

RICERCHE

Psychology is – and should be – central to cognitive science

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Abstract Cognitive science is typically defined as the multidisciplinary study of mind, with the disciplines involved usually listed as philosophy, psychology, artificial intelligence, neuroscience, linguistics, and anthropology. Furthermore, these six “core disciplines” are generally regarded as having equal status vis-à-vis cognitive science. In contrast to the latter position, I argue that psychology has a special status here: it is central to cognitive science in a way that none of the other five disciplines is. I support this argument via both theoretical and empirical considerations.

KEYWORDS: Psychology; Cognitive Science; Interdisciplinarity/Multidisciplinarity

Riassunto *La psicologia è – e dovrebbe essere – al centro della scienza cognitiva* - La scienza cognitiva viene definita comunemente come indagine multidisciplinare sulla mente e tra le discipline che vi sono coinvolte vengono solitamente indicate la filosofia, la psicologia, l'intelligenza artificiale, la neuroscienza, la linguistica e l'antropologia. Queste sei “discipline fondamentali” sono generalmente considerate come aventi pari dignità nell'ambito della scienza cognitiva. A dispetto di quest'ultima posizione sosterrò, invece, che alla psicologia vada riconosciuto uno status speciale: la sua importanza per la scienza cognitiva è tale da non poter essere eguagliata da nessuna delle altre cinque discipline. A supporto di questa posizione porterò alcune riflessioni di natura teoretica ed empirica.

PAROLE CHIAVE: Psicologia; Scienza cognitiva; Interdisciplinarietà/Multidisciplinarietà

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1 What is cognitive science?

ACCORDING TO THE *STANFORD ENCYCLOPEDIA OF PHILOSOPHY*, cognitive science is «the interdisciplinary study of mind and intelligence, embracing philosophy, psychology, artificial intelligence, neuroscience, linguistics, and anthropology».¹ Exactly this definition is widely accepted, including by Wikipedia² and many other sources.³

However, one must consider here the difference between the terms “interdisciplinary” and “multidisciplinary”. Choi and Pak draw this distinction. For them, a field is *interdisciplinary* if it «analyzes, synthesizes and harmonizes links between disciplines into a coordinated and coherent whole». A field is *multidisciplinary* if it «draws on knowledge from different disciplines but stays within the boundaries of those fields».⁴

Is cognitive science meant to be interdisciplinary, or is it meant to be multidisciplinary? Nuñez, Allen, Gao and colleagues ask the same question in a different way.⁵ They approach the question via a distinction drawn by Gardner between *strong* and *weak* conceptualizations of the nature of cognitive science. According to the strong conceptualization, in cognitive science the constituent disciplines «blend together into one seamless cognitive science»: ⁶ this is *interdisciplinarity*. According to the weak conceptualization, in cognitive science the constituent disciplines «call for cooperation among the [...] member disciplines»: ⁷ this is *multidisciplinarity*. Their critique of the field, entitled *What happened to cognitive science?*, argued that cognitive science was intended to be interdisciplinary but has failed to achieve this aim:

Cognitive science has failed to move from a multidisciplinary collection of collaborations (Gardner’s weak version) to a cohesive interdisciplinary field (Gardner’s strong version) – a new science of the mind.⁸

However, the claim that cognitive science originally set out to be interdisciplinary has been disputed. Recently Gentner⁹ asked two of the founding fathers of the field, Don Norman and Allan Collins, whether they had in mind at the beginning that cognitive science was meant to have a cohesive subject matter. Both said “No”, Collins commenting «we just thought that AI and Psychology and Computational Linguistics were addressing related issues, and it would be good to have a journal that focused on the theoretical interactions between them».¹⁰ That is multidisciplinary; and indeed the title of the journal *Cognitive Science*, which was founded in 1977, has always included the subtitle *A multidisciplinary journal*.

If one respects the distinction between interdisciplinarity and multidisciplinary, then in my view the correct way of expressing the standard

definition of the field referred to above is: Cognitive science is the multidisciplinary study of mental processes. Others agree. For example, the definition by French stresses multidisciplinary. According to him, cognitive science is

an attempt to bring together researchers who are interested in a single overarching issue – how the mind works – in order to have them exchange ideas with one another. The fundamental principle of cognitive science today, one that does not involve a predefined list of interacting disciplines, [is] researchers from different fields talking to one another about the mechanisms that give rise to cognition.¹¹

Similarly, Gentner concurs:

cognitive science cannot and should not aim for a crystalized theory [...] I propose instead the metaphor of a multilingual set of people gathered to solve a common problem. It’s unlikely that the six languages will evolve into a new combined language. Rather, each person does their best to become bi- or tri-lingual so that they can learn from others. The most productive interactions are likely to be dyadic or at most triadic, and which ones will take off cannot be predicted in advance. Every now and then, some group will hit on an arena in which enormous progress can be made, possibly leading to a new subfield. And apart from the big breakthroughs, little gems of insight will come floating along at more regular intervals. This includes disagreements – discovering that a neighboring field has made assumptions that contradict one’s own can be quite enlightening.¹²

Whenever the constituent disciplines of cognitive science are listed, one typically finds the particular six listed in the *Stanford Encyclopedia* and *Wikipedia* definitions of cognitive referred to above. These are AI (sometimes referred to as computer science or computing), anthropology, linguistics, neuroscience, philosophy and psychology, and so I will refer to these six as the “core disciplines” of cognitive science. There are also other disciplines (e.g. archaeology, economics or psychiatry)¹³ which are sometimes mentioned as occasional contributors to cognitive science.

But that is not to say that *all* work in any of these six core disciplines counts as cognitive science. Work in AI that focusses on developing automatic face recognition systems is often not intended to elucidate how people recognize faces, but is meant instead to produce practical solutions to engineering problems (e.g. as a part of a passport control system). This point was made in the editorial of the very first issue of the journal *Cognitive Sciences*: «I will list examples [...] of articles which the editors will be biased against no matter how ex-

cellent they be. 1. Descriptions of intelligent systems that do not provide any insight into human¹⁴ processing». ¹⁵ The reason Collins gave for making this point is that such work «belongs exclusively to one of the established disciplines rather than to cognitive science [so] will likely be rejected by the three editors as inappropriate». ¹⁶

The same point applies to the other five core disciplines. Work in *linguistics* sometimes focusses on language as an abstract object without being specifically interested in how language-processing tasks are actually executed. Much *neuroscience* is not about the brain at all, let alone about the mind. Only one subfield of *philosophy* – philosophy of mind – is concerned with mental processes. And not all *psychology* is cognitive psychology.

Cognitive psychology is the study of mental processes, and so is cognitive science: so one might ask what the difference is between the two. The answer is: multidisciplinary. A great deal of work in cognitive psychology does not draw upon any other disciplines i.e. is monodisciplinary: when this is so, such work, in the words of Collins, quoted above, «belongs exclusively to one of the established core disciplines¹⁷ rather than to cognitive science». ¹⁸

2 What is a cognitive scientist?

A first thought: a cognitive scientist is someone with expertise in anthropology, artificial intelligence, linguistics, neuroscience, philosophy and psychology. But that is absurd, of course, because there are no such people.

A weaker version of this thought is: a cognitive scientist is someone with expertise in at least two of the six core disciplines – but even this is a mistake.

Consider the paper by Fodor, Garrett and Bever on the syntactic determinants of sentence complexity.¹⁹ One might think of this as a classic early example of work in cognitive science on the ground that when this paper was written these authors had expertise in different core disciplines of cognitive science: philosophy (Fodor), psychology (Garrett), and linguistics (Bever). They did not have notable expertise outside their own individual disciplines. Nevertheless what they were doing in this research was cognitive science.

This was so even though it does not follow, simply because its authors came from different disciplines, that this piece of research had to be multidisciplinary (i.e. meets this criterion for being cognitive science). Whether a piece of research meets this criterion can only be determined by examining the research itself. So we need to ask: Did the work reported in this paper draw upon more than one discipline?

It did. That is why it counts as a classic early example of work in cognitive science.

Scrutiny of this paper reveals that the theoretic-

cal basis of the work came from linguistics; in particular, the work used the notions of *base structure tree*, *deep structure* and *surface structure*, and these theoretical notions were drawn from (Chomskyan) linguistics.²⁰ The notions were used in developing a theory of sentence processing. This theory, derived from linguistics, was expressed in cognitive-psychological terms. It was then experimentally tested, and the techniques used in the experiments were typical cognitive-psychological ones: paraphrasing sentences and reconstructing sentences from their scrambled words. So though this work did not draw upon the discipline of philosophy (despite the fact that one of the authors of the paper was a philosopher), it was genuinely multidisciplinary, because it did draw upon two distinct disciplines: linguistics and psychology. That is why it qualifies as an example of a piece of work in cognitive science.

This argument provides an answer to the question we are considering (*What is a cognitive scientist?*), the answer being that a cognitive scientist is a person who does cognitive science i.e. who participates in and contributes to multidisciplinary research on mental processes. Whether such people themselves are expert in more than one discipline is irrelevant. It is the work such people contribute to that must be multidisciplinary, not necessarily the people themselves.

3 Cognitive psychology and cognitive science

Could there be research in which there was no involvement of cognitive psychology that nevertheless counts as cognitive science?

Imagine that a group of AI people wanted to develop a new predictive text processing system for mobile phones. It would be bizarre if they did not draw upon what linguistics has told us about semantic and syntactic constraints on sentence structure to guide them in this development, and if they did so they might well produce an effective system. Such a project would be multidisciplinary (AI plus linguistics), and it would result in a system that performs a task that human cognizers can do (namely, enhance their sentence processing by using prediction). But this would not count as a piece of work in cognitive science, because this project need not have any implications for understanding how human readers do predictive processing. If that is what the AI group had wanted to do, they would have had to draw upon what cognitive psychology has told us about this. It is because of the absence of cognitive psychology here that this hypothetical piece of work does not qualify as an example of cognitive science, even though it is multidisciplinary and even though both disciplines involved in the work are core disciplines of cognitive science.²¹

The same point can be made re any pair of cognitive science's core disciplines that excludes cognitive psychology. When linguists and anthropologists get together to study a variety of languages in exotic locations in order to investigate whether there are language universals – properties shared by all languages no matter how dissimilar they seem – the object of study here is language itself, not the mind. That is why this multidisciplinary project again does not count as an example of cognitive science.

This is a theoretical argument in support of the conclusion that (cognitive) psychology is central to cognitive science while the other five core disciplines are peripheral. But empirical support for this conclusion can also be sought – by, for example, analysing the papers published in the journal *Cognitive Science* (which according to Nuñez and colleagues is «the flagship journal of the Cognitive Science Society»)²² to obtain a picture of the current state of the art in cognitive science.

■ 3.1 *The bibliometric work of Nuñez and colleagues (2019)*

Something of this kind was attempted by Nuñez and colleagues. They adopted a bibliometric approach (rather than scrutinising the contents of the papers published in the journal, as I have done and report later in this paper). They used two bibliometric measures: the departmental affiliation of the authors of papers in the journal, and journal – journal citation patterns and environments of papers in the journal.

■ 3.1.1 *Authors' affiliations in Cognitive Science*

Nuñez and colleagues made two points from their author-affiliation data.

The first was that «Overall, data show that after 2000, less than 10% of affiliations came from departments or programs in cognitive science».²³ But such data do not show that the field of cognitive science has been changing over time (e.g. shrinking), because most work in cognitive science has not been carried out in cognitive science department, simply because there are not many such departments; indeed, if there were no departments of cognitive science at all in the world, it would not follow that no work in cognitive science is being done.

And if the number of cognitive science departments in the world's universities has indeed been shrinking, that does not mean that less and less work in cognitive science is being done, since it could equally be the case that more and more work in cognitive science is being done in departments with other affiliations – psychology departments, for example.

The second point these authors made from their analyses of the affiliation data was:

authors with psychology affiliations have continued to be consistently overrepresented among the core disciplines [...] making up more than half of the affiliations in Cognitive Science [...] In stark contrast, anthropologists and philosophers are functionally absent in the journal, accounting for just 1% and 3% of the total affiliations, respectively. Interestingly, affiliations in neuroscience are also underrepresented in the journal (7%). We also observe a small contribution from authors with affiliations in computer science (8.5%) [...] Overall, the disciplinary distribution of affiliations of Cognitive Science authors has been consistently characterized by strong lop-sidedness over the years.²⁴

What bearing do these particular bibliometric findings have on the status of cognitive science? If all of a paper's authors come from departments of psychology, does it follow that the work reported in this paper cannot count as cognitive science? Obviously not. What matters is the nature of the work reported in the paper, not what departments the authors happen to be employed by. That is why the lop-sidedness referred to in the quote above is not informative concerning the status of cognitive science.

■ 3.1.2 *Journal-journal citation patterns and environments: Scientometrics*

Nuñez and colleagues analysed the citation environments²⁵ of papers in the journal for the years 2000, 2007 and 2014. They reached the following conclusions:

For each of the 3 years examined (2000, 2017, 2014), the environment shows a dominance of psychology journals, a nearly complete lack of anthropology and philosophy journals, and a weak presence of neuroscience journals. Over the years the number of journals in the citation environment decreases and becomes less diverse.²⁶

and

In all 3 years, the journal's citation environment showed a complete lack of anthropology and philosophy journals, a weak presence of neuroscience and an overrepresentation of psychology journals. Moreover, across the analyzed period, the number of journals in the citation environment shrank by 23%. This reduction was not uniform; the environment became less diverse, as computer science and other miscellaneous journals were no longer present [... there has been ...] a decline in interdisciplinarity in both the knowledge base and audience of cognitive science's literature.²⁷

Discipline(s)	2020	2021
	N=417 papers submitted N=599 fields selected	N=393 papers submitted N=537 fields selected
Anthropology	2.3	1.5
Biology + neuroscience	8.2	9.9
AI + Computer science	9.3	10.4
Education	4.0	5.6
Linguistics	19.5	18.8
Philosophy	9.0	8.2
Psychology	47.6	45.6

Table 1. For papers submitted to *Cognitive Science* in 2020 or 2021, percentage for each field selected as a function of total number of field selections.

These bibliometric findings are, again, not informative about the status of cognitive science. All they tell us is that authors working in research in cognitive science are publishing their work more and more in psychology journals. It does not at all follow from this that research in cognitive science itself is shrinking, or changing in any way.

3.2 The bibliometric work of Cooper (2019)

At the point of manuscript submission, the journal *Cognitive Science* asks authors to select, as relevant to their paper, any number of fields (including none) from a list of nine fields (these nine fields are listed in *Table 1*). As Cooper notes, such data «provide a more accurate characterization of manuscript content and orientation than departmental affiliation». ²⁸ So Cooper carried out and reported analyses of these field choices for all submissions to the journal between August 1, 2002 and August 31, 2019. Here I report further analyses of this kind for the years 2020-2021, to enable comparisons with the data from the 2021 volume of the journal which I report in Section 3.3.

Table 1 indicates author choices of the fields of their papers for the two most recent complete years of the journal. ²⁹ This table combines data from biology and neuroscience, and from artificial intelligence and computer science, to yield the traditional six core disciplines of cognitive science, and adds a seventh discipline (education).

As reported by Nuñez and colleagues, ³⁰ psychology is much more strongly represented here

than any other discipline; and for this method of analysis, Linguistics is the second-most represented discipline. After Linguistics come AI, Neuroscience and Philosophy, with fairly similar rates of representation (in the range 8.2% - 10.4%), then Education, and lastly Anthropology.

More informative perhaps are data on the number of different fields selected for each paper upon submission. These data are shown in *Table 2*.

One thing stands out here. Although the journal refers to itself as a multidisciplinary journal, around 44% of authors chose just a single discipline as characterizing their paper. If it is correct to infer from this that around 44% of the journal's papers do not report multidisciplinary work, then that is a major departure from the strictures offered in the first issue of the journal by one of its editors, according to which monodisciplinary work «will likely be rejected by the three editors as inappropriate». ³¹

I return to this point in section 3.3. Here I will just point out that if an author chooses during the process of submission only one of the core disciplines, the inference that the paper does not draw upon any of the other disciplines is not a legitimate one. Bibliometric analyses cannot tell us what we want to know here. The only way to establish this securely is to actually read the paper.

3.3 An alternative to the bibliometric approach

I have argued that bibliometric analysis of the contents of the journal *Cognitive Science* has not

Number of fields selected	2020	2021
	N submissions = 417	N submissions = 393
0	14.1	14.8
1	44.6	44.0
2	28.8	33.1
3	9.4	6.9
4	2.2	1.0
5	1.0	0
6	0	0
7	0	0.3

Table 2. For papers submitted to *Cognitive Science* in 2020 or 2021, percentage of submissions as a function of number of fields selected.

yielded results that permit us to draw any conclusions about the state of cognitive science. What must be done is to analyse the actual content of the papers published in this journal – that is, to read them. I have done this for the most recent full volume of the journal.

A recent volume of this journal, *Cognitive Science* (2021), consists of 12 issues containing a total of 131 papers. These are listed in my *Supplementary Table 1* (ST1), indexed in the first column of that table by issue number and name of first author. In this section, I refer to these papers by issue number plus author's first name e.g. 2/Smith.

I read all of these papers so as to be able find the answers to three questions about each paper. These three questions, and the answers to them, were as follows.

Question 1: Did the paper offer any conclusions about mental processes, and if so what were these conclusions? The current *Author Guidelines* for the journal require this: they state that «*Cognitive Science* is an online journal of the Cognitive Science Society focusing on the multidisciplinary study of minds and other intelligent systems».

Column 2 of ST1 provides answers to *Question 1*. There were three papers for which I could not easily identify what conclusions about mental processes the paper was offering. These were:

5/Beekhuizen: This project sought to determine whether the ambiguity of a word and the relatedness of its senses influence its semantic representation in a detectable way by analysing the dictionary definitions of 5395 words. It was found that similarities for monosemes are higher than those of polysemes, which are in turn higher than those of homonyms. But no attempt was made to investigate whether such findings are related to human mental processing. The authors acknowledged this «While we have shown that distributional semantic representations created from natural corpora exhibit this ambiguity structure, it remains as future work to see whether the representations would show the behavioral correlates found in [computational cognitive] models». (p. 20). So this was purely a paper about linguistics.

10/Richter. According to the Abstract: «We provide a neural dynamic account for both perceptual grounding, in which relational concepts enable the attentional selection of objects in the visual array, and for the generation of descriptions of the visual array using relational concepts [...] The model points toward a neural dynamic theory of higher cognition». But nothing is said about what the model might tell us about how humans perform the relevant cognitive-perceptual tasks. So this purely a paper about AI.

11/Jing: This project analysed the Universal Dependencies corpus database to look at 6 forms of dependency in 71 languages. The Abstract says: «These findings challenge received theories of across-the-board effects of complexity on word order and word order variation and call for theoretical models that relativize effects to specific kinds of syntactic structures and dependencies». But no evidence is considered that would allow one to decide whether or not any of these specific kinds of syntactic structures and dependencies have any influences upon human language processing. So this was another paper purely about linguistics.

Thus virtually all of the 131 papers from this volume of the journal did indeed offer conclusions about mental processes.

Question 2: Did the paper draw upon the literature of more than one of the core Cognitive Science disciplines for its rationale, method and/or discussion (i.e. was it multidisciplinary)?

Column 4 of ST1 provides answers to this question. A “No” in column 3 indicates that in my judgement the paper did not draw upon more than one discipline.

There are 54 papers with a No in this column (these included all 3 papers referred to above in relation to *Question 1*): that amounts to 41% of all the papers published in this volume of the journal. If my judgement about each of these papers is correct – the judgement that the paper drew only upon one discipline – then these papers do not report work that is multidisciplinary (which confirms what is reported above in *Table 2*). Hence one might ask how they could be deemed to meet the journal's *Author Guidelines* quoted above. And one might also wonder what to make of the journal *Cognitive Science* referring to itself as *A multidisciplinary journal* if almost half of the papers it publishes are not multidisciplinary.

The remaining 77 papers (59%) all drew upon at least two of the core disciplines i.e. were multidisciplinary. The disciplines that these papers drew upon are listed in Column 4 of ST1. The representations of the core disciplines were: Linguistics 38 papers, AI 26 papers, Philosophy 18 papers, Cognitive Neuroscience 8 papers and Anthropology 6 papers – and Psychology 77 papers i.e. 100% of them. Which brings us to the third question.

Question 3: Did the paper draw upon findings from cognitive psychology for its rationale, method and/or discussion, and if so what parts of that literature were drawn upon?

Column 3 of ST1 provides my answer to this question. My judgement was that every one of the

131 published papers (which included the 3 papers referred to above in relation to *Question 1*) did draw upon findings in cognitive psychology in one way or another (no matter whether the paper was multidisciplinary or not). Column 3 provides the evidence for this claim: it gives examples for each paper of work in cognitive psychology that the paper drew upon.

In sum: Making the judgements upon which ST1 is based involved some element of subjectivity, so others making these judgements might come up with numbers differing slightly from those above. But I believe that anyone who carries out this exercise would reach the same three conclusions that I have reached, namely:

1. Virtually all of the papers in this volume of the journal offered some claims about mental processes and how they work.
2. All of the papers drew upon cognitive psychology.
3. A substantial proportion of the papers – between a third and a half – did not draw upon any discipline other than cognitive psychology, and hence were monodisciplinary rather than multidisciplinary. So something over half of the papers I surveyed reported work that was both multidisciplinary and offered conclusions about mental processes i.e. satisfied the standard definition of cognitive science with which I introduced this paper.

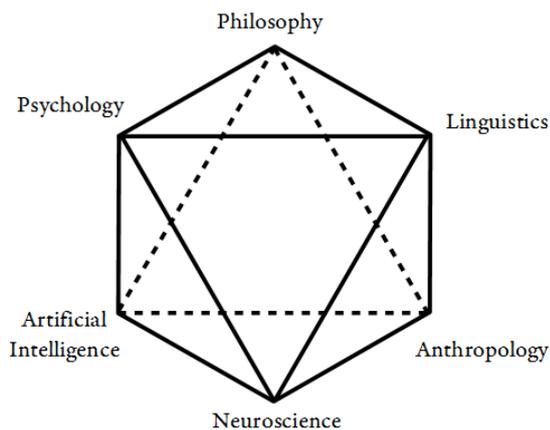


Figure 1(A). The cognitive science hexagon model

4. Conclusions

I therefore propose, for both theoretical and empirical reasons, that psychology has a different status vis-a-vis cognitive science than any other discipline, including the other five core disciplines. To count as cognitive science, a piece of work

must involve cognitive psychology. No other discipline is *necessarily* involved in this way, though there must always be *some* other discipline(s) involved (if there were not, this would be cognitive psychology, not cognitive science).

This is not at all to claim that any piece of work counts as cognitive science only if cognitive psychology *predominates* in that work: I claim only that cognitive psychology *must be present* in that work.

So what I am proposing here is that work counts as cognitive science if it is cognitive-psychological research that has been augmented (supplemented, enhanced, enriched) by taking into account and using findings from one or more of the other five core disciplines (or even other disciplines that are not one of these five).

Figure 1(A) shows the *Cognitive Science Hexagon*.³² This model is often included as an accompaniment to the kinds of definition of Cognitive Science referred to above, in the first paragraph of this paper. I am proposing a different diagrammatic representation of cognitive science, a Cognitive Science Hub and Spokes Model, as shown in *Figure 1(B)*.

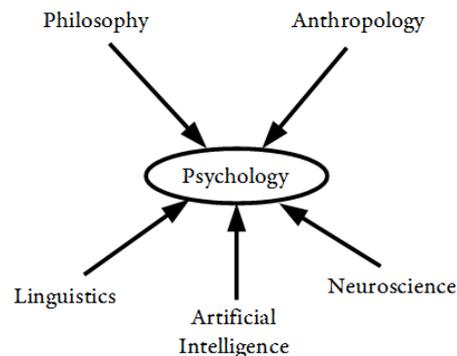


Figure 1(B). The cognitive science hub-and-spokes model

To the best of my knowledge, there are no other treatments of cognitive science which propose, as I have done here, that cognitive psychology is central to cognitive science. However, there certainly is widespread agreement that cognitive psychology happens to be represented much more strongly in cognitive science than any of the other core disciplines, and analyses reported above confirm this.

Numerous authors have expressed dismay about this state of affairs. Cooper refers to views recently expressed in the literature such as «cognitive science is being consumed by cognitive psychology»³³ and «cognitive psychology is taking control of the discipline by stealth».³⁴

Rosenbloom and Forbus consider that «cognitive science has become dominated by cognitive psychology, to the detriment of the original goals of the field».³⁵ Gentner believes that «we in the Cognitive Science movement need to take steps to prevent the “victory” of Psychology over Cognitive Science»,³⁶ and wonders «will Psychology complete its conquest of Cognitive Science?».³⁷ Re the journal *Cognitive Science* and the annual conference of the Society for Cognitive Science, Gentner considers that «Psychology has become far too dominant in the journal and the conference».³⁸ And according to Goel «although cognitive science started in the 1970s as a multidisciplinary field with the goal of becoming an interdisciplinary one over time, it is now dominated by cognitive psychology».³⁹

And in the April 2021 issue of *Cognitive Science*, the incoming chief editor, Rick Dale, had this to say: «I resonate with the concern that our multidisciplinary definition may be at risk due to entrenchment of particular research traditions. Psychology has assumed this role [...] To address these issues in 2021, the Editorial Board will be joined by two philosophers, two anthropologists, two psychologists who are also cognitive neuroscientists, and an expert on human factors and applied cognition».⁴⁰

To the authors quoted in the above three paragraphs, and others who would wish to challenge the picture I have painted of psychology's having a prioritised role in cognitive science, I pose the following two questions, one at a theoretical level and the other at an empirical level:

1. Can you offer some examples – even hypothetical examples – of work that you would count as cognitive science that does not draw at all on findings from cognitive psychology? If not, is there any other discipline that is as ubiquitous in cognitive science as cognitive psychology is?
2. If cognitive psychology does not have a special status for cognitive science, why is it that every one of the multidisciplinary papers in the most recent complete volume of *Cognitive Science* made use of findings from cognitive psychology, whereas the next most represented discipline (Linguistics) is represented in fewer than 50% of these papers?

Some examples of the practice of cognitive science as I see it:

- A cognitive psychologist completes a typical project in cognitive psychology, and then wonders: “Are my conclusions about cognition true only for people from WEIRD⁴¹ societies, or might they also hold in cultures very different from the one I studied?” *calls anthropologist*

to propose a collaboration.

- A cognitive psychologist completes the construction of a model of how people perform some cognitive task, a model in which process X precedes process Y, and then wonders whether there might be brain signatures of when X and Y are happening, and whether there are brain imaging techniques that can tell you whether X really does happen before Y in real time as the task is being performed. *calls neuroscientist* to propose a collaboration.

- A cognitive psychologist completes a very detailed single case study of an aphasic person with a semantic impairment and develops from these data a theory about the nature of semantic representations, then wonders what linguists have said on this topic: might there be linguists who have developed theoretical arguments that support or conflict with this theory about semantic representation? Or might such arguments even be used to refine or extend the theory? *calls linguist* to propose a collaboration.

- A cognitive psychologist studying word recognition wonders how people avoid confusion between sets of words composed of exactly the same letters (now/won/own; pirates/parties) and hears of a technique used in machine learning that has been successful in discriminating items that differ only in the order of their elements. This is the “string kernels” technique.⁴² *calls AI person* to propose a collaboration.

- A cognitive psychologist is interested in learning more about the nature of normal belief processes by studying pathologies of belief such as delusional conditions. The starting point is the proposal by William James that the adoption of a delusional belief is an attempt to explain an unpredicted and unusual experience. The inference from an experience to its explanation is not deductive or inductive: it is abductive. The concept of abductive inference was developed by the philosopher Charles Sanders Peirce. What did Peirce mean by this concept? *calls philosopher* to propose a collaboration.

Of course, the initiator of such multidisciplinary projects does not have to be the cognitive psychologist. The cognitive psychologist can be the person called, rather than the caller.

Acknowledgement

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Notes

- ¹ Cf. P. THAGARD, *Cognitive science*.
- ² Cf. URL: https://en.wikipedia.org/wiki/Cognitive_science.
- ³ Cf. R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *What happened to cognitive science?*, p. 783.
- ⁴ B.C.K. CHOI, A.W.P. PAK, *Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness*, p. 359.
- ⁵ R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *For the sciences they are a-changin': A response to commentaries on Nuñez et al.'s (2019) "What happened to cognitive science?"*, here p. 792.
- ⁶ H. GARDNER, *The mind's new science: A history of the cognitive revolution*, p. 389.
- ⁷ *Ibid.*, pp. 389-390.
- ⁸ R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *For the sciences they are a-changin'*, p. 800; see also R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *What happened to cognitive science?*.
- ⁹ Cf. D. GENTNER, *Cognitive science is and should be pluralistic*.
- ¹⁰ *Ibid.*, p. 887.
- ¹¹ R.M. FRENCH, *Missing the forest for the trees: Why cognitive science circa 2019 is alive and well*, p. 882.
- ¹² D. GENTNER, *Cognitive science is and should be pluralistic*, p. 886.
- ¹³ Consider here journals such as *Cognitive Neuropsychiatry*, which publishes multidisciplinary work combining philosophy and psychiatry (cf., e.g., M. COLTHEART, M. DAVIES, *Failure of hypothesis evaluation as a factor in delusional belief*), as does *Mind and Language* (cf., e.g., T. STONE, A.W. YOUNG, *Delusions and brain injury: The philosophy and psychology of belief*). *Philosophy, Psychiatry & Psychology* is a journal devoted specifically to work in the area of overlap between philosophy, psychiatry, and psychology.
- ¹⁴ The adjective "human" is unnecessarily restrictive here, if there is such a thing as (nonhuman) animal cognition – which is widely recognized (cf. the titles of journals such as *Journal of Experimental Psychology: Animal Learning and Cognition* or *Animal Cognition*). Hence cognitive science includes the study of mental processes in nonhuman animals, as indicated by the fact that studies of nonhuman animals' cognition can be found in the pages of the journal *Cognitive Science* (cf. S.M.W. WOOD, J.N. WOOD, *Distorting face representations in newborn brains*).
- ¹⁵ A. COLLINS, *Why cognitive science?*, p. 2.
- ¹⁶ *Ibidem*.
- ¹⁷ Psychology, in this case.
- ¹⁸ A. COLLINS, *Why cognitive science?*, p. 2 – italics added.
- ¹⁹ Cf. J.A. FODOR, M. GARRETT, T.G. BEVER, *Some syntactic determinants of sentential complexity. II: Verb structure*.
- ²⁰ Cf. N. CHOMSKY, *Aspects of the theory of syntax*.
- ²¹ That is not to say that every project which draws upon two or more cognitive-science disciplines automatically therefore contributes to cognitive science: such a project must in addition yield inferences about human cognition. I thank Jelle Bruineberg for draw-

ing my attention to this point.

- ²² R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *What happened to cognitive science?*, p. 788.
- ²³ R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *What happened to cognitive science?*, p. 785.
- ²⁴ *Ibidem*.
- ²⁵ The citation environment of a paper consists of the set of papers it cites plus the set of papers which cite it.
- ²⁶ *Ibid.*, p. 785-787.
- ²⁷ *Ibid.*, p. 787.
- ²⁸ R. COOPER, *Multidisciplinary flux and multiple research traditions within cognitive science*, p. 874.
- ²⁹ I am indebted to Rick Cooper for carrying out this analysis and the analysis reported in *Table 2*, and for providing me with the results of these analyses
- ³⁰ Cf. R. NUÑEZ, M. ALLEN, R. GAO, C.G. MILLER RIGOLI, J. RELAFORD-DOYLE, A. SEMENUKS, *What happened to cognitive science?*.
- ³¹ A. COLLINS, *Why cognitive science?*, p. 2.
- ³² Cf. D. GENTNER, *Cognitive science is and should be pluralistic*, adapted from the 1978 Sloan Foundation State of the Art report on cognitive science.
- ³³ R. COOPER, *Multidisciplinary flux and multiple research traditions within cognitive science*, here p. 872.
- ³⁴ *Ibid.*, p. 878.
- ³⁵ P.S. ROSENBLOOM, K.D. FORBUS, *Expanding and repositioning cognitive science*, p. 918.
- ³⁶ D. GENTNER, *Psychology in cognitive science: 1978-2038*, p. 333.
- ³⁷ *Ibid.*, p. 336.
- ³⁸ D. GENTNER, *Cognitive science is and should be pluralistic*, p. 885.
- ³⁹ A. GOEL, *A cognitive reformation*, p. 892.
- ⁴⁰ Cf. R. DALE, *The mindset of cognitive science*.
- ⁴¹ Cf. J. HENRICH, S.J. HEINE, A. NORENZAYAN, *The weirdest people in the world?*, here p. : «western, educated, industrialized, rich and democratic».
- ⁴² Cf. T. HOFMANN, B. SCHOLKOPF, A.J. SMOLA, *Kernel methods in machine learning*.

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Appendix

Supplementary Table 1

First author	Claims made re mental processes	Cognitive psychology domains drawn upon	Other disciplines drawn upon
ISSUE 1 - 10 papers			
Pyers	Inhibiting gestures reduces TOT resolution for those with weak verbal STM.	Tip of Tongue. Verbal STM. Spatial STM.	None
De Deyne	Multimodal information is important for capturing both abstract and concrete words. Fully representing word meaning requires more than purely linguistic information.	Semantic networks. Affect.	AI
Chen	Subject relatives with an inanimate head are harder to process than object relative counterparts.	Sentence processing. Surprisal / expectation.	Linguistics; AI
Jraissati	Odors are represented in local conceptual spaces.	Categorization. Conceptual spaces.	Anthropology; Linguistics
Henne	People more frequently elect norm-violating factors, relative to norm-conforming ones, as the cause of some future outcome.	Causal reasoning. Norms.	Philosophy
Goupil	Improvised vs scripted joint actions are more continuous with one another than it first seems, and they differ merely in the extent to which they rely on emergent or planned coordination mechanisms.	Goal representations. Shared intentions.	None
White	Culture and cognition have independent roles in supporting different kinds of supernatural beliefs in distinct cultural contexts.	Mentalizing. Intuitive thinking. Cognitive biases.	Anthropology; Philosophy
Pooney	Within-domain flexibility in humans derives from task representations composed of propositional rules written in terms of objects and relational categories.	Transfer learning. Reinforcement learning.	AI
Mangiarulo	Participants' judgements are deeply affected by impact though they should only depend on probability distributions over features. Dissociation between evidential impact and posterior probability increased number of errors.	Visual features. Probabilistic reasoning.	AI
Wu	Seemingly small differences in languages can cause us to describe the world in surprisingly different ways.	Language production. Referential communication.	Linguistics
ISSUE 2 - 5 papers			
Reins	People have a broader conception of lying than is usually assumed.	Research on lying and on conversational implicature.	Philosophy
Fairchild	Differences in ToM are associated with pragmatic competence in neurotypical individuals	Studies on response to underinformative sentences and on scalar implicatures, including in autism.	Philosophy; Linguistics
Zhang	Instructed hand movements – even when presented as an unrelated, secondary task – can affect students' learning of a complex concept.	Studies of role of gesture in teaching and learning. Studies related to embodied cognition.	None
Stocco	Individual differences in reward processing underpin human fluid reasoning abilities.	Research on relationship between working memory and Ravens performance and on strategies used in Ravens performance.	Cognitive neuroscience; AI
Dubey	Social information plays an important role in shaping our curiosity.	Research on curiosity, and its role in learning. Research on social influences on decision and action.	None
ISSUE 3 - 6 papers			
Hawkins	In communicative situations, people are not simply "mind-blind"; they use contextually appropriate expectations to navigate the division of labor with their partner.	Research on perspective-taking in communicative situations.	Philosophy
Freudenthal	The factors that conspire to make English verb inflection particularly challenging for learners with weak sequential learning abilities are much reduced or absent in Spanish. This provides an explanation for why learning Spanish verb inflection is relatively unaffected in children with DLD.	Specific language impairment. Developmental language disorder. Sequential learning.	Linguistics; AI
Zhang	In speech perception there is dynamic mapping of input to category representations and it is flexibly tuned according to interactive processing accommodating both lexical knowledge and idiosyncrasies of the acoustic input.	Literature on speech perception extensively used.	None
Ou	Categorization gradience may be a consistent within-individual property in speech perception. Listeners who	Literature on speech perception extensively used.	None

	show greater categorization gradience tend to adopt a buffered processing strategy, especially when cues arrive asynchronously in time.		
Garofalo	Adjectives can shape the sensorimotor activation elicited by nouns of graspable objects, highlighting that language simulation goes beyond the single-word level.	Extensive use of literature concerning how affordances derive from perception-action patterns stored in memory, resulting from consolidated and constant (or relatively constant) experiences across different contexts of hand-object interaction.	Cognitive neuroscience; Linguistics.
Van der Mijl	Assessed the role of attention in a naturalistic setting that more directly generalizes to real-world settings than typical laboratory studies.	Research on interval timing, foreperiod effects, the Attentional Gate theory, and the role of attention in timing.	None
ISSUE 4 – 22 papers			
Balzarotti	Editing density of moving images by increasing the number of cuts effectively altered viewers' experience of time.	Time perception.	Cognitive neuroscience
Yoon	Perceptions about the relevant discourse history are a key determinant of how language is used in the moment. Conversational partners form asymmetric representations of the discourse history.	Psycholinguistic studies of discourse comprehension.	None
Sun	Visual complexity is extracted efficiently and automatically, and even arouses a kind of "perceptual curiosity" about objects that encourages subsequent attentional engagement.	Behavioural work on the determinants of perceived visual complexity.	None
Luthra	There is strong evidence in favor of computational models of spoken word recognition that include top-down feedback.	Context effects in spoken word recognition and phoneme identification.	Cognitive neuroscience
Hamami	A search procedure for counterexamples, which proceeds object-wise, could underlie diagram-based geometric reasoning. Transposing points, lines, and circles to our spatial environment, the present study may ultimately provide insights into how humans reason about topological relations between positions, paths, and region.	Literature on spatial deductive reasoning and psychology of geometric reasoning.	Philosophy
Vogelzang	Cognitive capacities may constrain the acquisition of linguistic forms and their meanings in various ways.	Sentence comprehension especially pronoun comprehension.	Linguistics; AI
Martin	All of the same signature properties that accompany the outcome-to-intent shift in moral judgement in childhood characterize the "intent-to-outcome" shift obtained under cognitive load in adults.	Literature on moral judgement and its development.	None
Tasimi	Identified the mechanisms that contribute to the belief that money carries traces of its moral history.	Work in cognitive psychology on money being thought to carry traces of its moral history, especially developmental research.	None
Berent	People view psychiatric disorders as more likely to be innate and immutable when diagnosis is supported by a brain test as compared to a behavioral test. So people spontaneously essentialize psychiatric conditions that are linked to the brain, even when the brain probe offers no additional diagnostic or genetic information. This bias suggests that people consider the biological essence of living things as materially embodied.	Empirical research on two principles of intuitive psychology. Dualism and Essentialism.	None
Li	The results provide novel insights into how polysemy emerges from contextual processing of word meaning from both a theoretical and computational point of view.	Psycholinguistic work on people's ratings of semantic similarity and of context effects on reading times.	Linguistics; AI
Thorn	Human subjects are sensitive to the difference between fitted and unfitted classes and are more credulous concerning inheritance inference based on fitted classes.	Cognitive-psychological studies of concept formation.	Philosophy; AI
Duan	The efficiency of an action bounds the generalization of the action across social group members through a process that is spontaneous and implicit. This constrained action generalization may be due to inefficient actions being represented as culture-specific conventional forms.	Work on effects of group membership on categorization of individuals (stereotyping).	None
Lisson	Assuming an activation-based model, intermittent deficiencies may be the best explanation for the cause of sentence processing impairments in aphasia, although slowed syntax and lexical delayed access may also play a role.	Review of behavioural research on sentence processing impairments in aphasia. Data comparing aphasics and controls in a self-paced sentence comprehension task.	Linguistics
Kirkland	Standard textbook word problems may be able to be rewritten in ways that mitigate a "senseless" mindset.	Research on neglecting world knowledge in problem solving.	None
Kurtz	Human learners often extend the alternation pattern – a finding of critical interest given that leading theories of	Research on human category learning.	None

	categorization based on similarity or dimensional rules fail to predict this behavior.		
Perry	Iconicity not only can serve to help children identify the referent of novel words but can also support their ability to retain even noniconic word-referent mappings.	Children's word learning.	None
Annerer-Walcher	What eye parameters are best suited as indicators of internal versus external attentional focus in different settings.	Eye parameters as indices of internal vs external focus of attention.	AI
Rottman	Tree-huggers have relatively amplified tendencies to attribute mental capacities to animals and relatively reduced tendencies to attribute mental capacities to out-group members – thus having elevated rates of both anthropomorphism and dehumanization. These findings necessitate a reconceptualization of both the extension of moral worth and the attribution of minds.	Moral attitudes in childhood. Moral cognition.	None
Cassani	Words with more coherent diachronic usage patterns tend to be acquired earlier. The results support theories positing a link between ontogenetic and ethnogenetic processes in language.	Research on factors influencing AoA of words.	AI; Linguistics
Gong	Cognitive reflection, rational thinking, and normative thinking dispositions converge even in a culture that emphasizes holistic nonanalytic thinking.	CRT: research on analytic vs intuitive thought.	Anthropology
Monaghan	Iconicity is revealed as a feature of ultra-conserved words and potentially also as a property of vocabulary early in the history of language origins.	Experiments investigating production of iconicity in communicative studies. Subjects' ratings of word iconicity.	Linguistics
Aryawibawa	Balinese conceptualizes directness of causation in a similar way to speakers of languages unrelated to Balinese.	Work in which adult native speakers rated causative events in terms of four properties. Research with Balinese making grammaticality judgements.	Linguistics; AI
ISSUE 5 – 13 papers			
Saide	There is a connection between children's animistic and anthropomorphic reasoning for unobservable entities, and an indirect effect of cultural input on such reasoning.	Research on young children's application of heuristics concerning animacy and anthropomorphism. Studies of how children and adults conceptualize God and germs in terms of general psychological and physiological traits.	None
Napoli	Re sign language: once iconicity is considered, handshape and movement parameters interact at the sublexical level. Thus, consideration of iconicity makes transparent similarities in grammar across both modalities, allowing one to maintain certain key findings of phonological theory as evidence of cognitive architecture.	Phonological aspects of signing.	Linguistics
Baggio	Offers a dual-stream model of language-processing.	Evidence from animal and human research shows that memories of events may be encoded in two "formats". Research on redundant representations of items in working memory tasks. Research on idiom processing.	Cognitive neuroscience; Linguistics; AI
Beekhuizen	There is a factor influencing latencies in a speech production task: linguistic complexity, which translates as increasing processing demands when a word is merely retrieved from long-term memory when in addition it undergoes morphosyntactic computation, and in case on top of the two preceding operations, it requires phonological computation.	Experimental work on various aspects of lexical processing (lexical decision, semantic priming, sentence processing).	Linguistics
Akita	Phonation types make a considerable contribution to Japanese speakers' sound-symbolic ratings of size and shape.	Research on sound symbolism.	Linguistics
Thornton	The work indicates a unity of composition in thought and language, and identifies extensional superposition as the underlying mechanism. Relationships between linguistic and conceptual composition are identified.	Research on concepts.	Linguistics
Ludusan	Speaker variability can impair certain learning algorithms (supervised algorithms) but help other ones (unsupervised algorithms). This makes the prediction that as infants develop and become more able to exploit top-down information, speaker variability should have a progressively facilitatory effect.	Evidence on the impact of variability on robust phonetic category learning.	AI
Guo	On some measures that primarily relied on metalinguistic cues, gender concepts resembled dual-character concepts.	Research on factors affecting category membership judgement.	None

	However, on other measures that depicted transgressions of traditional gender norms, neither “man” nor “woman” appeared dual-character-like.		
Dubova	The human visual system adapts its encodings to the feature structure of the environment, uses categorical expectations for robust reconstruction, allocates encoding resources with respect to categorization utility, and adapts to prevent miscategorizations.	Research on perceptual learning and perceptual categorization.	None
Thorne	Epistemic appraisals of concepts form a psychologically important yet previously overlooked aspect of the structure of concepts.	Took inspiration from a study by Haslam, Rothschild, and Ernst (2000) on the different ways a social concept could be based on an “essence”.	Philosophy
Devitt	There are both descriptive and causal-historical elements to the reference determination of some natural kind terms. We should abandon the common assumption that any one theory of reference fits all natural kind terms.	Research on subjects judging natural kind membership under conditions of ambiguity.	Philosophy
Loos	Re sign language: what matters in echo phonology is the visual percept of temporally coordinated movement that repeats a salient movement property in such a way as to give the visual impression of a copy. Echoes are not obligatory motor couplings of two or more articulators but may enhance phonological distinctions that are otherwise difficult to see.	Research on head movements that accompany signing.	Linguistics
Speed	There are associations between the sound of a word and its odor valence.	Research indicating that emotion is a critical dimension on which we encode and understand odor.	Linguistics
ISSUE 6 – 11 papers			
Meylan	There is no cross-linguistic evidence of a stronger correlation between in-context predictability and word length than word frequency and word length.	Empirical research on Zipf’s Law as applied to human language use.	Linguistics
Benitez-Burraco	Language evolution is a multifactorial process, with each player acting upon the other, engaging in an intense mutually reinforcing feedback loop. Language evolution as a gradual process, continuous with the pre-linguistic cognitive abilities, which are engaged in a positive feedback loop with linguistic innovations, and where gene-culture co-evolution and cultural niche construction were the main driving forces.	Influences of cultural niche construction on cognition. Influence of one’s language on one’s working memory. Relationship between reactive aggression and aspects of social cognition. Impact of self-domestication on cognition.	Anthropology; Linguistics
Van Schijndel	A full explanation of syntactic disambiguation difficulty may require recovery mechanisms beyond predictability	Garden-path effects on sentence comprehension.	Linguistics; AI
Messenger	Neither immediate nor long-term priming effects differ between children and adults but both children and adults show significant immediate and persistent effects of the priming when the test phase occurred immediately after the exposure phase and when a short delay separated the exposure and test phase.	Syntactic priming effects with human speakers.	Linguistics
Levin	Eye movement studies of cognition during dynamic naturalistic stimuli show that the tyranny of dynamic stimuli is real, and that links between eye movements and cognition are highly dependent on task and stimulus properties.	Research on top-down cognitive processes influencing on eye movements.	None
Martin	There is a causal link between perceptions of “internal wickedness” and moral judgment.	Effects on social cognition of priming of essentialist thinking.	None
De Jonge-Hoekstra	This work extends the phenomenon of gesture-speech mismatches to difficult tasks in general. Aksoi shows how temporal alignment, semantic similarity, and complexity matching are related, and how they predict participants’ task performance.	Work on gesture-speech synchronization in adults and children during e.g. problem-solving.	None
Barrett	While dualist thinking is a possible mode of thought enabled by evolved human psychology, such thinking does not constitute a default mode of thought. Rather, our data support what we will call <i>intuitive materialism</i> – the view that the underlying intuitive systems for reasoning about minds and death produce, as a default, the judgment that mental states cease to exist with bodily death.	Empirical research on kinds of afterlife belief in children and adults. Intuitive physics and intuitive psychology.	Anthropology
Stanley	Results have implications for competing theoretical views on the relationship between memory and morality and for functional theories of counterfactual thinking.	People’s memories of their past moral transgressions. Episodic counterfactual thinking.	None
De Cesarei	If the visual characteristics of the environment are not learned by CNNs, their visual categorization may depend only on a subset of the visual information on which humans	Research on categorization of visually presented stimuli by humans.	AI

	rely, for example, on low spatial frequency information.		
Yu	The magnitude of the OAE differs by accent, indicating that not all “other” accents are processed in the same way. The OAE can disrupt talker recognition as severely as the LFE. While confidence is related to accuracy within a given accent, listeners’ confidence ratings do not faithfully reflect accent-based differences in talker recognition performance.	Research on influences of talker accent on talker recognition.	None
ISSUE 7 – 9 papers			
Willett	Experience-based learning over long timeframes exhibits similar strengths and weaknesses as in short timeframes. However, learning over long timeframes may become more impaired with more complex tasks.	Empirical and theoretical studies of causal learning.	None
Zhang	Children’s word learning is a continuous process by means of real-time information integration.	Studies of word learning in young children.	None
Thomas	Once people’s behavior on a set of problems has been used to establish individual-level cognitive models, the cognitive models can predict how those people would have behaved for other problems.	Research on “wisdom of the crowd” using sequential decision-making tasks	None
Abramov	Children with higher cognitive abilities convey significantly more meaning via gesture and less solely via speech. These findings suggest that young children’s use of cospeech representational gesturing is positively related to their mental representation and reasoning abilities.	Research on how speech and gesture work together	None
Cranford	We developed an instance-based learning (IBL) model of an attacker using the Adaptive Control of Thought-Rational (ACT-R) cognitive architecture to investigate how humans make decisions under deception in cyber-attack scenarios.	Research on how deception succeeds through the exploitation of human processing constraints and perceptual, cognitive, and social biases.	AI
Siew	Global feature distinctiveness is associated with earlier age of acquisition ratings, and is a stronger predictor of age of acquisition than local feature distinctiveness. These results suggest that the global structure of the semantic feature network could play an important role in language acquisition, whereby globally distinctive concepts help to structure vocabulary development over the lifespan.	Experimental studies of language development.	None
Pouw	Gestures can come to embody the linguistic system at the level of interrelationships between communicative tokens, which should calibrate our theories about form and linguistic content.	Experiments in which agents are tasked to learn a novel set of signals. These signals are iteratively transmitted to later generations and/or used in communication by later generations (iterated learning + communication), where, over many cycles of learning and use, they are affected by various transmission biases	Linguistics; AI
Capuano	Linguistic negation acts very differently from a logical operator, proving itself to be in fact highly restrictive in the suggestion of alternative scenarios: naturally produced alternatives are very similar to the negated entity.	Research on processing difficulties of negation in sentence comprehension tasks	Linguistics
Martínez-Huertas	Words with early maturation and subsequent semantic definition promote emotional propagation. Second, an interaction effect between age of acquisition and abstractness explains model performance.	Research on children’s acquisition of abstract words	AI
ISSUE 8 – 11 papers			
Gumbsch	Event-predictive learning combined with active inference may be critical for eliciting goal-anticipatory gaze behavior in infants.	Eye-tracking studies of infants watching goal-oriented actions.	AI
Myers	Finding of metrical regularity inhibiting speech production is inconsistent with an abstract metrical structure that is planned independently of phonemes at the point of phonological encoding.	Research on metrical priming in speech comprehension and production tasks.	None
Caddick	Participants were tasked with repeatedly choosing policies. Evidence of motivated reasoning is found despite financial incentives for accuracy. This research advances the field of causal learning by studying the role of prior preferences, and in doing so, integrates the fields of causal learning and motivated reasoning.	Research on motivated reasoning and on causal learning.	None
Paape	Using a self-paced reading study investigating number attraction effects in Eastern Armenian. our data are better accounted for by an encoding-based model of agreement attraction, compared to a retrieval-based model.	Empirical work on the effect of agreement attraction in sentence acceptability and sentence production tasks.	AI

Dotlacil	Develops a novel psycholinguistic parser and tests it against experimental and corpus reading data.	Research on memory in parsing focusing on the role of memory during comprehension. Modelling data from self-paced reading studies.	Linguistics; AI
Wood	Slowly changing visual experiences play a critical role in the development of human-face recognition by chicks, akin to basic-level object recognition. Thus, face recognition is not a hardwired property of vision but is learned rapidly as the visual system adapts to the temporal structure of the animal's visual environment.	Studies exploring the origins of face recognition in newborn humans. Research on effects of experience on monkeys' face recognition abilities.	Cognitive neuroscience
Hannakainen	There is cross-cultural convergence in people's understanding of the nature of law. There is a striking degree of universality in beliefs about the essential properties of law, despite abundant historical and regional variation in the way actual laws manifest.	Work on subjects reporting their moral reactions – for example, of perceived shame and wrongness – in response to hypothetical violations of outdated laws. When asked to simultaneously consider actual and possible laws, participants reported that laws often abide by the procedural principles, though it would be possible for laws to violate them.	Anthropology; Philosophy
Drenea	Both foveal and extrafoveal processing are simultaneously involved during a categorical search, and the specificity of their interaction is determined by the spatial orientation of objects, type of distractors, the prohibition to use overt attention, and individual characteristics of the participants.	Treisman feature-integration theory. Work on object semantics being processed extrafoveally and then used to guide saccadic programming in a top-down manner. Research on covert attention and on categorical search.	None
Carcassi	Monotone quantifiers are easier to learn, and are also widespread in language <i>because</i> of their learnability.	Evidence that humans find monotone quantifiers easier to learn.	Linguistics; AI
St. Pierre	To help infer the meanings of novel words, children frequently capitalize on their current linguistic knowledge to constrain the hypothesis space.	Studies of children learning the meanings of function words.	None
Richie	Modelled human judgments of similarity among cohyponyms of various categories, using various similarity metrics, which are all related to classic psychological models of similarity like common features/additive clustering, distinctive features, and multidimensional scaling.	Research on effects of similarity on various cognitive tasks and on tasks where participants are given a cue word and asked to respond with whatever words come to mind.	AI
ISSUE 9 – 10 papers			
Donnelly	The lexicons of 30-month-olds exhibit lexical-level competition, with competition increasing with vocabulary size.	Neighbourhood size effects in spoken word recognition in infants and adults.	None
Western	The name-based model of the representation of categories has superior explanatory potential with regard to concept acquisition. Illustrates the complexity of the relationship between language and the world, the acknowledgment of which is paramount to enhancing our understanding of both natural language and human cognition.	Research with experiments that collect human judgments of category relatedness and category membership	Linguistics; AI
Abudarham	Our findings validate human perceptual models of face recognition, enable us to use DCNNs to test predictions about human face and object recognition as well as contribute to the interpretability of DCNNs. The approach we used here for the study of face recognition can be similarity applied to other cognitive tasks to improve our understanding of human cognition and the interpretability of artificial neural networks.	Human psychophysical experiments revealing a subset of view-invariant facial features that are critical for human face recognition	AI
Fay	Our evolved cognitive preferences are moderated by our social goals.	Experimental studies showing that compared to positive information, negative information has a greater impact on impression formation and is more believable. Transmission chain studies <i>a la</i> Bartlett	None
Valtonen	People distort claims about the brain from the wider culture to fit their dualist belief that minds and brains are distinct, interacting entities: Exposure to cultural discourse about the brain as the physical basis for the mind prompts people to posit that mind-brain interactions are asymmetric, such that the brain is able to affect the mind more than vice versa.	Research on lay intuitive theories about the mind and the brain, and how these develop in children.	Philosophy
Karjus	People tend to colexify similar meanings with artificial languages. Speakers' communicative needs affect their lexification choices.	Research with pairs of participants faced with the task of communicating single-word messages using a small set of artificial words.	Linguistics
Goldwater	Spontaneous use of causal principles in analogy generati-	Research on the influence of expertise on	Philosophy

	on is particularly characteristic of experts.	encoding processes during problem-solving, and on analogical retrieval and generation.	
Shin	For Korean-speaking children's comprehension of a transitive construction, the Agent-First strategy is activated properly only in conjunction with other types of interpretive cues.	Studies of early acquisition of word order.	Linguistics
Kryven	People attribute intelligence based on plans given sufficient context and cognitive resources and rely on the outcome when computational resources or context are limited.	Research on factors governing humans' attributions of intelligence.	None
Lowder	Results provide important information regarding the locus of relative-clause processing effects and highlight the importance of carefully considering how intervening material might unintentionally alter the structure or the meaning of a sentence.	Psycholinguistic research on comprehension of sentences containing relative clauses.	Linguistics

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Holtgraves	Documented how the interpersonal context influences the communication process and how language users are sometimes unaware of their communication failures.	Work on miscommunication e.g. sender-receiver asymmetry in communicative confidence.	Philosophy; Linguistics
Kneer	Ordinary people are willing to ascribe deceptive intentions to artificial agents and to blame them for this.	Empirical work on the Folk's concepts of lying.	Philosophy; AI
Haward	The distinction between properties that bear principled connections to their kinds, and merely generic-supporting properties structures novel kind representations, provides strong evidence that this distinction is part of the formal structure of kind representations.	Work showing that distinction between generic-supporting and idiosyncratic/accidentally related properties emerges early in ontogenesis, reflected in the child's language and thought by at least two and a half years of age.	Philosophy
Entzmann	There is no automatic prioritization of emotional faces, at least for saccades with short latencies, but salient local face features can automatically attract attention.	Work on guidance of attention by face stimuli.	Cognitive neuroscience
Flanagan	Children and adults hold a nuanced understanding of free choice that is sensitive to both the agent type and constraints within a given scenario.	Research showing that from early in life, children understand choice as the ability to consider alternative means for achieving a goal, and to flexibly switch between these alternatives when faced with new constraints.	None
Canessa	Blind individuals show many of the same processing differences between abstract and concrete concepts found in sighted individuals, but our model shows that those differences are noticeably less pronounced than in sighted individuals.	Empirical studies of concepts using the Property List paradigm.	None
Nancekivell	Findings reveal the complexity of learning style beliefs, and how they interact with evidence in previously undocumented ways.	Research on efficacy of multimodal learning.	None
Braithwaite	Results have implications procedural knowledge, conceptual knowledge, and metacognitive processes in math problem solving.	Research on use of conceptual knowledge during problem solving.	None
Foppolo	A verb's perfective aspect triggers the culmination inference incrementally during sentence processing. This offers novel evidence for the continuous integration of linguistic processing with real-world visual information.	Research on effects of verb type on sentence comprehension.	Linguistics
Kumar	Both associative and distributional models can capture relatively unconstrained search processes in a cooperative game setting, and Connector I is particularly suited to examine communication and semantic search processes.	Research on retrieval from semantic memory.	None
Scheer	These findings may thus redound to the advantage of psycholinguistic studies by identifying two new factors, as well as produce results that speak to the linguistic quarrels.	Cognitive models of language production and evidence related to them.	Linguistics
Payir	Children appraise the likelihood of story events actually happening in light of their beliefs about causal regularities. A religious upbringing does not impact the frequency with which children invoke causal regularities in judging what can happen, even if it does impact the type of causal factor that children endorse.	Developmental research on children's grasp of the distinction between reality and pretence.	None
Richter	The model points toward a neural dynamic theory of higher cognition. This demonstrates how elements of higher cognition, including the capacity to sequentially operate on objects, to form and reject hypotheses, and to apply local networks to global representations, may be	Discusses research on how siblings establish joint attention via conversation.	AI

	grounded in sensory-motor processing.		
Banks	Results support the linguistic short-cut hypothesis in semantic processing and provide strong evidence that both linguistic and grounded representations are inherent to the functioning of the conceptual system.	Research with the category exemplar production task.	Linguistics; AI
Verosky	Generalized scale degree associations are informed by both adjacent and nonadjacent relationships between melodic notes influence listeners' melodic predictions above and beyond n-gram context, highlighting the need to consider a broader range of statistical learning processes that may underlie listeners' expectations for upcoming musical events.	Data from trained human singers performing a musical cloze task, to assess musical knowledge.	AI
Leontyev	The response time (RT) and motion-based decision tasks converge well at a fundamental level, and mouse-tracking features such as area under the curve and maximum velocity indicate the degree of decision conflict and impulsivity.	Research indicating that mouse trajectory features such as AUC (area under the curve) reveal the subject's perceptual, cognitive, and social conflicts in the decision-making process.	None
Kim	A recent study proposed a computational model that combined a model of trial-to-trial changes with a model for the internal scaling of discrete numbers. Here, we tested a surprising prediction of the model – a situation in which children's estimates of numerosity would be better than those of adults.	Developmental studies of numerical estimation.	AI
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Hoicka	High-proportion quantifiers, including generics, lead adults, and to some extent children, to generalize, but not essentialize, about novel social kinds.	Work showing that generics help adults and children learn novel information about known and novel kinds.	None
Jing	These findings challenge received theories of across-the-board effects of complexity on word order and word order variation and call for theoretical models that relativize effects to specific kinds of syntactic structures and dependencies.	Effects of sentence complexity on self-paced reading.	Linguistics
Skovgaard-Olsen	Both stances – neutrality about the antecedent in indicatives and the falsity of the antecedent in subjunctives – are conveyed by conversational implicatures.	Experimental data indicating that participants prefer indirect to direct meanings when committing problematic acts when the hearer is likely to be antagonistic and when the potential costs are high. Data indicating that participants prefer to trust speakers who implied (more technically, “implicated”), rather than explicitly said or presupposed, false information.	Linguistics
Kempe	Detection of systematic form-meaning linkages requires stable combinatorial units that can guide learners toward the structural properties of signals.	Research using Bartlett iterative communication technique.	Linguistics
Favela	Person-plus-tool systems can be classified as extended cognitive systems. A framework for quantifying system-level properties of these systems is proposed.	Results of experiments analyzing the movement dynamics of participants engaged with tools during a task centered on affordance judgments.	Philosophy
Valentini	Bilingual children exposed to English earlier have larger vocabularies and better morpho-syntactic skills.	Evidence that older children between the ages of 5 and 7 and adults too can use syntactic information to deduce the meanings of unfamiliar verbs. This provides further support for the role of syntactic bootstrapping past the earlier stages of lexical acquisition.	None
Lev-Ari	Widely spoken languages rely on different sound symbolic patterns than less common languages. Community size can thus shape linguistic forms and influence the tools that languages use to facilitate communication.	Empirical research of the effects of sound symbolism on word acquisition in children.	Linguistics
Sehl	Children do not anticipate the sunk cost bias in first person scenarios, or in interpersonal sunk cost scenarios, where costs are sunk by others. Young children may struggle to understand and predict irrational behavior.	Developmental research demonstrating that young children come to expect others to behave rationally in light of their beliefs and desires, and environmental constraint.	None
Boduch-Grabka	A cognitive factor, processing fluency, can lead individuals to distrust information when it is delivered in a foreign accent. Ensuring exposure to foreign accent can reduce discrimination against non-native speakers.	Empirical research on effects of processing fluency on information evaluation.	None

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Fitch	There are similarities and differences in the information that learners may have access to in acquiring signed versus spoken languages.	Language acquisition research on extensively on how do infants take arbitrary word forms from the input and map each onto the correct meaning and on a variety of cues that children employ, including joint attention and iconicity.	None
White	Happening is perceived at a moment and is constituted by an information structure of connected recent historical information.	Evidence that perceptual asynchronies can be corrected or recalibrated, though Errors of synchronization do occur.	None
Slooman	“Exploration” may not be a single cognitive property, but rather the emergent result of three distinct behavioral and cognitive mechanisms, namely, (a) breadth of generalization, (b) quality of prior expectation, and (c) relative valuation of self-obtained information.	Cognitive phenomena involved in social learning.	None
Berent	Mind–body interactions elicit a latent dualist dissonance in intuitive psychology.	Research on infants’ perceptual expectations. Theory of mind research.	None
Tourtour	A bounded-rational account of overspecification is proposed according to which even redundant words can be beneficial to comprehension to the extent that they facilitate the reduction of listeners’ uncertainty regarding the target referent.	Research showing that (a) In situated contexts the visual input rapidly informs listeners’ incremental language processing; (b) Contra the Gricean view – which deems only minimal specifications to be optimal – speakers do frequently overspecify.	Philosophy; Cognitive neuroscience
Biesaga	People high in the Need For Cognition can maintain cognitive motivation for a longer period and consequently on average generate more random series.	Research indicating that people cannot produce perfectly random series.	None
Dewi	These results and conclusions have important implications for learning theories because they demonstrate that a shift from counting to retrieval over training cannot be deduced from verification time differences between outside and within-count equations in an alphabet-arithmetic task.	Research showing that Some knowledge can be learnt directly and deliberately by the memorization of associations, while other knowledge can be created after repeated practice of counting procedures. In the latter case, a shift from procedural to retrieval strategies necessarily occurs during learning.	None
Loy	Speakers align with their partner’s linguistic behavior to produce overspecific or minimally specific descriptions. Little evidence that the alignment was enhanced by lexical or semantic repetition across prime and target trials.	Research on overspecification posing a problem for theories of language production that emphasize communicative efficiency.	None