Pragmatics and modularity: a developmental perspective

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Abstract: Cognitive research on pragmatics relies on the idea that pragmatic comprehension is a matter of inferring speaker intentions. Sperber and Wilson elaborate on this idea from a modular perspective by positing the existence of a mental module dedicated to pragmatic comprehension. The purported modularity of pragmatics is debated in the contemporary landscape, but little effort has been dedicated so far to exploring the possible developmental implications of this modular view. This paper aims to fill this gap by reconciling extant findings from developmental psychology with the hypothesis of a pragmatics module for interpreting overt communicative behaviors.

Keywords: Developmental pragmatics, modularity, infancy, ostensive communication.

1. *Introduction*

In the late twentieth century, language and cognition research has been marked by two influential trends: a modular view of the mind, and an intentional-inferential view of communication. According to the modular view systematized by Fodor[1], the mind is a cluster of sub-systems, or "modules", that perform specific cognitive functions with relative independence from each other. According to the intentional-inferential view, pioneered by Grice[2] and developed in cognitive psychology by Sperber and Wilson[3], human communication relies on the inferential attribution of speakers' communicative intentions. The modular view, initially applied to describe peripheral and "encapsulated" cognition was unsuitable to account for global

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1 Jerry A. Fodor, *The Modularity of Mind*, Cambridge, MIT Press, 1983.

2 Paul H. Grice, *Meaning*, "The Philosophical Review", 66(3), 377, 1957, pp. 377-388.

3 Dan Sperber, Deirdre Wilson, *Relevance: Communication and Cognition*, Blackwell, Oxford 1986/1995.

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and context-sensitive communicative inferences; over time, reformulations of the modular view led it to converge with the intentional-inferential view. This convergence is realized in Sperber and Wilson's[4] "Pragmatics Module Hypothesis" (henceforth, 'PMH', or 'the Hypothesis').

The Hypothesis states that pragmatic comprehension is carried out by a dedicated cognitive system closely related to the mind-reading system underlying the interpretation of others' behavior in terms of attributed mental states. Building on Grice's[5] intuition that understanding meaningful utterances requires reading the speaker's intentions, Sperber and Wilson[6] argue that communicative intentions are inferred through an inferential heuristic (i.e., the pragmatics module) which is triggered by ostensive communicative stimuli and is guided by expectations of relevance. Ostensive stimuli, though, are both verbal and non-verbal: linguistic utterances, pointing gestures, showing gestures, or nodding by catching the addressee's attention, *inter alia*, can all be ostensive behaviors. In principle, this broadens the scope of PMH to include the prelinguistic stages of children's pragmatic development, characterized by the comprehension of pointing gestures and overtly intentional demonstrations. This opens a meaningful testing ground for assessing the empirical plausibility of the Hypothesis: Can early pragmatics be explained along a modular view? How can the Hypothesis be articulated from a developmental perspective?

Early involvement in ostensive communication is nowadays supported by a wealth of data from developmental psychology. Still, this body of research is mostly considered in relation to the Natural Pedagogy mechanism adapted for social learning[7], and less with respect to the hypothesis of an early interpretative heuristic for communicative behaviors. Although developmental research has early been pointed out as a promising testing ground for PMH[8], little theoretical effort has been dedicated so far to exploring its developmental side. This paper aims to fill this research gap by providing a cognitive account for articulating the Pragmatics Module Hypothesis from a developmental perspective, thus assessing its empirical significance in light of available data from infant pragmatics.

The paper is structured as follows. In section 2, I provide a concise overview of the concept of modularity after Fodor[9], and I illustrate three main conceptions of

[4] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, "Mind & Language", 17, 2002 pp. 3-23.

[5] P.H. Grice, *Meaning*, cit.

[6] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, cit.

[7] Gergely Csibra, György Gergely, *Natural Pedagogy*, "Trends in Cognitive Sciences", 13, 4, 2009, pp. 148-153.

[8] Deirdre Wilson, *New directions for research on pragmatics and modularity*, "Lingua", 115, 8, 2005, pp. 1129-1146.

[9] J.A. Fodor, *The Modularity of Mind*, cit.

modularity that will help to navigate different facets of PMH. In section 3, I spell out PMH by discussing its theoretical foundations in Relevance Theory and its relationship with the three conceptions previously outlined. Throughout section 4, I focus on the centerpiece of PMH, and I articulate it from a developmental perspective by discussing its consistency with key empirical findings from infant pragmatics. Finally (section 5), I argue that these findings are best explained by positing a unique cognitive mechanism for pragmatic comprehension.

2. *Kinds of modularity*

Fodor's[10] modularity hypothesis is based on the distinction between two types of cognitive systems: input modular systems, which pertain to peripheral cognition and support basic cognitive processes (e.g., vision and syntactic parsing), and central non-modular systems, which integrate information from different sources and support high-level cognitive processes (e.g., belief fixation and decision-making). Fodor's modules are domain-specific, automatic, fast, hardwired, functionally dissociable, innately specified, and "informationally encapsulated", in the sense that they draw from a limited proprietary database without being influenced by contextual factors, expectations, or beliefs. Among these properties, encapsulation is the heart of Fodorean modularity[11], and serves as an architectural constraint that marks the distinction between peripheral and central cognition: insofar as informational integration and globality of processing are negatively correlated with encapsulation (hence, modularity), central cognition, which requires both, cannot be modular.

Along the intentional-inferential view, pragmatic inference is conceived as a context-dependent process of fixing a belief about the speaker's intended meaning and is thus a bad candidate for Fodorean modularity: "[s]ince there is no principled restriction on the type or source of contextual information used in constructing hypotheses about the speaker's meaning, the process would be global in Fodor's sense"[12]. Overall, there was no room for convergence between the modular and the intentional-inferential views within Fodor's modular mind[13].

[10] *Ivi*.

[11] J.A. Fodor, *The Mind Doesn't Work That Way*, MIT Press, Cambridge 2000, p. 63.

[12] D. Wilson, *New directions for research on pragmatics and modularity*, cit., pp. 1140-1141. For an insightful discussion about encapsulation, cognitive impenetrability, and pragmatic inference, see Nicholas E. Allott, *Encapsulation, inference and utterance interpretation*, "Inquiry", 2023, pp. 1-35.

[13] Cfr. D. Wilson, D. Sperber, *Pragmatics and Modularity*, in S. Davis (ed.), *Pragmatics: A Reader*, Oxford University Press, 1991, pp. 583-595. But see also Asa Kasher, *On the pragmatic modules: A lecture*, "Journal of Pragmatics", 16, 5, 1991, pp. 381-397, for a seminal account of linguistic pragmatics from a modular perspective.

Later conceptualizations of the modularity hypothesis overcome the sharp distinction between peripheral and central cognition, thus paving the way for investigating high-order cognitive processes from a modular perspective. Evolutionary psychologists proposed a 'massively modular' picture of the mind as composed of a network of specialized modules that evolved under selective pressure. Just as each blade of the Swiss knife is suitable to perform a specific function, each module of the mind was shaped by natural selection to deal with specific adaptive problems[14]. The evolutionary perspective substantially departs from Fodor's view. Mental modules are defined "by the specific operations they perform on the information they receive, rather than by a list of necessary and sufficient features"[15], and are largely conceived as *evolved adaptations*, namely, domain-specific computational mechanisms tailored to solve adaptive problems across human evolution. This consistently loosened Fodor's constraints on the notion of "mental module", thus marking the shift from an architectural to a *functional* conception of modularity. Domain-specificity (i.e., the property of being specialized to process specific classes of inputs) is entailed by the functionalist approach and is the only necessary property of modules in the massively modular mind, though other Fodorean properties are variably (and often inconsistently) invoked by massive modularity theorists[16].

The evolutionary-functionalist approach strongly influenced early developmental research on mind-reading[17], and the shift to the modular view of pragmatics in Relevance Theory went along with Sperber's[18] involvement in the massive modularity debate. However, the fact that the notion of modularity lacks univocal treatment within the functionalist approach, makes it difficult to pin down a specific framework against which to evaluate PMH[19]. If pragmatics is not a Fodorean module, which kind of module would it be?

[14] Leda Cosmides, John Tooby, *Beyond intuition and instinct blindness: Toward an evolutionary rigorous cognitive scienc*e, "Cognition", 59, 1994, pp. 41-77.

[15] H. Clark Barrett, Robert Kurzban, *Modularity in cognition: Framing the debate*, "Psychological Review", 113, 3, 2006, p. 629.

[16] For a discussion, see Giordana Grossi, *A module is a module is a module: Evolution of modularity in Evolutionary Psychology*, "Dialectical Anthropology", 38, 3, 2014, pp. 333-351. For an overview of the main commonalities between different massive modularity accounts, see H.C. Barrett, R. Kurzban, cit.

[17] Simon Baron-Cohen, *Mindblindness*, Cambridge, MIT Press, 1995; Philip Gerrans, *The theory of mind module in evolutionary psychology*, "Biology & Philosophy", 17, 3, 2002, pp. 305-321.

[18] D. Sperber, *Modularity and Relevance: How Can a Massively Modular Mind Be Flexible and Context-Sensitive?*, in P. Carruthers, S. Laurence, S. Stich (Eds.), *The Innate Mind*, Oxford University Press, 2005 (pp. 53-68).

[19] For a discussion see Marco Mazzone, *Pragmatica e Modularismo*, in F. Domaneschi, V. Bambini (a cura di), *Pragmatica Sperimentale*, Bologna, Il Mulino, 2022, pp. 247-258.

Drawing on Samuels[20] and Gerrans[21], I propose to disentangle three distinct but related conceptions of modularity that are often intertwined in evolutionary psychology. These conceptions articulate the notion of functional specialization at the basis of the massive modularity approach along three explanatory directions:

- *Epistemic conception*: modules are domain-specific bodies of knowledge. They are functionally specialized to the extent that they evolved to solve ancestral adaptive problems.
- *Algorithmic conception*: modules employ domain-specific algorithms. They are functionally specialized to the extent that they exploit specific procedures tailored to the regularities of their input domain.
- *Hardware conception*: modules are neurocognitive mechanisms with distinct neural realizations. Their algorithmic-functional specialization is implemented at the neural level.

The thread linking the three conceptions is the notion of domain specificity: it is part and parcel of the Epistemic and Algorithmic conception, and it is presupposed by the Hardware conception. Still, the three conceptions undertake different explanatory and theoretical commitments. The Epistemic conception aims at providing plausible evolutionary hypotheses about the adaptive challenges that bore on the selection of a modular adaptation throughout phylogeny; however, it is noncommittal to the architectural features of modules. By contrast, the Hardware conception entails that modules are localizable in the brain and functionally dissociable. The Algorithmic conception focuses on the analysis of the algorithmic procedures, or processing mechanisms, that are exploited by a posited module to process inputs from its proprietary domain. In this case, too, none of Fodor's features but domain specificity is necessarily required by algorithmic modules, but whether a given module has any of these features is an open empirical question[22]. Keeping in mind this threefold distinction between modularity conceptions will be useful for properly understanding the Hypothesis.

[20] Richard Samuels, *Evolutionary Psychology and the Massive Modularity Hypothesis*, "The British Journal for the Philosophy of Science", 49, 4, 1998, pp. 575-602.

[21] P. Gerrans, *The theory of mind module in evolutionary psychology*, cit.

[22] For an analogous conception of modularity based on the necessity of domain-specificity at the expense of other properties (included encapsulation), see Max Coltheart, *Modularity and Cognition*, "Trends in Cognitive Sciences", 3, 3, 1999, pp. 115-120.

3. *The Pragmatics Module Hypothesis*

The foundations of the Hypothesis rely upon Sperber and Wilson's theory of ostensive communication, according to which communicators provide evidence of their intended meanings by way of ostensive stimuli, and addressees work these meanings out through mentalistic inferences[23]. Ostensive stimuli express a communicative intention (that is, a second-order informative intention), and the addressee's inferential interpretation of an ostensive stimulus leads to the attribution of a communicative intention to the communicator; crucially, this mentalistic attribution underlies the interpretation of any kind of attended ostensive stimulus, being it linguistic or not. Relevance Theory considers intention attribution as part and parcel of the pragmatic interpretation of utterances, in particular, and of ostensive stimuli, in general, and the mentalistic character of pragmatic inferences grounds Sperber and Wilson's[24] proposal that pragmatic comprehension involves a sub-module of mind-reading.

A methodological assumption behind PMH is that mind-reading is underpinned by "a set of special-purpose mechanisms or sub-modules attuned to regularities in narrower domains"[25], rather than by a monolithic capacity. Baron-Cohen[26] put forth this assumption with a modular account of mind-reading which distinguishes multiple cognitive mechanisms subserving the computation of different kinds of mental states, such as the 'Intentionality Detector' and the 'Theory-of-Mind Mechanism', respectively tailored to the attribution of volitional and epistemic states. Broadly speaking, Sperber and Wilson's[27] proposal aimed at fitting the pragmatics module within a multi-component 'Mindreading System' akin to Baron-Cohen's, i.e., a cognitive mechanism specifically tailored to the attribution of communicative intentions[28].

How should we conceive the relationship between Relevance Theory and the three conceptions of modularity previously outlined? Let us move by dismissing the Hardware conception, for which modules are localizable in the brain. Relevance Theory is primarily concerned with providing a cognitive psychological account of the information-processing mechanisms underlying pragmatic comprehension at the sub-personal *behavioral* level of analysis, while not specifying any implementational account of the neurocognitive

[23] D. Sperber, D. Wilson, *Relevance*, cit.

[24] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, cit.

[25] D. Wilson, *New directions for research on pragmatics and modularity*, cit., p. 1138.

[26] S. Baron-Cohen, *Mindblindness*, cit.

[27] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, cit.

[28] This raises the (still open) question about the relationship between the purported pragmatics module and the other mind-reading mechanisms. For a take on this point in light of data from clinical pragmatics, see Diana Mazzarella, Ira Noveck, *Pragmatics and mind reading: The puzzle of autism*, "Language", 97(3), 2021, e198-e210.

mechanisms that realize pragmatic processes in the brain[29]. In this sense, relevance theorists are not necessarily committed to the Hardware conception.

A pragmatics module along the Epistemic conception was initially advanced by Sperber[30] as the corollary of an argument for language evolution from non-linguistic forms of ostensive communication, which, in turn, emerged as an exaptation from advanced metapsychology. According to a recent version of this view[31], ostensive communication evolved in a partner-choice social ecology where cooperative means for manipulating others' mental states and complementary inferential skills of social vigilance gained adaptive value, and it was made possible by the sophisticated capacity for "recursive mind-reading"[32] that is needed to attribute full-blown communicative intentions (that are, second-order intentions)[33]. Prolonged recursive mind-reading favored the emergence of a dedicated cognitive mechanism that made ostensive communication operate more efficiently. Without delving into the details of this account, it is worth noticing for our discussion that relevance theorists often describe the pragmatics module as an evolved adaptation that facilitated the recursive mentalistic processes required for fully participating in ostensive communication,

[29] Robyn Carston, *Thoughts and Utterances: The pragmatics of explicit communication*, Oxford, Blackwell, 2002, pp. 1-12. Specifically, Carston draws upon Dennett's distinction between personal and sub-personal levels of analysis, the former explaining human action according to a wide pattern of rational activity, the latter focusing on the level of the underlying psychological mechanisms (Daniel Dennett, *Content and Consciousness*, Routledge, London 1969). At the sub-personal level, she further distinguishes between behavioral analyses in terms of information-processing mechanisms, and implementational analyses in terms of underlying neural activity.

[30] D. Sperber, *Metarepresentations in an Evolutionary Perspective*, in D. Sperber (ed.), *Metarepresentations: A Multidisciplinary Perspective*, Oxford University Press, 2000; Gloria Origgi, D. Sperber, *Evolution, communication and the proper function of language*, in P. Carruthers, A. Chamberlain (Eds.), *Evolution and the Human Mind*, Cambridge University Press, 2000, pp. 140-169.

[31] Christophe Heintz, Thom Scott-Phillips, *Expression Unleashed: The evolutionary and cognitive foundations of human communication*, "Behavioral and Brain Sciences", 46, e1, 2023.

[32] T. Scott-Phillips, *Speaking our Minds*, Basingstoke, Palgrave Macmillan, 2015.

[33] According to D. Sperber, *Metarepresentations in an Evolutionary Perspective*, cit., pp. 117–138, the attribution of full-blown communicative intentions requires entertaining a fourth-order metarepresentation, whose analytical complexity is appealed to as an argument supporting the existence of a pragmatics module that computes high-order metarepresentations in communication. This account has important limitations on developmental grounds, and the lack of evidence on children's advanced metarepresentational abilities precludes the possibility of reconciling empirical data with (Epistemic) PMH. Minimalist alternatives about the mentalistic burden of early ostensive communication have been provided (e.g., Richard Moore, *Gricean Communication and Cognitive Development*, "The Philosophical Quarterly", 67(267), 2017 pp. 303–326; Nima Mussavifard, *Metarepresenting in Communication*, "Synthese", 202(168), 2023). The Algorithmic modularity view defended in this paper can be further articulated along with a minimalist analysis of communicative intentions (much in line with Juan Carlos Gómez, *Mutual awareness in primate communication: A Gricean approach*, in S. T. Parker, R. W. Mitchell, M.L. Boccia (Eds.), *Self-Awareness in Animals and Humans*, Cambridge University Press, 1994, pp. 61-80). Due to space constraints, I postpone the discussion of this issue to a later occasion.

thereby fulfilling the explanatory requirement of the Epistemic conception of modularity. Evolutionary arguments about adaptive problems, though, are difficult to extend on developmental grounds straightforwardly and therefore beyond this paper's purposes.

The centerpiece of Sperber and Wilson's proposal is best captured by the Algorithmic conception of the pragmatics module[34], and it is based on the claim that pragmatic inference is underpinned by a domain-specific algorithmic procedure for processing ostensive stimuli, also called "relevance-guided comprehension procedure":

a. Follow a path of least effort in computing cognitive effects by testing interpretative hypotheses in order of accessibility;
b. Stop when your expectations of optimal relevance are satisfied[35].

The application of this comprehension procedure is justified by the fact that ostensive stimuli exhibit a specific regularity, namely, they communicate a "presumption of optimal relevance" (i.e., the Communicative Principle of Relevance[36]), in the sense that they are assumed to be (1) sufficiently relevant to be worth the addressee's attention, and (2) the most relevant ones compatible with the communicator's abilities and preferences[37]. In other terms, by producing an ostensive stimulus that attracts the addressee's attention, the communicator invites the addressee to presume that the stimulus will satisfy the addressee's expectation of relevance; accordingly, the addressee accesses possible interpretations of the stimulus by following the least effort path and retains the interpretation that satisfies her occasion-specific expectations of relevance[38]. Crucially, the relevance-guided comprehension procedure works as a 'fast and frugal heuristic'[39], namely, a non-demonstrative inferential process that automatically accomplishes a certain task in an efficient

[34] See also R. Carston, *Relevance-theoretic pragmatics and modularity*, "UCL Working Papers in Linguistics", 9, 27., 1997; D. Mazzarella, *Pragmatics, Modularity and Epistemic Vigilance*, "Argumenta", 1, 2, 2016, pp. 181–193; D. Mazzarella, I. Noveck, *Pragmatics and mind reading*, cit.; D. Wilson, *New directions for research on pragmatics and modularity*, cit.; D. Wilson, D. Sperber, *Relevance Theory*, in L.R. Horn, G. Ward (eds.), *The Handbook of Pragmatics*, Blackwell, 2004, pp. 607-632.

[35] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, cit., p. 18.

[36] D. Wilson, D. Sperber, *Relevance Theory*, cit., p. 612.

[37] D. Sperber, D. Wilson, *Relevance*, cit., pp. 266-278.

[38] "Relevance" is technically understood as a property of inputs to cognitive processes, and it is defined as a cost-benefit notion: the greater the cognitive benefits gainable from processing an input, the greater its relevance; the lesser the processing effort needed to gain these benefits, the greater the relevance. For a detailed analysis, see D. Wilson, D. Sperber, *Relevance Theory*, cit.

[39] Gerd Gigerenzer, Peter M. Todd, the ABC Research Group, *Simple Heuristics that Make us Smart*, Oxford University Press, 1999.

(though error-prone) way, while granting economy of processing effort[40]. The relevance-guided heuristic spells out the domain-specific algorithm that is automatically applied to process ostensive stimuli, and it is tailored to the regularity of this specific input domain, thereby fulfilling the explanatory requirement of the Algorithmic conception of modularity.

To summarize, the pragmatics module takes as input an ostensive stimulus, delivers as output an interpretative hypothesis about the communicator's intended meaning, and is underpinned by an inferential heuristic guided by expectations of optimal relevance. Evolutionary considerations about the adaptive value of a dedicated mechanism for pragmatic comprehension (i.e., Epistemic modularity) frequently go along with PMH, but the centerpiece of Sperber and Wilson's proposal relies on the automatic application of the relevance-guided heuristic to ostensive stimuli, which articulates PMH from an Algorithmic modularity perspective. How can this algorithmic view be fruitfully extended on developmental grounds?

4. *An early developing pragmatics module*

To spell out the conceptual and empirical implications of PMH on developmental grounds some preliminary remarks are needed. First, the relevance-guided heuristic is generally discussed in Relevance Theory in relation to utterance interpretation, but it is assumed to be recruited, with some caveats, for the processing of any attended ostensive stimulus. As for linguistic utterances, the "testing of interpretative hypotheses" in clause (a) (cf. sect. 3) refers to the reconstruction of the explicit and implicit meanings by way of disambiguation, pragmatic enrichment, and implicature derivation, *inter alia.* Pre- and proto-linguistic children lack the lexical knowledge to fully draw on these linguistic pragmatic processes. However, data from infant pragmatics, as will be shown, can be brought to bear on the hypothesis that non-linguistic ostensive behaviors are spontaneously processed through inferential heuristics guided by context-specific relevance expectations – that is, the core tenet of Relevance Theory. This body of data will thus be the focus of our investigation throughout the next sections.

Second, against the backdrop of the Algorithmic conception, the pragmatics module is *domain-specific* to ostensive stimuli, i.e., it is specialized to process *only* stimuli belonging to this input domain. Since the class of ostensive stimuli is quite heterogeneous (cf. sect. 1), we must preliminarily constrain it by specifying some criteria for characterizing a given stimulus as

[40] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, cit.

ostensive or not. Drawing on Sperber and Wilson[41], we can technically define ostensive stimuli as behaviors designed and intentionally performed by the communicator to (i) attract the audience's attention, and (ii) prompt the audience's inference towards the conveyed informative content. Furthermore, ostensive behaviors regularly (iii) convey a presumption of optimal relevance, as entailed by the Communicative Principle of Relevance (cf. sect. 3). Thus, we will take (i), (ii), and (iii) as defining criteria for a given behavior to belong or not to the class of ostensive stimuli.

Now, arguing for a domain-specific algorithmic module for ostensive behaviors amounts to claiming that a specific processing mechanism is recruited to selectively respond to behaviors that jointly fulfill (i), (ii), and (iii). This entails, by Hypothesis, that the pragmatics module would 'recognize' ostensive behaviors as such, and its underlying functioning would be evidenced by spontaneous behavioral responses that somehow reflect this recognition. Specifically, the operations of the pragmatics module would be evidenced by spontaneous behavioral responses showing that ostensive behaviors

(a) attract the recipient's attention;
(b) prompt the recipient's inference toward the conveyed content;
(c) elicit the recipient's expectations of relevance;

whereas analogous responses would not be jointly elicited by non-ostensive behaviors[42]. In sum, empirical data showing the behavioral responses (a), (b), and (c) in the presence of ostensive behaviors, and concurrent lack of such responses to non-ostensive behaviors, would evidence the underlying functioning of a cognitive mechanism *specialized* for processing ostensive stimuli, thus vindicating PMH on empirical grounds. Accordingly, my survey of the data from infant pragmatics will be directed at presenting empirical studies showing that ostensive behaviors (a) attract infants' attention, and (b) prompt infants' inferences toward the conveyed content by (c) eliciting expectations of relevance. While discussing these findings, I will spell out a threefold graded distinction between relevance expectations that guide infants' communicative understanding, thus highlighting the nature and the scope of early pragmatic inferences. Then, I will argue that, from an Algorithmic modularity perspective, such data are best explained by positing a pragmatics module specialized for ostensive stimuli.

41 D. Sperber, D. Wilson, *Relevance*, cit., pp. 151-155.

42 More specifically, (a), (b), and (c) are likely realized by two kinds of spontaneous behavioral responses: the first bringing about the receiver to preferentially attend to the ostensive stimulus over competing ones, the second prompting the receiver to infer the content conveyed on the basis of the context-specific expectations of relevance raised by the stimulus. Thanks to an anonymous reviewer for prompting me to clarify this point.

4.1. *Preferential attention toward ostension*

A compelling hypothesis on the role of ostension in infancy comes from Csibra[43], who argues that young infants are endowed with a hardwired "ostension detector" rendering them strongly responsive to *ostensive signals* such as eye contact, infant-directed speech (or 'motherese'), and contingent responsivity. Ostensive signals have the function of marking an action as communicative[44], and directly specify their target as the addressee of the communicative act.

Infants' attentional responsiveness to ostensive signals is nowadays corroborated by a wealth of empirical studies[45]. Preference for eye contact over averted gaze is found in newborns[46], and it goes along with active enjoyment in maintaining it and discontent with breaking it[47]. Preference for motherese over adult-directed speech is already present at birth[48], it is corroborated by multi-lab studies[49], and it is cross-culturally complemented by caregivers' tendency to shift to motherese whenever they address infants[50]. Contingent responsivity and alternated response patterns emerge precociously in mother-infant interactions[51], and several studies show that infants prefer and try to prolong contingent interactions[52]. Altogether, these findings show that young infants preferentially attend to the source of an ostensive signal, thus providing empirical evidence that ostensive stimuli (a) attract infants' attention. In other

[43] G. Csibra, *Recognizing Communicative Intentions in Infancy*, "Mind & Language", 25, 2, 2010, pp. 141-168.

[44] See N. Mussavifard, *Metarepresenting in Communication*, cit.

[45] For a systematic review, see G. Csibra, *Recognizing Communicative Intentions in Infancy*, cit.

[46] Teresa Farroni, G. Csibra, F. Simion, M. H. Johnson, *Eye contact detection in humans from birth*, "Proceedings of the National Academy of Sciences", 99, 14, 2002, pp. 9602-9605.

[47] Sylvia M.J. Hains, Darwin. W. Muir, *Infant Sensitivity to Adult Eye Direction*, "Child Development", 67, 5, 1996, pp. 1940-1951.

[48] Robin P. Cooper, Richard N. Aslin, *Preference for Infant-Directed Speech in the First Month after Birth*, "Child Development", 61, 5, 1990, pp. 1584-1595.

[49] The ManyBabies Consortium, *Quantifying Sources of Variability in Infancy Research Using the Infant-Directed-Speech Preference*, "Advances in Methods and Practices in Psychological Science", 3, 1, 2020, pp. 24-52.

[50] Elise A. Piazza, Marius C. Iordan, Casey Lew-Williams, *Mothers Consistently Alter Their Unique Vocal Fingerprints When Communicating with Infants*, "Current Biology", 27(20), 2017, pp. 3162-3167.

[51] S. Dominguez, E. Devouche, G. Apter, M. Gratier, *The Roots of Turn-Taking in the Neonatal Period*, "Infant and Child Development", 25, 3, 2016, pp. 240-255.

[52] Lynne Murray, Colwyn Trevarthen, *Emotional regulation of interactions between two-month-olds and their mothers*, in T. Field, N. A. Fox (eds.), *Social perception in infants*, Ablex, Norwood 1985, pp. 177-197; A. Henning, T. Striano, *Infant and Maternal Sensitivity to Interpersonal Timing*, "Child Development", 82, 3, 2011, pp. 916-931.

words, ostensive signals effectively function as *acts of address*[53] for prelinguistic infants, who recognize being the intended targets of communication and readily direct their attention toward communicators[54].

Ostensive communication seems already at work in early infancy, but data on infants' attention biases towards ostension are yet undetermined to support PMH. In addition, we need evidence that ostensive behaviors (b) prompt infants' inferences toward the content by (c) eliciting their expectations of relevance. Csibra's account of the cognitive mechanisms underlying the processing of ostensive behaviors provides a fruitful framework to navigate extant data from infant pragmatic research.

4.2. *Early relevance expectations*

According to Csibra, ostensive signals "create a shortcut for triggering inferential processes that would interpret accompanying actions of the same source"[55]. Being addressed by an ostensive signal would thus set out favorable conditions for gathering evidence to infer the content of the informative intention. From the perspective of the underlying cognitive mechanisms, detecting ostension and inferring the content can be temporally and procedurally separated, but they are *bound* together: ostension triggers interpretative inferences constrained by specific pragmatic expectations that are selectively elicited when infants are addressed ostensively. By reviewing some empirical studies on infants' interpretation of ostensive-referential behaviors, I suggest that these early pragmatic expectations can be understood as different declinations of more general expectations of relevance about the content communicated.

First, ostensive stimuli trigger expectations of *local* relevance in young infants[56], namely, expectations that the target referent of an ostensive-deictic act is worth the addressee's attention[57]. Several studies show that when a po-

[53] R. Moore, *Gricean Communication and Cognitive Development*, cit.

[54] It is widely debated in the literature whether early responsiveness to ostensive signals reveals infants' capacity to recognize full-blown "communicative intentions" (i.e., second-order informative intentions; see G. Csibra, *Recognizing Communicative Intentions in Infancy*, cit.; J.C. Gómez, *Mutual awareness in primate communication: A Gricean approach*, cit.; R. Moore, *Gricean Communication and Cognitive Development*, cit.; Antonio Scarafone, *What would it be like for prelinguistic communication to be Gricean?*, "Language & Communication", 90, 2023, pp. 82-94). The modular view put forth in this paper shares the concerns of more deflationary positions on the issue which consider available developmental data undetermined for demonstrating a full grasp of communicative intentions (cfr. footnote 33).

[55] G. Csibra, *Recognizing Communicative Intentions in Infancy*, cit., p. 144.

[56] György Gergely, Pierre Jacob, *Reasoning about Instrumental and Communicative Agency in Human Infancy*, "Advances in Child Development and Behavior", 43, 2012, pp. 59-94.

[57] These are also called "referential expectations" in the literature (G. Csibra, cit.). The proposed rephrasing in terms of relevance expectations is motivated by the fact that ostensive-deictic acts

tential deictic behavior (e.g., gaze-shifting) is preceded by ostensive signals, infants expect to find something at the location where the source's gaze is directed, as manifested by gaze-following responses. For instance, in Senju and Csibra's eye-tracking study[58], 6-month-old infants were presented with video stimuli starting with an adult looking down at a table, followed by an attention-getting phase, and ending with the adult's gaze shifting toward one of two toys placed on either side. The experimental manipulation occurred in the attention-getting phase: in the ostensive condition, the adult looks into the camera and raises her eyebrows before looking at one of the objects. In the non-ostensive condition, the infant's attention is caught by a moving cartoon appearing on the adult's head, before she turns toward the toy. Results show that infants are significantly more likely to follow the adult's gaze shift and to look at the target toy in the ostensive condition, as compared to the non-ostensive one. In a second experiment, the attention-getting event occurs simultaneously with a vocal greeting, either in motherese (ostensive) or in adult-directed speech (non-ostensive). Again, infants follow the adult's gaze in the ostensive condition and not in the non-ostensive one, thus showing that both visual and auditory ostensive signals strongly affect infants' tendency to follow referential gaze-shifting. These results have been corroborated by larger-sample multi-lab studies[59], and replicated with young infants from non-Western populations less prone to face-to-face interactions with babies[60]. In sum, expectations of *local* relevance assist the grasping of the communicator's referential intention to direct the addressee's attention toward a target object, thereby bringing infants to attentively focus on it. Enhanced gaze-following in ostensive conditions with young infants provides evidence for the precocious manifestation of this kind of expectation.

Second, ostensive-referential communication triggers expectations of *episodic* optimal relevance, that is, expectations that ostensive stimuli convey relevant and useful information in the episodic context of cooperative joint activities[61]. Studies on infants' interpretation of informative pointing provide

pre-empt the audience's attention to preferentially focus on a target object, thus functioning as cues for presumed relevance.

58 Atsushi Senju, G. Csibra, *Gaze Following in Human Infants Depends on Communicative Signals*, "Current Biology", 18, 9, 2008, pp. 668-671.

59 Krista Byers-Heinlein *et al.*, *The development of gaze following in monolingual and bilingual infants: A multi-laboratory study*, "Infancy", 26(1), 2021, pp. 4-38.

60 Mikolaj Hernik, Tanya Broesch, *Infant gaze following depends on communicative signals: An eye-tracking study of 5- to 7-month-olds in Vanuatu*, "Developmental Science", *22*, 4, 2019, pp. 1-8.

61 The notion of *episodic* optimal relevance extends Gergely and Jacob's (cit., p. 75) notion of *local* relevance, which "enables [*infants*] to determine the intended referent of the communicator's deictic referential act required for fulfilling the shared episodic goal". The two notions slightly diverge in scope. Determining the referent of the communicator's deictic act may not be enough to understand the episodic information conveyed through it (see T. Behne *et al.*, cit., p. 498). For this

evidence for the emergence of this expectation during the second year of life. Behne, Carpenter, and Tomasello engaged 14- and 18-month-olds in a cooperative hide-and-search game where they had to find a toy in one of two buckets[62]. In the familiarization trials, the experimenter visibly places the toy in one of the buckets and encourages the child to search for it. In the experimental trials, the experimenter conceals the hiding process to the child and points toward the toy's location in different ways depending on the condition. In the ostensive condition, the pointing gesture is accompanied by eye contact, raised eyebrows, and alternated gaze between the child and the bucket. In the non-ostensive condition, the experimenter extends her index finger toward the target bucket absentmindedly by pretending to examine her wrist. Despite the gesture's surface structure being similar across conditions, children search randomly in the non-ostensive one, while in the ostensive condition, they interpret the pointing as indicating the toy's hiding place and approach the correct bucket above chance levels[63]. This result shows that young children interpret similar deictic gestures differently depending on whether these are performed ostensively or not[64]. Overall, these studies suggest that, shortly after the first birthday[65], infants infer the content of the informative intention expressed through ostensive-referential gestures by selecting a relevant interpretation (i.e., "the toy is there") in the shared episodic context. This interpretation is "optimally relevant" because it warrants worthwhile improvements (i.e., "cognitive benefits"[66]) to infants' representation of the hide-and-search scenario for low cognitive effort, and it is presumably the most easily accessible in the cooperative context established by the experimenter during the familiarization phase. Crucially, the

reason, I distinguish "local relevance" expectations needed for identifying the intended referent (i.e., grasping the referential intention), and "episodic relevance" expectations that guide the inference to the intended content (i.e., understanding the informative intention). The proposed reading extends the notion of *local* relevance even to contexts not involving shared goals (cf. footnote 70) and allows accounting for partial (i.e., merely referential) understanding of pointing gestures.

62 Tanya Behne, Malinda Carpenter, Michael Tomasello, *One-year-olds comprehend the communicative intentions behind gestures in a hiding game*, "Developmental Science", 8, 6, 2005, pp. 492-499.

63 Similar results are observed in a second experiment which measures infants' reactions to the experimenter's gaze shifts toward the target bucket in ostensive *versus* non-ostensive conditions.

64 For analogous results, see Tiziana Aureli, Paola Perucchini, Maria Genco, *Children's understanding of communicative intentions in the middle of the second year of life*, "Cognitive Development", 24, 1, 2009, pp. 1-12; Olivier Mascaro, Ágnes M. Kovács, *The origins of trust: Humans' reliance on communicative cues supersedes firsthand experience during the second year of life*, "Developmental Science", 25, 4, 2022, e13223.

65 See T. Behne, Ulf Liszkowski, M. Carpenter, M. Tomasello, *Twelve-month-olds' comprehension and production of pointing*, "British Journal of Developmental Psychology", 30, 3, 2012, pp. 359-375, for a similar task adapted for 12-month-olds.

66 D. Wilson, D. Sperber, *Relevance Theory*, cit.

episodic relevance expectations that guide this pragmatic inference must be concurrently assisted by *local* relevance expectations which help to anchor referentially the conveyed content. Behne and colleagues' study shows that these relevance expectations are selectively prompted by ostensive-referential behaviors, while not being jointly elicited when deictic behaviors are deprived of their ostensive character.

Third, infant-directed ostensive communication elicits expectations of *enduring* relevance[67], namely, expectations that ostensive stimuli provide new and socially relevant (non-episodic) information for them to acquire, and that, as a result, can be shared by other individuals outside the preceding communicative interaction. Enduring relevance expectations are the basis of the Natural Pedagogy mechanism for social learning through ostensive communication (cf. sect. 5) and seem more prominently triggered in communicative contexts that do not involve shared episodic goals between the adult and the infant. Egyed, Király and Gergely's study with 18-month-olds provides compelling evidence for this kind of expectation[68]. In the familiarization phase, one experimenter (the demonstrator) shows two novel objects to the infant, and expresses positive emotions (e.g., joy/interest) when looking at one, and negative emotions (e.g., dislike/disgust) when looking at the other. This phase varies across two conditions. In the ostensive condition, the demonstrator addresses the infant with eye contact and name-calling in motherese before displaying the object-directed emotion. In the non-ostensive condition, the demonstrator acts as being alone without addressing the infant before or after the emotion display. In the test phase, a second experimenter (the requester) enters the scene without looking at the objects and asks the infant to give her one of the two. Results show that infants are more likely to give the requester the object toward which the demonstrator emoted positively in the ostensive condition, while they are at chance in the non-ostensive condition. Infants seem to assume that the ostensively displayed preference can be generalized to the requester, while this assumption is not licensed in the absence of ostension[69]. This study suggests that infants interpret ostensive emotional demonstrations toward a novel object as displaying an enduring pleasant/unpleasant property of the object-kind, rather than expressing the idiosyncratic preference of the demonstrator, and the presence/absence of

[67] G. Gergely, P. Jacob, *Reasoning about Instrumental and Communicative Agency in Human Infancy*, cit., pp. 74-80.

[68] Katalin Egyed, Ildikó Király, G. Gergely, *Communicating Shared Knowledge in Infancy*, "Psychological Science", 24(7), 2013, pp. 1348-1353.

[69] For similar results, see G. Gergely, K. Egyed, I. Király, *On Pedagogy*, "Developmental Science", 10(1), 2007, pp. 139-146; Christopher Vredenburgh, Tamar Kushnir, Marianella Casasola, *Pedagogical cues encourage toddlers' transmission of recently demonstrated functions to unfamiliar adults*, "Developmental Science", 18(4), 2015, pp. 645-654.

ostension appears to be crucial for disambiguating between these two interpretations. The generalization of the ostensively expressed preference to the requester shows that, in this context, emotional displays are likely interpreted as transmitting novel and worthwhile (i.e., relevant) information that helps young children navigate the social world. In sum, *enduring* relevance expectations can assist young children's interpretation of ostensive actions as vehicles of non-episodic information about socially relevant preferences that are generalizable across individuals and worth learning[70].

Another meaningful study on the effect of relevance expectations in infancy is the one by Marno and Csibra with 18-month-olds[71]. In the demonstration phase, children are introduced to a wooden device with a heart-shaped lamp in the middle and two buttons (one blue, the other red) on the two sides of the device, and they see two different experimenters (E1 and E2) who, in turns, enter the room and press three times either the red button (e.g., E1) or the blue one (e.g., E2). During E1's turn, the device emitted lights and sounds twice out of three attempts with the red button, while the blue button pressed by E2 triggered the beeping event only once. In the crucial experimental condition, E1 acts on the device without looking at or communicating with the child, whereas E2 greets the infant before pressing the button and displays excitement in an ostensive way after the only successful attempt with the blue button[72]; then, in the testing phase infants are allowed to act on the device themselves. Results show that most of them pressed the ostensively demonstrated blue button although it was less effective than the red button during the demonstration phase[73]. That is, first-hand evidence about the efficiency of two alternative methods as a function of their probability of producing an effect from the device can be overridden by ostensive emotional demonstrations, thus causing infants to opt for the less effective one. Presumably, young children interpreted the ostensive demonstration as showing the relevance of the demonstrated information and indicating which button should be pressed at the expense of consideration of efficiency. Interestingly, while the cost of choosing any of the two buttons is equal, the benefits of opting for the most effective one (quantifiable as a function of effects' probability) are higher; however, the ostensive demonstration biases children

[70] When the ostensive demonstration is directed to a target, as in Egyed and colleagues' study, *enduring* relevance expectations must be assisted by concurrent *local* relevant expectations about the intended referent to which kind-relevant information is presumed to apply.

[71] Hanna Marno, G. Csibra, *Toddlers favor communicatively presented information over statistical reliability in learning about artifacts*, "PLoS One", 10, 3, 2015, e0122129.

[72] Importantly, the order of communicative *versus* non-communicative demonstrations was counterbalanced across participants.

[73] By contrast, the proportion of children pressing the most effective red button is reversed in a baseline experiment with a different group of participants whereby both E1 and E2 act non-ostensively.

to assume they could likely gain more benefits from the least effective choice, thus providing evidence for stronger expectations of relevance prompted by ostensive communicative actions. It is unclear whether the expectations elicited in this study relate to cases of episodic or enduring relevance; most likely, they lie somewhere between expecting to get more excitement in the 'here and now' and gaining pedagogical instructions about the right way to act on novel artifacts.

Infants' interpretation of ostensive behaviors is assisted by early pragmatic expectations. According to the analysis just proposed, these can be viewed as graded declinations of general relevance expectations: local relevance expectations that bias infants' attentional focus toward target objects or situations, episodic relevance expectations about useful information in cooperative joint activities, and enduring relevance expectations about generalizable knowledge and behaviors to be learned and possibly reproduced, although the distinction between them is not cut and dried. While local relevance is evidenced in 6-month-olds' gaze-following, episodic and enduring relevance expectations are increasingly manifested during the second year of age, when children become more acquainted with triadic interactions involving objects and events in the world[74]. Crucially, the ostensive character of the deictic act (e.g., gaze shifts, pointing, demonstrations) appears to be a necessary condition for triggering such expectations in early childhood. Altogether, these studies empirically support the hypothesis that ostensive stimuli (b) prompt infants' inferences toward the content communicated by (c) eliciting expectations of relevance. In the next section, I discuss additional findings that shed further light on the nature of these early pragmatic inferences.

4.3. *Early relevance inferences*

What is the scope of young children's relevance-guided inferences? Whereas in Behne et al.'s study the inferential distance between the communicative cue (i.e., pointing to the bucket) and the intended meaning (i.e., "the toy is there") was relatively short, Schulze and Tomasello probed 18-month-olds' pragmatic inferences in a more challenging setting by increasing the distance between the ostensively-provided evidence and the content to be inferred[75]. In the familiarization phase, the experimenter (E1) and the in-

[74] Empirical studies on the "genericity bias" in imitative learning at 10 months of age (e.g., Judit Futó, Ernó Téglás, G. Gergely, G. Csibra, *Communicative function demonstration induces kind-based artifact representation in preverbal infants*, "Cognition", 117, 1, 2010, pp. 1-8) could suggest an earlier developmental pathway of enduring relevance expectations.

[75] Cornelia Schulze, M. Tomasello, *18-month-olds comprehend indirect communicative acts*, "Cognition", 136, 2015, pp. 91-98.

fant play with a "pling-machine" that produces funny sounds whenever small cubes are introduced. When no more cubes are available, the infant is guided to the opposite side of the room where there is a locked box that contains more cubes. Another experimenter (E2) shows a special key to the infant and demonstrates how to open the box with it by letting the infant practice the opening mechanism. After taking the remaining cubes from the box, E1 and the infant go back to play with the pling-machine on the opposite side, while E2 covertly fills the box with other cubes. When all cubes are introduced, E1 points this out to the infant, calls her name, and makes the special key visibly salient to the infant in different ways. In the *ostensive* condition, E1 holds the key up, alternates gaze between the key and the infant and places the key in front of her. In the *intentional* condition, E1 lets the key fall and marks this act as accidental by saying 'Oops'. Then, E1 retrieves the key and examines it quizzically without looking at the infant before placing it on the floor. In the *accidental* condition, E1 accidentally pushes the key toward the infant's direction while pointing to the pling-machine without looking at the infant or the key. Results show that half of the infants in the ostensive condition take the key, unlock the box, and retrieve further cubes to keep playing with the pling-machine, thus interpreting the ostensive showing of the special key as indirectly providing relevant information in the episodic context of the game (i.e., "here is the key; get more cubes from the locked box"). In the other two conditions, only 3 out of 40 infants used the key to open the box, despite all of them being previously familiarized with the key's function. Crucially, while the E1's actions are equally salient across conditions, ostensive signals are more likely to prompt inferences about the relevance of the showing gestures in the experimental context. This study shows that 18-month-olds can interpret ostensive showing as an indirect communicative act whose implicit meaning is relevant in the shared episodic context, thus providing further evidence about the importance of ostension in triggering early relevance-based interpretations of attended behaviors.

While the studies presented so far focus on infant-directed ostensive communication, there is indirect evidence that infants apply such relevance-based inferential heuristics also when they attend to ostensive interactions from a third-person perspective. In Tauzin and Gergely's looking-time studies, 13-month-olds are familiarized with videos showing self-propelled "flat-fishes" entities who interact in a turn-taking manner by exchanging sequences of sound triplets[76]. Then, infants see one agent (the addressee) repeatedly reaching for a ball that jumped back and forth into one of two boxes on either side of the scene. In the test phase, the addressee pushes the ball into

[76] Tibor Tauzin, G. Gergely, *Communicative mind-reading in preverbal infants*, "Scientific Reports", 8, 1, 2018, pp. 1-9.

the box and leaves without interacting with the second agent (the communicator). When only the communicator is present, the ball jumps into the opposite box; then, the addressee returns and interacts in a turn-taking way with the communicator, either via sound-sequences with varying melodic tones (variable-signals condition), or by contingently reproducing identical sounds (echo condition). After the interaction, the addressee approaches either the empty box where he left the ball or the correct one where it was just moved. Infants' looking times of these different outcomes are recorded and compared across conditions. In the variable-signals condition, infants look significantly longer (i.e., are surprised) when the addressee approaches the wrong box as compared to the correct one, while they look longer when the correct box is approached in the echo condition. This suggests that infants presumably take the contingent interaction with variable signals as providing the addressee with useful information about the new ball's location and expect the addressee to approach the correct box as a result of this informative exchange. By contrast, the turn-taking exchange of identical sounds does not trigger the inference that relevant information about the ball's location is being transmitted; hence, infants expect the addressee to search for the ball where she left it, as shown by looking times in the echo condition. This result provides indirect evidence that when infants observe ostensive contingent interactions from a third-party perspective, they draw context-based inferences about the communicated content as conveying information that is relevant in the context where a situational change related to the addressee's goal has just occurred, and they look surprised if the addressee acts in contrast with the presumed relevant information. Crucially, the variability of exchanged signals seems necessary for interpreting turn-taking interactions as involving relevant information transfer.

Taking stock, I have proposed that the hypothesis of a specialized processing mechanism for ostensive stimuli can be articulated from a developmental perspective by focusing on developmental data showing that ostensive behaviors (a) attract infants' attention, and (b) prompt infants' inference toward the conveyed content by (c) eliciting their expectations of relevance. Altogether, the studies discussed so far empirically support the hypothesis that infants spontaneously respond to ostensive stimuli according to these behavioral patterns. Crucially, these are jointly elicited only in ostensive conditions, thus supporting on empirical grounds their domain-specificity. Still, to fully vindicate PMH on developmental grounds, it remains to argue that these behavioral patterns are ultimately underpinned by a unique mental module.

5. *Pragmatics or pedagogy module?*

In developmental psychology, empirical data on early ostensive communication is typically assessed in relation to Csibra and Gergely's proposal for a Natural Pedagogy mechanism that fosters social learning in communicative contexts[77]. Natural Pedagogy fits harmoniously within Relevance Theory, but the complementarity of these two accounts raises the following question: How many cognitive modules should be posited to explain young children's behavioral responses to ostensive communication? One possibility, suggested (but not endorsed) by Moore[78], is to posit two distinct but complementary cognitive systems: the pedagogy module, responsible for detecting ostension and alerting the recipient *when* the communicator is acting upon a communicative intention, and the pragmatics module, which infers *what* the communicator is conveying via relevance-based heuristics. Here, I pursue a more parsimonious theoretical path by capitalizing on the previous sections. Preliminarily, let us briefly discuss the extent to which the two purported modules can be conceptually teased apart.

Natural Pedagogy is described as a human-specific adaptation that has facilitated the transmission of generic knowledge to naïve conspecifics. Csibra and Gergely[79] hypothesize that the birth of Pedagogy was necessitated by recursive tool-making practices in hominid groups, which required an efficient learning mechanism for transmitting unobservable knowledge about artifacts by way of ostensive-referential demonstrations of kind-relevant information, learned by naïve pupils and generalized as culturally shared. Natural Pedagogy was thus the 'cradle' of ostensive communication[80], and the "genericity assumption" was the primary bias characterizing hominids' interpretative abilities. Once the pedagogy mechanism became available, ostensive communication was extended beyond pedagogical purposes, thus providing efficient means of information transfer that eventually paved the way for language evolution. Without delving further into this evolutionary account, it is worth noticing that the pedagogy mechanism is here construed against the background of an Epistemic conception of modularity, that singles out an evolved mechanism by hypothesizing its adaptive value (e.g., tool-use) in ancestral times. This account diverges from Relevance Theory because the evolution of ostensive communication is traced back to pedagogical functions, rather

77 G. Csibra, G. Gergely, *Natural Pedagogy*, cit.

78 R. Moore, *Ontogenetic constraints on Grice's theory of communication*, in D. Matthews (Ed.), *Pragmatic development in first language acquisition*, John Benjamins, 2014, pp. 87-104.

79 G. Csibra, G. Gergely, *Natural pedagogy as evolutionary adaptation*, "Philosophical Transactions of the Royal Society", 366, 1567, 2011, pp. 1149-1157.

80 N. Mussavifard, *Metarepresenting in communication*, cit.

than cooperation and manipulation of others' mental states (cf. sect. 3[81]). Evolutionarily speaking, the purported pedagogy and pragmatics modules can be conceptually teased apart as discrete Epistemic modules posited by different evolutionary accounts, which single out different primary functions for ostensive communication. However, if we assess the pedagogy mechanism by looking at the algorithmic procedure that underpins its functioning, the two postulated mechanisms fall short of being clearly distinguishable. The main tenet grounding the Natural Pedagogy proposal is that ostensive behaviors elicit the presumption of optimal relevance in the recipient (i.e., the learner)[82]:

> This aspect of pedagogy […] is analogous to the communicative principle of relevance in verbal communication (Sperber & Wilson, 1986) in that it provides guidance for the learner in figuring out the knowledge content that he is supposed to acquire by the teacher's communication[83].

The genericity assumption which constrains the learner's interpretation of ostensive demonstrations is ultimately grounded on the presumption of optimal relevance because to fulfill its pedagogical function the relevance of acquired knowledge must be presumed and not verified by the learner. The genericity bias observed in developmental studies[84] can thus be conceived as a particular manifestation of the same interpretative heuristic guided, specifically, by expectations of *enduring* relevance about non-transient properties of novel objects. However, in contexts involving shared goals with the ostensive communicator, infants are able to interpret ostensive behaviors as vehicles of relevant episodic information[85]. From this perspective, the interpretative inference triggered by ostension can more parsimoniously be described as underpinned by the same relevance-based heuristic specialized for ostensive stimuli, whose output varies as a function of the nature of the pragmatic expectations that guide its operations according to infants' appraisal of the communicative context: *enduring* relevance about generalizable kind-related information to be acquired, and *episodic* relevance pertaining to information

[81] See also N. Mussavifard, G. Csibra, *The co-evolution of cooperation and communication: Alternative accounts*, "Behavioral and Brain Sciences", 46, e11, 2023.

[82] For a discussion on this point, see Emiliano Loria, *Learning through others. Natural pedagogy and mindreading: a possible cooperation*, Torino, Accademia University Press, 2020, pp. 24-28.

[83] G. Csibra, G. Gergely, *Social learning and social cognition: The case for Pedagogy*, in Y. Munakata, M.H. Johnson (Eds.), *Processes of change in brain and cognitive development*, Oxford University Press, 2006, p. 256.

[84] In K. Egyed, I. Király, G. Gergely, *Communicating Shared Knowledge in Infancy*, cit.

[85] In T. Behne, M. Carpenter, M. Tomasello, *One-year-olds comprehend the communicative intentions behind gestures in a hiding game*, cit.

about the 'here and now'[86]. In sum, the pedagogy mechanism which Csibra and Gergely describe as a discrete evolved adaptation on the backdrop of an Epistemic conception of modularity, can well be conceived, from an Algorithmic perspective, as underpinned by the same inferential procedure underlying the interpretation of ostensive stimuli in general, which can vary in pedagogical contexts as a function of the nature of the relevance expectations (i.e., enduring *versus* episodic) that drive its functioning[87].

Thus, how many cognitive modules should be posited to account for infants' behavioral responses to ostensive communication? In this section, I have merged the Pedagogy and the Relevance proposals under the hypothesis of a unique pragmatics module specialized for ostensive stimuli. Beyond theoretical parsimony, this account is based upon an Algorithmic conception of modularity which focuses on the actual processing mechanism (or algorithmic procedure) that underpins infants' interpretation of ostensive behaviors, rather than on the adaptive fitness of presumed Epistemic modules. According to this view, the pedagogy mechanism is ultimately underpinned by the same relevance-based heuristic that yields non-generic (i.e., episodic) pragmatic interpretations of ostensive behaviors; hence, the pedagogical function highlighted by Csibra and Gergely can well rely on the nature of the pragmatic expectations of relevance built into the pragmatics algorithmic module posited by Sperber and Wilson[88], without the necessity to postulate a different mental module.

6. *Conclusion*

Building upon Grice's idea that human communication is essentially intentional and inferential, Relevance Theory put forth a cognitive account of pragmatic comprehension that locates this capacity within the overall cognitive architecture of the human mind. In this paper, I have focused on Sperber

[86] The studies presented in this paper suggest that enduring relevance is elicited when the communicator's ostensive behavior occurs in a context that does not involve shared goals; instead, episodic relevance builds upon increasing shared motives in the familiarization phase of the task. However, the distinction between these expectations is not clear-cut (see H. Marno, G. Csiba, *Toddlers favor*, cit.; see sect. 4.2). More systematic studies that keep ostension constant while manipulating the context across conditions are needed to unravel how children distinguish cases in which the adult is communicating episodic information from cases where the adult is teaching.

[87] This conclusion is largely consistent with what is recently suggested in D. Sperber, D. Wilson, *Rethinking ostensive communication in an evolutionary, comparative, and developmental perspective*, https://doi.org/10.31234/osf.io/zp3fx, Draft May 2024.

[88] D. Sperber, D. Wilson, *Pragmatics, Modularity and Mind-reading*, cit.

and Wilson's[89] Pragmatics Module Hypothesis and argued that this hypothesis can be empirically supported by findings in developmental psychology. The Hypothesis centers upon the claim that pragmatic comprehension is underpinned by a relevance-guided inferential heuristic which is automatically and spontaneously recruited for processing ostensive stimuli (section 3). By elaborating on the domain-specificity of this purported "pragmatics module", I have spelled out the conceptual and empirical implications of the Hypothesis on developmental grounds, thus reconciling it with existing accounts of the cognitive mechanisms that support ostensive communication in infancy[90]. Specifically, I have argued that the hypothesis of a domain-specific, early-developing pragmatics module predicts that ostensive behaviors (a) attract infants' attention, and (b) prompt infants' inference toward the conveyed content by (c) eliciting their expectations of relevance, while these behavioral patterns are not jointly elicited by non-ostensive behaviors (section 4). Then, I have discussed a series of studies from infant pragmatics that support this prediction, thus shedding light on the context-specific nature of early relevance expectations (section 4.2) and highlighting the pivotal role of ostension in prompting infants' inferences toward the content (section 4.3). To conclude, I have drawn upon different conceptions of the modularity hypothesis (section 2) to argue that the reviewed data are more coherently (and parsimoniously) explained by hypothesizing a unique relevance-guided pragmatics module (section 5). The proposed account bridges theoretical approaches in cognitive pragmatics with empirical investigations on young children's proficiency with ostensive communication, thus highlighting the significance of turning to developmental research for unraveling open foundational questions in cognitive pragmatics.

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[89] *Ivi*.
[90] G. Csibra, *Recognizing Communicative Intentions in Infancy*, cit.