Development of early morphological awareness in Greek: Epilinguistic vs. metalinguistic and inflectional vs. derivational awareness

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Abstract

This cross-sectional study examined the development of morphological awareness in Greek children 4–7 years old. A distinction was adopted between epilinguistic control, evidenced in judgment tasks and indicative of elementary levels of awareness, and metalinguistic awareness, evidenced in production tasks and indicative of full-blown conscious awareness. The morphological domains of inflectional and derivational morphology were specifically contrasted to determine whether they follow distinct developmental trajectories. Trial-level performance data from 236 children in four morphological awareness tasks as a function of age were modeled using generalized additive models. Significant performance increase with age was found for all four awareness tasks. Results further indicated that production of derivational morphemes was consistently more difficult than production of inflectional morphemes and judgment of derivational morphemes, whereas the differences between the two inflectional and between the two judgment tasks were not significant. This suggests that at these ages epilinguistic control is similarly effective for the two morphological domains whereas full metalinguistic awareness of derivational morphology trails behind that of inflectional morphology, at least as measured by these specific tasks. The findings highlight the need for early tracking and finer distinctions within the domain of morphological awareness, to identify and potentially enhance the critical skills related to the development of vocabulary and reading comprehension.

Keywords: Morphological awareness, inflectional morphology, derivational morphology, epilinguistic, metalinguistic, cross-sectional study

Development of early morphological awareness in Greek:

Epilinguistic vs. metalinguistic and inflectional vs. derivational awareness

Reading comprehension cannot succeed unless the reader appreciates morphological word formation, that is, how differences in word forms relate to differences in meaning (Carlisle, 2003). The explicit understanding of morphological processes, termed *morphological awareness,* is closely related not only to reading comprehension (Deacon, Kieffer, & Laroche, 2014; Deacon & Kirby, 2004; Kirby et al., 2012; Kuo & Anderson, 2006; Tong et al., 2011), but also to spelling (e.g., Deacon & Bryant, 2005, 2006; across orthographic systems varying in consistency, Desrochers, Manolitsis, Gaudreau, & Georgiou, submitted; and surviving control for phonological awareness, e.g., Deacon & Kirby, 2004), vocabulary (Sparks & Deacon, 2015), and word and pseudoword reading (Deacon & Kirby, 2004; Kirby et al., 2012; Tibi & Kirby, in press). In particular, the contribution of morphological awareness to spelling is robust to a multitude of control variables (Deacon, Kirby, & Casselman-Bell, 2009) and includes both inflected and derived forms (Deacon, Campbell, Tamminga, & Kirby, 2010), going beyond the spelling of specific morphemes (Casalis, Deacon, & Pacton, 2011). Moreover, instruction in morphological awareness results in benefits across literacy domains, especially when combined with phonological awareness training (e.g., Lyster, 2002; Lyster, Lervåg, & Hulme, 2016; Manolitsis, 2017; see meta-analyses and systematic reviews in Bowers, Kirby & Deacon, 2010; Carlisle, 2010; Goodwin & Ahn, 2010, 2013; Reed, 2008).

The term *morphology* includes a variety of systematic word-formation processes, such as inflection, derivation, and compounding, which operate on morphemes, that is, the minimal language units that bear meaning (Nagy, Carlisle & Goodwin, 2014). Implicit knowledge of such processes is evident in native speakers' language use.

Beyond implicit language use, which demonstrates basic language competence, the term *morphological awareness* denotes the individual's ability to reflect upon and consciously manipulate morphemes, as well as the ability to deliberately apply word formation rules. In other words, it concerns the ability to analyze words into smaller meaning-bearing units, including prefixes, suffixes, and roots (Kuo & Anderson, 2006), and to synthesize words from such constituent morphemes. Because awareness focuses on conscious manipulation of language concepts it is considered to operate at a *meta-linguistic* level, distinct from implicit language use, which concerns the linguistic level. However, there is not a clear binary distinction between complete lack of conscious awareness, on the one hand, and deliberate, explicit manipulation, on the other. Thus, more nuanced approaches are called for.

Levels of Awareness

The development of metalinguistic awareness has been studied for decades (Cazden, 1976; Van Kleeck, 1982). Early views based on observations that children make spontaneous repairs to their speech at a very young age (Clark, 1978; Clark & Andersen, 1979) suggested that metalinguistic awareness develops in tempo with language acquisition. Others held that it is a kind of linguistic functioning that develops in middle childhood (Tunmer, Pratt, & Herriman, 1984). Later on, metalinguistic awareness development was thought to concern the growth of skill components, namely, the analysis of linguistic knowledge into structured categories and the cognitive control of attentional procedures to select and co-ordinate specific linguistic information, usually with time constraints (Bialystock, & Ryan, 1985). Alternatively, it was conceptualized as macrodevelopmental representational relations between the processes underlying both children's spontaneous repairs and metalinguistic awareness occurring in a phase-like manner, described as cycles of processes that reoccur as different aspects of the linguistic system develop (Karmiloff-Smith, 1986).

Following Karmiloff-Smith (1986), the term “meta” is not limited to conscious access but can be applied to certain unconscious operations as well. Nevertheless, a differentiation should be made between morphological awareness and children’s unconscious knowledge of morphological word formation processes (Gombert, 1992; Karmiloff-Smith, 1986; Nagy et al., 2014) evidenced in normal communicative language use. Unconscious use of morphology is considered to be typical of language development and can be observed through overgeneralizations produced by young children, such as “buyed” (instead of “bought”). The production of these errors suggests a gradual development in understanding the rules of inflectional morphology. In contrast, full-blown metalinguistic awareness is evidenced in noncommunicative situations calling for conscious reflection upon language elements (e.g., morphemes), which are treated as objects that can be attended to and manipulated.

Nonetheless, the distinction between tacit knowledge of morphological processes and conscious morphological awareness has not been sufficiently investigated. In many cases it is not clear whether differences in measures of morphological awareness reflect differences in meta-linguistic awareness or in implicit morphological knowledge (Nagy et al., 2014). Although linguistic competence is a pre-requisite to meta-linguistic awareness skills, development of the latter is by no means guaranteed by attainment of the former. Moreover, attainment of meta-linguistic awareness may not constitute an “all or none” phenomenon but, rather, a gradual progression of skill development and maturation. Thus, a more nuanced approach has been proposed whereby an intermediate *epi-linguistic* level is posited to intervene developmentally between the two. Specifically, Gombert (1992) postulated a model in which metalinguistic development occurs in four successive phases: (a) acquisition of the first linguistic skills, (b) acquisition of epilinguistic control, (c) acquisition of metalinguistic awareness, and (d) automation of the metaprocesses.

Deacon, Parrila and Kirby (2008) taxonomized morphological awareness tasks according to—among others—the cognitive processes that underlie task performance, which may operate at either an implicit or an explicit level. Researchers have traditionally used lexical judgment tasks, which require children to decide whether two words are related or not, to tap implicit morphological skills (e.g., Duncan, Casalis, & Colé, 2009; Mahony, Singson, & Mann, 2000), and analogy and production tasks to assess explicit skills (e.g., Berko, 1958; Carlisle, 2000; Derwing, 1976; Kirby, Deacon, Bowers, Izenberg, Wade-Woolley & Parrila, 2012; Nunes, Bryant, & Bindman, 1997). However, production tasks have also been differentiated between implicit and explicit (Casalis et al., 2000). Thus, there is at present no consensus as to which types of tasks best assess the different purported levels or phases of metalinguistic development.

In the present study we followed the operationalization of Carlisle (1995), who made a distinction between different levels of metalinguistic knowledge of morphology by using a judgment task of related spoken words to tap epilinguistic skills and a production task to tap metalinguistic skills. By definition, this design aligns levels of awareness with the types of tasks they can support, thereby inherently conflating essential task requirements with meta-linguistic representational flexibility. Far from being a methodological limitation, this conceptualization reflects the notion that intermediate levels suffice for certain types operations but not for others.

In particular, judgment tasks are appropriate for the assessment of intermediate (epi-linguistic) levels of awareness, because they combine (a) noncommunicative use of language objects, which are to be consciously attended to and judged, with (b) reduced or negligible demands on meta-linguistic manipulation and retrieval, because the elements to be judged are provided by the examiner and need not be produced by the participant. In this sense, a judgment task can be said to occupy an intermediate level of awareness. In comparison, production tasks are more demanding, because they require both (a) noncommunicative use of language objects, in the context of an artificial test interaction, and (b) increased retrieval demands, because the participant is required to spontaneously produce a desired form based on indirect information provided by the experimenter. Therefore it is reasonable to consider high performance in production tasks as strong evidence of full-blown meta-linguistic awareness.

Domains of Morphological Processes

A further complicating factor concerns the different domains of word formation insofar as the morphological processes of grammatical inflection and productive derivation may not be equally accessible to children's awareness. Specifically, awareness of inflectional morphology tends to be detected earlier than awareness of derivational morphology. There is evidence that the former is acquired in the first school years (Kuo & Anderson, 2006; Diakogiorgi, Baris, & Valmas, 2005), whereas the latter develops towards the fourth year (Anglin, 1993; Carlisle, 2000) and continues to grow thereafter (Berninger, Abbott, Nagy, & Carlisle, 2010). The acquisition of morphology, as well as the assessment of morphological development with tasks tapping either inflectional or derivational morphology (McBride-Chang, 2016), was first systematically investigated by Berko (1958). In her study, she created pseudowords that followed the phonological rules of English and presented them to children 4–7 years old, asking them to provide the plural form, verb paste tense, or possessive of the pseudoword. Her findings indicated that preschool children had already acquired some morphological knowledge that enabled them to manipulate made-up words. There was a difference in the performance of preschoolers and school-aged children, underlining the developmental change of morphological processing. Additional evidence for progressive development was seen in the lack of comparative suffixes by both preschool and early school-aged children (Berko, 1958; Anisfeld & Tucker, 1967).

In comparison, knowledge of derivational morphology does not seem to emerge so early. Appreciation of derivations is observed later than appreciation of inflections, and it is connected to ongoing development extending throughout the school years (Anglin, 1993; Berko, 1958). Children in first grade have a rudimentary knowledge of derived forms that is not on par with their knowledge of stems and inflected forms (Anglin, 1993; Kuo & Anderson, 2006). Carlisle (1995) suggested that children's awareness of derivational morphology makes a transition from an implicit to an explicit level at the ages of kindergarten and first grade. In comparison, Casalis and Louis-Alexandre (2000) found that French-speaking children can apply derivational rules with only moderate success after the first two years of schooling, as indicated by their performance on an implicit-level task. The transition from implicit to explicit awareness of derivational morphology was found to emerge as early as first grade among French-speaking children, but not among English-speaking children, whose ability to produce novel derivations from word roots improved at a slow pace during the first three grades (Duncan, Casalis, & Colé, 2009). It seems that explicit awareness of the structure and meaning of derived forms emerges around Grades 3–4 (Anglin, 1993; Kuo & Anderson, 2006).

Deacon et al. (2010) examined morphological priming in fragment completion and found no difference between inflected and derived primes across Grades 4–8, suggesting that implicit knowledge of derivational morphology may have largely caught up with inflectional morphology by these ages. However, this does not imply that they emerge concurrently at earlier ages or that they are comparably mastered explicitly (i.e., meta-linguistically) as well. Consistent with the view of late emergence of knowledge about derivational morphology, children at around 9 years of age were found to be sensitive to derivational suffixes when spelling, whereas younger children (around 7 years) were not (Sangster & Deacon, 2011). In comparison, children in the 5-to-8-year-old range spontaneously demonstrated awareness of inflections, but not of derivations, in spelling (Deacon & Bryant, 2005). However, children at these ages could use cues from related words to spell root morphemes or derivational suffixes when provided specifically (Deacon & Bryant, 2005, 2006), demonstrating some basic understanding of the morphological structure of written words.

Outstanding Issues

Overall, and despite much research attention on the relationship between morphological awareness and literacy (see, e.g., Carlisle, 2003, 2010, for reviews), the developmental progression of both inflectional and derivational morphological awareness itself requires further examination. If a distinction between epi- and meta-morphological awareness concerning the morphological domains of inflectional and derivational morphology can be established, it may be possible to increase the reliability in early detection of children at risk for difficulties and to provide early intervention. Moreover, most existing studies have examined English- and French-speaking groups, leaving open the question of generalization to languages with richer inflectional morphology than English or with more graphophonemically consistent relations across morphemes. The course of development that has been suggested for English may be partially due to peculiarities of English orthography or morphology that may not apply cross-linguistically (cf. Share, 2008). Finally, most studies have focused directly on the concurrent predictive power of morphological awareness for reading skills, necessarily testing children at the ages of elementary school grades, rather than examining the development of morphological awareness itself, which is expected to emerge, at least to some extent, prior to the onset of literacy instruction.

Thus, a theoretically interesting question concerns the development of metalinguistic awareness, across levels and morphological domains, in preschool ages. According to the aforementioned findings we would expect to observe two distinct progressions through epi- and meta- levels of morphological awareness: one regarding inflectional morphology, progressing earlier, and another regarding derivational morphology, following in later years. However, it is also possible that epi-morphological awareness, which puts less of a strain on attentional and linguistic processes, may develop early and in sync for both inflectional and derivational morphology. In contrast, the transition to the meta- level, which makes heavier demands on conscious manipulation and attentional control, may follow diverging developmental paths for the two morphological domains.

Therefore, this study aims to explore the developing progression of inflectional and derivational morphological awareness skills. Following Carlisle (1995), we assessed epilinguistic skill using a judgment task and metalinguistic skill using a production task. In this way we operationalized different levels of awareness with tasks posing corresponding challenges, while avoiding more cognitively demanding tasks, such as analogies, which may cause difficulties for reasons not closely related to linguistic and metalinguistic skill. The acquisition of epilinguistic control versus metalinguistic awareness was examined in children attending pre-kindergarten, kindergarten, and first grade, to determine whether epi-morphological abilities are indeed acquired earlier than meta-morphological awareness. This would be expected on the assumption that children's sensitivity to the morphological aspects of the language gradually becomes more explicit, culminating in the development of meta-morphological skills.

Relevant Properties of Greek

We worked in Greek, a language with rich inflectional and derivational morphology (see Ralli, 2003) and relatively consistent orthography (Protopapas & Vlahou, 2009). Nouns and adjectives are obligatorily inflected for gender, number, and case via fusional suffixation. For example, the noun χορός (/xoros/ "dance") is composed of the stem χορ- (/xor/ expressing the core semantics) and the inflectional suffix -ος (/os/ signifying masculine singular nominative case). Verb forms also include a stem and an obligatory inflectional ending, both of which may be simple or complex. Verbs are inflected for voice, aspect, tense, number, and person (Ralli, 2003; see Holton, Mackridge, Philippaki-Warburton, & Spyropoulos, 2012, and Klairis & Babiniotis, 2004, for comprehensive descriptions). For example, the verb χορεύω (/xorevo/ "I dance") is composed of the same stem χορ- (/xor/), the derivational affix -εύ- (/ev/ forming a verb from a noun), and the inflectional suffix –ω (/o/ signifying first person singular). Distinct inflectional classes are recognized for both nouns/adjectives and verbs, each with its own set of suffixation and stem alternation rules (Ralli, 2003, 2005; Holton et al., 2012). Word formation in Greek also includes systematic derivational processes, especially for nouns (based on verb stems) and adjectives (based on verb and noun stems). Compounding is also highly productive, as new adjectives, nouns, and verbs can be created from existing stems and words (see Ralli, 2003, 2005, for more information).

Morphology has extensive orthographic consequences in Greek, insofar as derivational and grammatical suffixes are associated with specific spellings, which also serve to disambiguate homonyms. Knowledge of the inflectional type is often required for correct spelling of adjective, noun, and verb suffixes (see Protopapas, 2017, for more information and references). Instructional activity related to morphological awareness takes place informally in the Kindergarten curriculum only as part of vocabulary instruction, in the context of shared book reading and retelling, including activities with words (nouns and verbs) differing in number inflection, along with phonological awareness activities such as letter-sound association and identification. Systematic decoding is taught in Grade 1, so that most children are able to read by mid-grade, as well as systematic teaching of distinct spellings of noun and verb vowel endings (i.e., inflectional suffixes).

Most Greek children have mastered the inflectional paradigms of the language to a large extent by the age of entering elementary education, at least as far as the suffixes with orthographic consequences are concerned (i.e., case, gender, and number, for adjectives and nouns, and person and number, for verbs). Normally developing Kindergarten children approach ceiling performance in the production of verb past tense and noun gender, number, and case (Mastropavlou, 2006) although persistent difficulties with verb aspectual formation and noun gender are observed in certain word classes with unusual properties (Stavrakaki & Clahsen, 2009; Varlokosta & Nerantzini, 2013, 2015). Thus morphological acquisition is largely but not entirely completed by Grade 1.

Method

Participants

The participants in this study were 236 children (139 girls) 4–7 years old (M = 67.8 months; SD = 11.5; range: 49–86), native speakers of Greek, without any diagnosed developmental delay or sensory deficits, sampled from schools in rural (17%), semi-urban (19%) and urban (63%) areas of four geographically dispersed provinces of Greece, including a variety of socioeconomic and ethnic backgrounds. 79 children attended pre-kindergarten, 58 children attended kindergarten and 99 attended first grade.

Procedure

Participants were randomly selected from each school. After obtaining parental approval and the child's oral assent, the examiner administered the tests in two to three sessions within two weeks (in the context of a variety of other tasks not reported here). Examiners were undergraduate and postgraduate students of psychology or education who were extensively trained and evaluated to ensure uniform administration. Assessments were conducted in a quiet room at the school. Breaks were provided as needed.

Materials

Morphological awareness was assessed using four different tasks, including two epimorphological and two metamorphological ones. Each pair included one task assessing inflectional and one assessing derivational morpheme awareness. The design and content of the tasks was targeted specifically for the age groups under study, aiming to avoid floor and ceiling effects in assessing the various morphological domains. Because of the relative ease of the inflectional domain, determined in pilot testing, both inflectional morphology tasks used pseudowords. Pseudowords were formed based on the depicted words, by replacing vowels and consonants in the stem while retaining the phonological structure, stress pattern, and inflectional suffix intact, e.g., /'skeno/ was derived from /'vɣazo/ "βγάζω" (take out); /'serapas/ was derived from /'xarakas/ "χάρακας" (ruler). In contrast, use of pseudowords was deemed potentially too challenging for the derivational morphology tasks, which are by nature more based on meaning. The implications of this difference between tasks are taken up in the discussion. Internal reliabilities of the tasks are reported as Revelle's omega total (ω_{RT}), calculated using polychoric covariance matrices and maximum-likelihood factor extraction using R package psych (Revelle, 2016), because of its superior performance compared to the commonly used Cronbach's alpha (McNeish, in press).

Inflectional morphemes judgment task (epi-morphological). In this task children were presented with a booklet of 30 pictures displaying either one or two turtles performing an action. For each picture, two sentences were spoken by two finger puppets for the child to choose the one matching the picture. Each pair of sentences contained one pseudo-word (17 pseudo-verbs and 13 pseudo-nouns) differing in the inflectional suffix in the pseudoword, which was either singular or plural. For example, given a picture of two turtles taking photographs, the two sentences were "the turtles *skeni*$_{3rd.sg}$ photos" and "the turtles *skenoun*$_{3rd.pl}$ photos"; given a picture of a turtle holding two rulers, the two sentences were "the turtle is holding the$_{acc.sg}$ *serapa*$_{acc.sg}$" and "the turtle is holding the$_{acc.pl}$ *serapes*$_{acc.pl}$" (the critical pseudoword is denoted by italics). The number of correct answers was noted. Internal reliability (ω_{RT}) was .94.

Derivational morphemes judgment task (epi-morphological). Children were presented with a booklet of 14 pictures. For each picture, two sentences were spoken by two finger puppets for the child to choose the correct one. Each pair of sentences contained a different derived adjective or noun differing in the derivational suffix and thereby matching or mismatching the sentence context. For example, given a picture of a lion, the two sentences were "the lion is the king of the animal/animistic kingdom" (Greek: /zoi'ko/ vs. /zo'oðes/, respectively; both are real adjectives with transparent semantics derived from the same stem but only the first fits the specific context).The task targeted a variety of derivational morphemes, denoting property, profession, establishment/institution, material, collection, comparatives, action, device, nationality/origin, etc. The number of correct answers was noted. Internal reliability was ω_{RT} = .87.

Inflectional morphemes production task (meta-morphological). Children were provided with a booklet of 29 pairs of pictures, each pair illustrating actions performed by turtles differing in the number of agents or patients of the depicted action. The examiner presented one picture along with a verbal description including a pseudoword (a pseudo-verb in 17 sentences, for the action, and a pseudo-noun in 12 sentences, for the object). Children were then provided with the beginning of a second sentence, matching the second picture, up to the subject of the verb, and were asked to change the pseudo-word number (from singular to plural or from plural to singular) accordingly. For example, given a picture of two turtles with sunglasses and a picture of one turtle with sunglasses, the examiner would say "The turtles *menane*$_{3rd.pl}$ glasses. The turtle…" and the child should say "*menaei*$_{3rd.sg}$ glasses"; given a picture of a turtle waving at a monkey and a picture of a turtle waving at two monkeys, the examiner would say "The turtle is greeting the$_{acc.sg}$ *reipou*$_{acc.sg}$. The turtle is greeting the$_{acc.pl}$" and the child should say "*reipoudes*$_{acc.pl}$" (the critical pseudoword is denoted by italics). The number of correct answers was noted. Internal reliability was ω_{RT} = .98.

Derivational morphemes production task (meta-morphological). Children were presented with a booklet of 23 pictures. For each picture, the examiner provided one sentence with a critical word (a different one for each sentence) and the beginning of a second sentence that was syntactically altered and required manipulation of a derivational morpheme on the critical word to be completed correctly (e.g., "The sea deepens. The sea is…" requiring "deep"; "Miriam always teases her friends. Miriam is a…" requiring "teaser" /piraxtiri/, derived from /pirazo/). The task targeted a variety of derivational morphemes, similar to the derivational morphemes judgment task. The number of correct answers was noted. Internal reliability was ω_{RT} = .91.

Results

All analyses were carried out in R version 3.3.1 (R Core Team, 2016). Total accuracy per task (in the 0–1 range) was calculated by dividing the number of correct responses by the total number of corresponding items, for illustration purposes only. Figure 1, produced using R package psych (Revelle, 2016), displays the scatterplots among age and morphological awareness tasks along with the corresponding Spearman's ρ (non-parametric correlation) coefficients and individual variable histograms. A locally weighted scatterplot smoother (loess) has been added to the scatterplots to facilitate visualization of their continuous relations. The correlation coefficients are sizeable, generally in the .5–.6 range, not only among tasks but also with age. Application of factoring criteria (parallel analysis: Horn, 1965; very simple structure: Revelle & Rocklin, 1979; minimum average partial: Velicer, 1976) and exploratory factor analysis indicated that a single factor suffices (cf. Tibi & Kirby, in press) and accounts for .59 of the variance in the four tasks, achieving an RMSEA index of .096 (95%CI [.015–.184]) and multiple R^2 with scores of .86.[1] This suggests that a common developmental path may account for much of the reliable variance and calls for an analytical approach that can tease apart differences between tasks beyond the common effects of age.

Further analysis of the data was conducted by fitting generalized additive models (GAM; Baayen, 2013) to trial-level individual responses using package mgcv (Wood, 2011). GAMs are regression models that include "smooth" terms to model

[1] After controlling for the linear effect of age by residualizing, the proportion of variance accounted for by the single factor was .45, RMSEA was .074, and multiple R^2 with scores reached .78. Factoring criteria did not suggest a need for a second factor.

curvilinear relations among continuous variables, thus providing better fit in cases of nonlinear relations (at the expense of additional model parameters, which are penalized for parsimony). As indicated by the scatterplots in Figure 1, the developmental progression (i.e., accuracy as a function of age) of at least some morphological awareness tasks appears to be nonlinear, potentially invalidating analytic approaches relying on linear relationships (such as ANOVA or linear regression). GAMs can track these nonlinearities by fitting as smooth curves as possible to reduce residual error while keeping the number of additional parameters low. Moreover, GAMs can include random effects (both intercepts and slopes) to appropriately model the grouping structure of the data and, hence, the correlations among subsets. In this way, the correlations among responses by the same child to different items, and the correlations among responses to the same item by different children, are simultaneously accounted for (as in linear mixed-effects models, but unlike analyses of variance, in which only nested—not crossed—grouping structures can be defined in "repeated measures" designs).

For our data, age (in months) was a continuous predictor for morphological awareness performance in each of the tasks, and its effect was allowed to vary between the four tasks. The dependent variable was response accuracy for each individual trial, coded as a binomial variable and analyzed via a logit link function. In this way variations in accuracy were modeled as differences in log odds, which do not suffer from the limited scale of 0–1 and are therefore relatively robust to the unavoidable floor and ceiling effects observed near the endpoints of accuracy scales (Dixon, 2008).

The random effects structure included random intercepts for participants (i.e., an average performance for each child) and for items (modeling the overall difficulty of each item within each task), as well as random slopes of task per participant (i.e., differences between tasks were allowed to vary between participants, specifically modeling their variance at the participant level) and random slopes of age per item (i.e., differences between items in the rate of increasing accuracy with age were specifically modeled as variance at the item level). Each of the aforementioned effects was retained in the model after being determined significant (by χ^2 test and the Akaike Information Criterion) in comparison against an alternative model that excluded it, using function compareML from R package itsadug v. 2.2 (van Rij, Wieling, Baayen, & Van Rijn, 2016). The resulting formula, in R mgcv notation, was: accuracy ~ task + s(age, by=task) + s(sID, bs="re") + s(sID, task, bs="re") + s(item, bs="re") + s(item, age, bs="re"). In this formula, the binomial dependent variable (accuracy, coded as 0 or 1) is modeled as a function of task (a four-level factor), a smooth continuous curvilinear effect of age (in months) allowed to vary between tasks, plus random effects for participants (sID) and items (item), as noted above. Figure 2 plots the estimated accuracy as a function of age, with associated 95% confidence intervals, based on the model parameters, after cancelling all random effects. It is clear that the derivational production task (meta-der) stands out as being more difficult across the age range examined, whereas the other three tasks follow very similar paths. This model accounted for 37.4% (adjusted R^2; cf. 34.7% deviance explained) of the total item-level response accuracy variance.

To examine differences among tasks in more detail, including age ranges in which they may significantly differ, we can compare pairs of these curves, in effect by subtracting them at each age point and plotting their continuous difference as a function of age. In this way we can visualize the differences over time. In addition, generalized additive modeling can provide estimates of confidence intervals for the differences between curves, which permits evaluation of differences as significant or not. Figure 3 plots pairwise differences between pairs of curves, separately for comparisons between levels of awareness (epi- vs. meta-morphological; top row) and for comparisons between morphological domains (inflectional vs. derivational; bottom row). The order between the two curves in each comparison was set to result in positive differences, for display purposes. In effect, these graphs plot the difference between pairs of curves seen in Figure 2, with associated 95% confidence intervals for the difference, in the analysis scale (i.e., logits, not proportion correct). Therefore, any regions in which the confidence intervals (shaded bands) do not straddle the horizontal zero line indicate significant differences in performance between the two tasks. These statistical comparisons confirmed that performance in production of derivational morphemes was lower than production of inflectional morphemes and than judgment of derivational morphemes. These differences fully spanned the age range examined, confirming that meta-linguistic awareness of derivational morphology is most demanding and therefore attained last.

There was also a minor, transient and small difference between epimorphological control and metamorphological awareness of inflections at 49–50 months of age (top left panel in Figure 3). This may constitute the trail of an earlier difference between these levels in the inflectional domain, which would be discernible in younger ages. Alternatively, it may be an artifact arising from penalizing the curvature of the performance-age relationship, evident at the edge of the modeling range, which is not bilaterally constrained and is therefore less reliable. For this reason we will refrain from further interpreting this minor finding. Finally, we note that additional analyses (available from the authors) including measures of expressive and receptive vocabulary did not reveal any differential effects of vocabulary on the pattern of differences among morphological awareness tasks as a function of age and were therefore omitted for the sake of simplicity in the presentation of statistical analysis.

Discussion

In this study we examined the early stages of the development of morphological awareness in a cross-sectional sample of Greek children spanning pre-kindergarten to first grade. Therefore, whatever attainment of morphological awareness is documented in the early parts of the age range is unlikely to be influenced by reading experience and thus can be considered a marker of meta-linguistic skill acquisition based on spoken language experience. In this sense our study differs from most other studies examining morphological awareness in that we have targeted earlier, and arguably somewhat purer, stages of morphological awareness development than typically examined in the context of literacy-related studies, in which the reciprocal effects between reading comprehension and morphological processing, or the effects of morphological instruction on literacy, are often of focal interest.

The data have revealed a nuanced picture that calls for both hypothesized distinctions in order to be interpreted, to the extent that our limited range of tests constitutes an acceptable index of the corresponding domains (an issue considered further below). On the one hand, there is some evidence that inflectional awareness precedes derivational awareness, at least for the specific sample and materials tested, but this is only true for the more demanding meta-linguistic level. On the other hand, there was also evidence for the differentiation between epilinguistic control, evidenced in less challenging tasks that do not require production or conscious manipulation, and full-blown metalinguistic awareness, evidenced in more demanding tasks, but this was only true for the domain of derivational morphology. This distinction parallels the corresponding distinction between epi-phonological and meta-phonological levels, which has been discussed in the phonological awareness literature (Duncan, Seymour & Hill, 1997, 2000; Goswami & East, 2000) and can be used to interpret the progression of performance through different kinds of phonological awareness tasks with increasing age. For example, Carroll, Snowling, Hulme, & Stevenson (2003) used a longitudinal design to document a developmental progression from implicit phonological awareness of large units, such as syllables and rimes, to explicit awareness of small units, namely phonemes.

As noted, our findings indicated that the acquisition of epilinguistic control precedes the acquisition of metalinguisitic awareness for the domain of derivational morphology, as assessed with these particular tasks. It cannot be ruled out that a similar progression might be evident for inflectional morphology at ages younger than the range examined here, or using tasks addressing more demanding inflections. Still, the observed distinction between levels of morphological awareness is consistent with Gombert's (1992) model of metalinguistic development, as we found that Greek children as young as 4 years old exhibit adequate epilinguistic control over both inflectional and derivational morphology. However, our results depart slightly from the phonological awareness literature, in which acquisition of epilinguistic control of phonological awareness is reported at around 5 years of age (see Gombert, 1992 for a review). It seems that the richness of Greek in inflectional and derivational morphology, compared to English, facilitates the development of morphological awareness at the implicit/epilinguistic level well before the onset of formal literacy instruction. Similarly, the onset of metalinguistic morphological awareness in the domain of inflection in our study seems to occur earlier than the reported onset of metaphonological awareness among English-speaking children, which has been identified at the age of 6 to 7 years (Calfee et al., 1973; Fox and Ruth, 1975; Rosner and Simon, 1971).

It should be noted that our task only tested manipulation of the number inflection. It is possible that inclusion of a wider variety of inflectional morphemes might have produced somewhat different results, perhaps exhibiting a range of initial attainment extending to older ages. This issue ought to be examined in follow-up research. However, it must also be clarified that the number inflection in Greek is quite unlike the one in English, in which a fixed single-phoneme morpheme applies uniformly to almost every noun and verb, and is only subject to minor phonological assimilation. In Greek there are several distinct inflectional classes (both verb conjugations and nominal declensions), each with its own set of suffixes. Ralli (2003, 2005) postulates eight general noun declensions, not distinguished by gender, whereas Holton et al. (2012) list more than twenty noun classes, classified by gender, and twelve adjective classes, plus variants and exceptions. Two major verb conjugations are also generally recognized, with additional suffix variants. Stem variation is present in both verbs and nouns/adjectives, with different allomorph stems used in different contexts (Ralli, 2003). As nouns and verbs are inflected by fusional suffixation, children have to judge or produce the singular or plural form while taking into account the gender, case, and class of the noun; or the person, tense, and class of the verb. In our task there were items from six different noun classes and two verb classes. Therefore, even though our tasks addressed only one inflectional domain, which is likely to have been attained in language use by this age, it cannot be said that they posed negligible epi- and meta-linguistic requirements, as might be the case for a plural task in English.

Our findings on early inflectional morphological awareness are in line with previous reports suggesting that English-speaking children can apply knowledge about inflectional morphology from the age of 4 years (Berko, 1958; Selby, 1972). Indeed, our findings establish that preschool children can manipulate the inflectional morphemes encoding the plural form of nouns, and of verbs in active voice present tense, indicating that they have at least partially progressed to the level of metalinguistic functioning prior to learning to read and write. Of particular interest in this regard is the finding regarding the early emergence of derivational morphological awareness at the epilinguistic level, as measured with our particular judgment task, standing in contrast to findings from other studies that have provided evidence for a later emergence of morphological awareness of derivational morphemes at the implicit level, both in English (Duncan et al., 2009) and in French (Casalis et al., 2000). This discrepancy cannot be attributed to particularly narrow assessment in this study because our derivational tasks included a wide variety of morphemes and associated meanings.

It remains to be determined in future studies whether the overall morphological richness of Greek makes both inflectional and derivational suffixes more salient, supporting earlier acquisition of epilinguistic control, or whether other task-related factors may account for the difference. Given that overall task demands depend both on the materials tested (e.g., words vs. pseudowords, particular lexical choices) and the procedures used (e.g., analogy, elicitation, judgment, production, with or without picture support, etc.), it seems possible to construct assessments purportedly addressing the same construct that differ greatly in how—and how much—they challenge the budding linguistic and meta-linguistic skills of young children. Therefore it is important to qualify the present findings on the basis of the properties of the tasks used, and to defer final conclusions until a wider range of tasks has been explored.

In sum, the significant difference between the derivational morphology judgment and production tasks, both of which included words with a variety of derivational morphemes, attests to the importance of drawing distinctions among levels of awareness and associated tasks to assess them. It seems clear that there is not only a single level of metalinguistic competence in the domain of morphology, and that different kinds of structured interactions can produce quite divergent results even if they rely on the same kinds of materials and same range of morphological distinctions. The differences are quite pronounced: In our data the level of performance achieved by 4 year olds in the judgment task was higher than that achieved by 7 year olds in the production task (see blue lines in Figure 2). This should be taken into account when comparing across studies that have employed different tasks to examine morphological awareness.

Based on pilot work, we chose to use pseudowords for the inflectional morphology tasks but real words for derivational morphology. Given that pseudowords are generally more demanding, and often seem to be especially challenging for young children, the results attest to the high attainment in inflectional morphology, both at the level of epilinguistic control and at the level of metalinguistic awareness. Evidently, most children were able to meet the demands of these tasks, perhaps in part due to related instructional activities (with real words) taking place already in Kindergarten, and probably also due to the child-friendly design and administration, demonstrating adequate control as well as awareness of grammatical number. Thus, our findings are consistent with the suggestion that Greek children can manipulate inflectional morphemes by the time formal literacy instruction commences (Rothou & Padeliadu, 2015). Future studies focusing on older children will likely have to rely on more challenging components of inflectional morphology, as normally developing Kindergarten children approach ceiling performance in the production of not only number but also verb past tense and noun gender and case (Mastropavlou, 2006), and our data suggest that this attainment largely translates to awareness performance as well.

The derivational morphology tasks were designed based on words, rather than pseudowords, because it was judged that they may be too challenging for the age range examined if based on pseudowords. This has proven to be an appropriate choice, especially taking into account preschool performance in the production task used to tap the meta-morphological level. However, this choice has also resulted in a confound between lexicality and level of awareness that somewhat limits the interpretability of our findings. We claim that this limitation is not too severe because in fact the word-based task requiring production of derivations proved more difficult than the pseudoword-based task requiring production of inflections. Therefore, using words has not unduly facilitated participants, and can be used to argue even more forcefully that conscious manipulation of derivations is indeed more demanding than that of inflections. No corresponding difference was observed between judgment of inflections and derivations, therefore it cannot be precluded that using words in the judgment of derivations might have critically facilitated the task to allow performance to rise up to the level observed with judgment of inflections (on pseudowords). Thus, the claim of uniformity regarding epilinguistic control is vulnerable to this confound; future studies aiming to chart the variability in performance attributable to task factors (such as lexicality, grammatical type, mode of administration, etc.) should address this issue in more detail. However, the confound does not affect the interpretation of within-domain performance comparisons, as both inflectional tasks were based on pseudowords and both derivational tasks were based on words.

Our findings have revealed a gradual improvement in performance, in both judgment and production tasks, across the age range examined. This general picture must be interpreted in the context of great individual variability, revealed in the scatterplots of Figure 1, indicating early attainment for some children and very low performance for others, including some in the relatively higher ages within the examined range. It is presently unknown whether the early gains may be beneficial (and whether trailing behind proves detrimental) to the eventual development of reading competence, including future fluency and comprehension. Regarding the children with low performance in the morphological awareness tasks, one may speculate that earlier difficulties with linguistic and metalinguistic skills, including phonological processing and phonological awareness, may be related to the relatively poor progress in morphological awareness (Cunningam & Carroll, 2015).

Our data do not indicate any abrupt increase in morphological awareness in first grade that might be associated with early reading experience. However, this cannot be unambiguously interpreted, as it may be due to the difficulty level of the tasks, which were designed to be achievable by our young participants. Moreover, it may be due to the limited reading experience that can possibly be accumulated during first grade, in which efforts are primarily concentrated on successful decoding. Thus, it is after first grade, and with somewhat more demanding (and perhaps time-pressured) tasks, that we would expect to see effects of reading experience on morphological awareness performance.

Finally, we acknowledge limitations arising from the operationalization of epilinguistic control vs. metalinguistic awareness as a distinction between judgment and production tasks. We contend that this methodological approach is well grounded theoretically and can help reveal informative differences between tasks differing in demands that are relevant for the study of the gradual emergence of metalinguistic skills, as revealed in our study. Still, reasonable reservations may be expressed regarding (a) the extent to which the relevant domains are well captured by single tasks, rather than groups of related tasks (a measurement issue, that can be addressed with multiply indexed latent variable approaches in future studies); (b) whether the epi- vs. meta- distinction provides a sufficiently rich framework to evaluate the emergence of metalinguistic skill, in comparison to more complex taxonomies (e.g., Deacon et al., 2008; but see Tibi & Kirby for a finding of near unidimensionality); and (c) whether the chosen tasks do in fact reflect the desired constructs (a core validity issue). For example, one might argue that repeated exposure to a certain feature (grammatical number) during the judgment task might result in a more conscious operation underlying task performance than supposed under the “epi” operationalization. Such criticisms can only be resolved empirically in future studies including a larger variety of theoretically grounded measures aiming to document systematic differences in the longitudinal development of skills indexed by partly dissociable sets of tasks.

In conclusion, morphological awareness of Greek inflections and derivations follows a developmental progression during the age range of 4 to 7 years. Epimorphological awareness, which puts less of a strain on attentional and linguistic processes, appears to develop earlier than metamorphological awareness, but in sync for both inflectional and derivational morphology. On the other hand, metamorphological awareness of derivational morphology appears to follow. Children as young as 4 years of age have some awareness of derivational morphology at the explicit level, but this ability reaches moderate levels of competence much later, around the age of 6 years. These conclusions must be tempered due to the limitation imposed by the small number of tasks and restricted range of morphemes assessed. Further research is required to investigate whether these findings generalize to other inflectional morphemes in Greek and to other languages with similar or more transparent orthographies. In particular, it will be important to assess each domain and level with a set of tasks, sampling wider ranges of morphemes, difficulty levels, and associated nonlinguistic task demands. Moreover it seems that assessment of children younger than four years will be necessary for determining the developmental onset of both implicit and explicit morphological awareness of inflectional morphology and of implicit awareness of derivational morphology.

Our findings have both theoretical and practical implications. Although based on a small range of tasks, they highlight the need for making finer distinctions within the domain of morphological awareness. Distinguishing between implicit/epilinguistic and explicit/metalinguistic levels of morphological awareness, in conjunction with different domains of morphological knowledge (inflectional vs. derivational), will enable us to fully appreciate the onset of development and progression of the critical skills related to the development of vocabulary and reading comprehension. Moreover, it may allow early identification of risk factors related to reading and spelling difficulties and enable educators to enhance those skills at a very young age.

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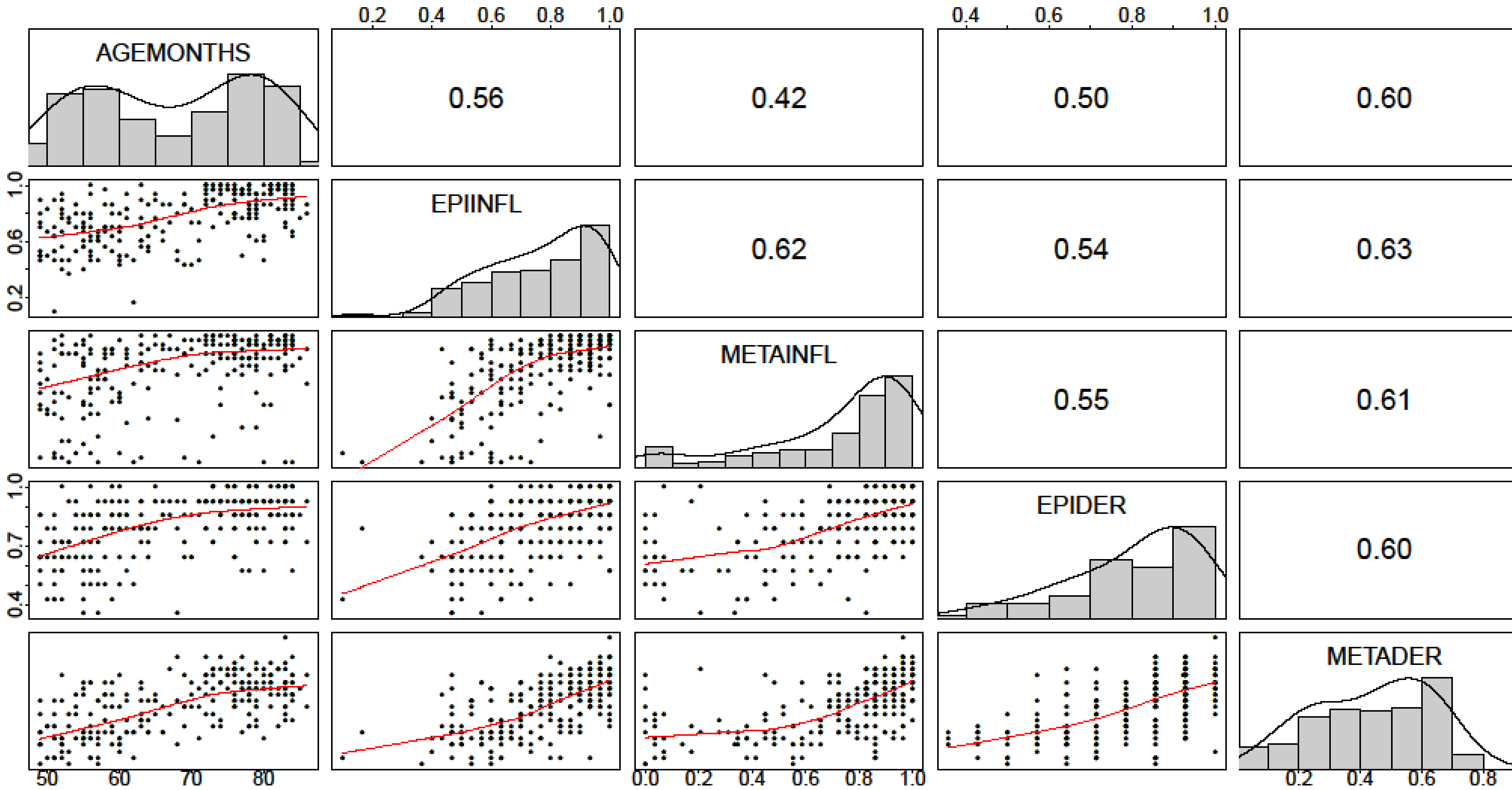
Figure captions

Figure 1. Raw data display including scatterplots among age (in months) and accuracy (proportion of correct responses) in the four morphological awareness tasks (EPI=epimorphological level; META=metamorphological level; INFL=inflectional morphology, DER=derivational morphology) and corresponding (non-parametric) correlation coefficients and individual variable histograms. In each panel, each point corresponds to one child. The red lines over the scatterplots show locally-weighted smooth curves fit to the data points using the loess method.

Figure 2. Generalized additive model smooths for age fitted to the data for the four morphological awareness tasks, and associated 95% confidence intervals after canceling all random effects.

Figure 3. Differences between age smooths for different tasks. Top row, comparisons between levels of awareness; bottom row, comparisons between morphological domains. The vertical axis is scaled in logits and is not directly interpretable in terms of task accuracy (see Figure 2 for the scaled smooths). Ranges of significant differences between the two contrasted smooths are indicated by a red-colored horizontal axis, with vertical dotted lines marking their extent.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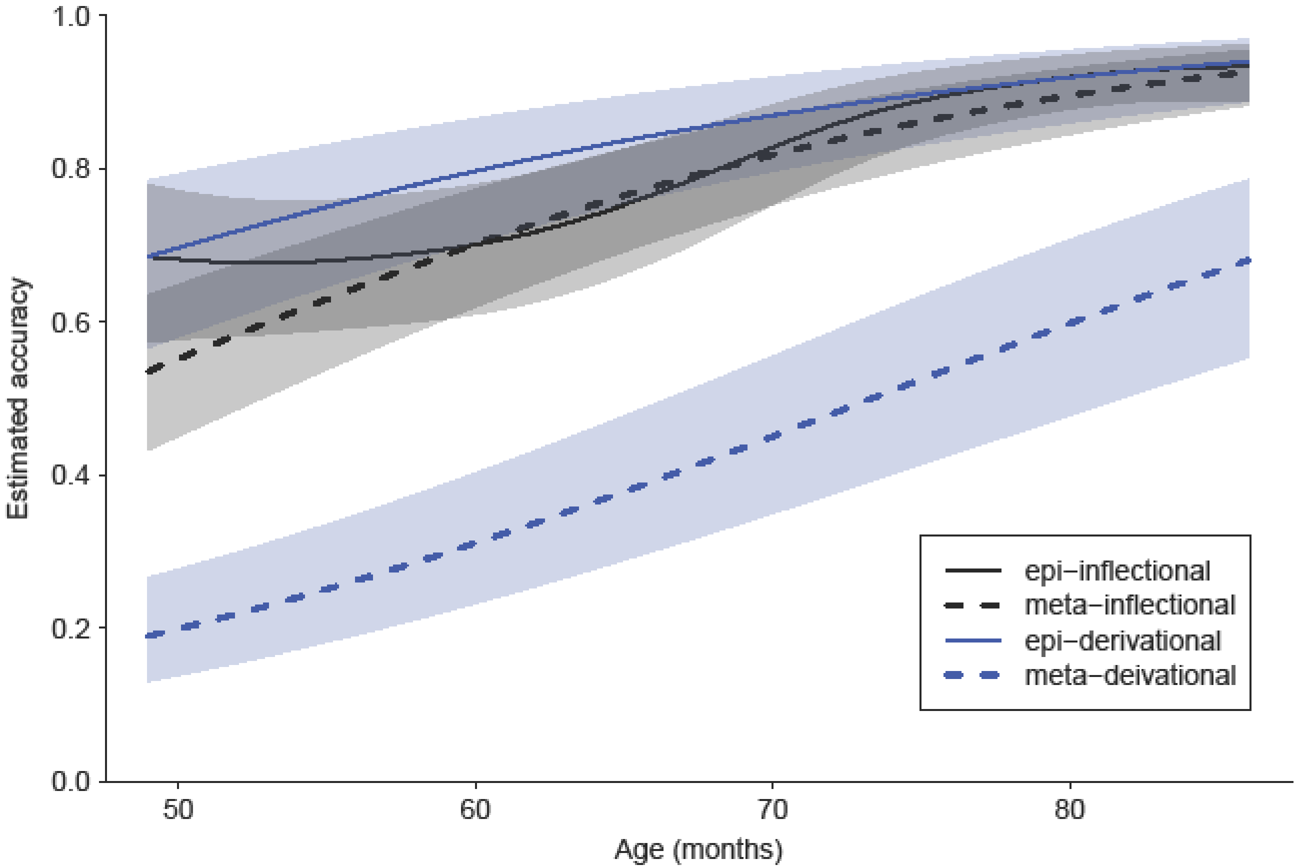
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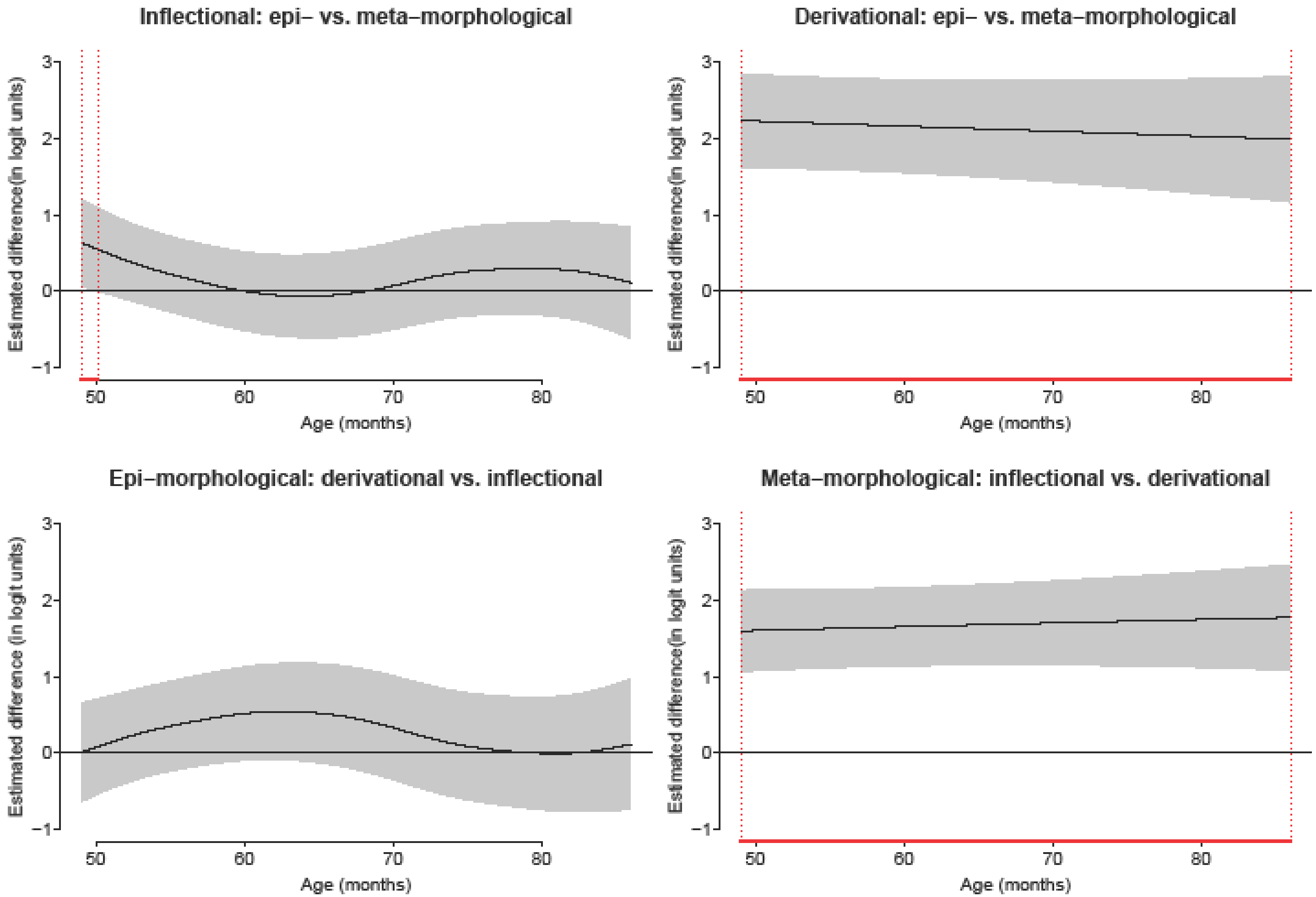
epi–derivational
meta–deivational


Inflectional: epi– vs. meta–morphological
Derivational: epi– vs. meta–morphological
Epi–morphological: derivational vs. inflectional
Meta–morphological: inflectional vs. derivational
Estimated difference (in logit units)
Age (months)
3
2
1
0
−1
50
60
70
80