-linguistic research has shown that there is a qualitative innovation in the temporal and spatial systems

of child language (Weist, Atanassova, Wysocka, & Pawlak, 1999; Weist Lyytinen, Wysocka, & Atanassova, 1997). In order to capture the essence of the innovation that occurs in the spatial as well as the temporal domains, Weist (1991) introduced the "mono-referential"/"bi-referential" distinction. These phases in system development were defined as follows: "Location in time and space was defined as mono-referential when the locative configuration requires a single referent time/object with sufficient inherent properties and a proximity relation, e.g., past/future tense or *into/out of*, and location was defined as bi-referential when two or more referent times/objects are required and a perspective relation, e.g., past perfect or *between*" (Weist et al. 1999, p. 269). The shift from a mono-referential to a bi-referential system has been documented in research involving production (e.g., Johnston & Slobin, 1979 for space and Weist & Zevenbergen, 2008 for time) and comprehension (e.g., Weist et al., 1997, 1999 for space and time). The perspective relationships within these emerging systems vary depending on the temporal versus spatial domains. In the temporal domain, the child's perspective is initially speaker-centered and external episodes are located relative to speech time, e.g., Naomi (1;11) *I throwed it* (Sachs, 1983). The temporal system becomes more complex when the child integrates reference-time, and the child can take an episode-internal perspective at remote locations in time, e.g., Abe (2;9) *I didn't cry when I burned myself* (Kuczaj, 1976, and see Pawlak, Oehlrich, & Weist, 2006, Table 2, p. 286). Perspective in the spatial system is initially object-centered, e.g., Naomi (1;9) *Diapers on*, and Naomi (1;10) *Going in there* (Sachs, 1983), and the system becomes more complex when relationships are established between the child's location and the primary object or between more than one external object, e.g., Abe (2;8) *And Tom was hiding in front of the tree*, and Abe (3;0) *I maked Mommy a thing ... and a real long thing right in the middle of it* (Kuczaj, 1976, and see also Johnston & Slobin, 1979, Table 5, p. 537).

Space and Time in Finish and Polish

It is possible to identify properties of the structure of a language which have the potential to influence conceptual development, e.g., the remote tenses of Inuktitut or the environment-centered spatial perspective of Tzeltal. However, it is difficult to demonstrate that such language structures implement changes in the pattern of conceptual development. The Polish-Finnish-English research program was designed to find the link from diverse language structure to cognitive development (Weist et al., 1997, 1999). The research focused on the structural differences in the Polish and Finnish temporal and spatial morpho-syntactic systems. With regard to morpheme-to-concept mapping, Finnish is structured with one-to-one mapping in the spatial system, and Polish approaches one-to-one mapping

in the temporal system (Weist, 2009, Table 5.2, p. 72). Because of this and related structural differences, Weist et al. (1997, 1999) argued that Finnish children should show an advantage in the acquisition of the spatial system compared to Polish children who should have the advantage in the temporal system. Polish and Finnish children in the 2;6 to 6;0 age range were tested in cross-sectional language comprehension and conceptual development experiments. On the linguistic side, comprehension problems were designed to evaluate mono- and bi-referential distinctions in space and time. The procedure involved the presentation of two illustrations and/or two video programs and asking the children to identify the picture that matched a sentence, for example, as follows: 1) Space & Mono-referential, '*onto/off* of', a girl jumps onto/off of a rock, 2) Space & Bi-referential, non-featured (i.e., deictic) '*front/back*', a girl stacks cookies in front of/in back of a glass, 3) Time & Mono-referential, '*will blow/blew*', a girl prepares to blow out candles on a cake/the girl picks extinguished candles out of a cake, and 4) Time & Bi-referential, '*before/after*', a girl kisses her doll before/after she puts her to bed (see Weist et al., 1999, Figures 4a&b, pp. 284-285). On the conceptual side, the spatial test involved higher-order spatial thinking, e.g., rebuilding a scene from 180-degree rotated perspective, and the temporal test evaluated the capacity to incorporate narrative structure into story telling[5] (cf. Fivush, Haden, & Adam, 1995 on narrative structure).

In general, in both the spatial and temporal domains, significant developmental trends were found in the linguistic and the conceptual tests, and furthermore, the developmental accomplishments were correlated. Hence, the tests were properly designed to evaluate change during the 2- to 6-year old age range. In general, the Finnish children performed better than the Polish children on the spatial comprehension tests, and the Polish children were relatively better on the temporal tests (Weist et al. 1997, Figures 7&8, pp.106 & 107 and Weist et al. 1999, Table 3, p. 296). This outcome supports the prediction that one-to-one (i.e., morpheme-to-concept) mapping facilitates acquisition. While the Finnish children demonstrated some spatial advantages on tests in the conceptual domain, the crucial "Whorfian" cross-over interaction was illusive, i.e., absent. While the linguistic interaction of Finnish-Polish languages by spatial-temporal dimensions of language structure was significant, demonstrating Whorfian potential, the companion interaction derived from the conceptual tests would be needed to provide strong evidence for language structure shaping conceptual development.

[5] In the temporal domain, unlike the spatial domain, the evaluations of conceptual development were not language-independent as they involving narrative / story structure (e.g., Weist, et al., 1997 utilized picture card story arrangement and completion tasks). Narrative structure was / is viewed as higher-order linguistic competence, and evidence for narrative structure has been linked to the development of autobiographical memory.

Concluding rematks

Does language have an influence on non-linguistic cognitive development, and if so, what is the form of such potential influence? While considering "neo-Whorfian perspective", Levinson (2003, p. 306) presented two pictures of language acquisition as follows: "In that old picture, language development primarily reflects underlying conceptual development which must first make available the concepts to be labeled", and alternatively, "In the new, emerging picture, language facilitates such cognitive development by helping to construct complex concepts". The developmental Whorfian hypothesis, proposed here, is consistent with Levinson's "new, emerging picture". Clark's (1973, p. 62) view of the language-thought interaction is consistent with the "old picture", "the child acquires English spatial expressions by learning how to apply them to his prior knowledge about space, and he acquires English temporal expressions in turn by extending the spatial terms in a metaphor about time", and Bowerman's (1985 pp. 1284 & 1285) view is representative of the alternative, regarding their language, "children are prepared from the beginning to accept guidance as to which distinctions – from among the set of distinctions that are salient to them – they should rely on in organizing particular domains of meaning." Bowerman's concept of "guidance" is a developmental principle which operates during the construction of mental representations. In a recent review of the relationship between language and mental representation, Ünal and Papafragou (2016) proposed that, "When language is available as a means of encoding the perceptual world, then it offers an additional way of representing the information in the world. This additional medium can create enhanced representations that go beyond the visual or spatial representations alone, thus augmenting representational power" (p. 571). Furthermore, they claim that, "language does not lead to long-lasting changes in mental representation" (p. 554). Their argument is consistent with Levinson's "old picture" where language can augment/enhance existing mental representations but language does not have a role (e.g., facilitation) in the construction of representations during development (see also Newport, 2017 regarding the "augmentation" argument).

In summary, in order to understand the particulars of the language acquisition process, we need to know how developmental processes are advancing in the cognitive domain. Regarding temporal systems, it is important to know that episodic memory is available to children when tense-aspect-modality morphology is emerging so as not to mistake the early deictic value of tense for aspect or modality. Regarding spatial systems, the research that shows the development of child's capacity for dead-reckoning provides the understanding of how a child might acquire an environment-centered spatial language. Knowing that language structures time and space differently and assuming that Bowerman's argument is correct, the structure of the child's

emerging language will be diverse, and this diversity provides the potential to influence cognitive development in different ways. This is the developmental version of the Whorfian hypothesis. By investigating cross-linguistic research, I have shown that the Whorfian potential is instantiated in structure of child language, and I have demonstrated the kinds of methodology that have been applied to discover the possible links between linguistic structure and cognitive development. Levinson (2003, p. 303) distinguished between Slobin's (1996) concept of "thinking-for-speaking" and the more controversial "experiencing-for-speaking". Regarding thinking-for-speaking, thoughts have to be programmed on-line to fit the structure of the target language, and storytelling research in children learning diverse languages supports this concept (Berman & Slobin, 1994). Furthermore, when preparing to describe a motion event (and only when "thinking-for-speaking"), the allocation of visual attention, measured by eye movements, was different for fluent speakers of the manner language, English than the path language, Greek (Papafragou, Hulbert, & Trueswell 2008)[6]. Alternatively, Levison's idea, experiencing-for-speaking entails cognitive processing at a deeper level. According to Levison (2003, p. 303) "experiencing-for-speaking" requires that "events at the moment of experience must be coded in terms appropriate for latter expression in the local language", and this will involve shaping mental representations. This paper reviews research in the domains of time and space that reflect on this controversial idea. The developmental Whorfian hypothesis has two corollaries. To begin, it is proposed that language acquisition will be facilitated when the structure of the target language, in some domain (e.g., the temporal or spatial system), makes the components of that domain accessible for information processing (e.g., one-to-one morpheme-to-concept matching). Given the research included in this review, this proposal is left uncontested. It follows that since languages differ in the manner in which they code various domains (e.g., the temporal and/or the spatial), there will be differential facilitation outcomes (e.g., Polish-Finnish comparisons). The argument becomes controversial when innovations in language acquisition are linked to innovations in mental representations (i.e., the level of conceptual development). The current view of language acquisition obtains its Whorfian perspective when the final step (step 4) is taken in the argument as follows: 1) Children have the capacity to process linguistic information, 2) The elements of the morpho-syntactic structure of temporal and spatial systems varies cross-linguistically, 3) A match between processing potential and linguistic structure yields facilitated acquisition differentially across languages,

[6] In their study of the relationship between eye movement and event perception, Papafragou, et al. (2008 p. 162) compared the performance of native English speakers with native Greek speakers who, "were students or junior faculty at various Universities in the Philadelphia area." Thus, the Greek speakers were obviously Greek-English bilinguals. If we were to expect a manner versus path processing difference at a level of processing deeper than "thinking-for-speaking", we would need to know when (e.g., during childhood) they acquired their path orientated second language.

and 4) Since language acquisition influences conceptual development, that influence will be related to specific components of the structure of different languages (i.e., the developmental Whorfian hypothesis).

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