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Collins's Taxonomy of Tacit Knowledge: Critical Analyses and Possible Extensions

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Résumé : Dans cet article, nous discutons et développons la taxonomie de la connaissance tacite proposée par Collins dans son livre de 2010, *Tacit and Explicit Knowledge*. Dans un premier temps, nous critiquons la définition et le nom d'une des trois catégories de connaissance tacite introduites par Collins, à savoir la connaissance tacite *relationnelle* (RTK). Après avoir expliqué quel principe fondamental individualise en fait RTK comme *une* catégorie *distincte des deux autres* catégories que sont la connaissance tacite somatique (STK) et la connaissance tacite collective (CTK), nous suggérons pour RTK un autre nom, plus en harmonie avec ce principe. Dans un second temps, nous mettons en évidence une possible ambiguïté dans l'interprétation de RTK, STK et CTK, et nous indiquons comment éviter les possibles confusions associées, notamment en introduisant plusieurs notations qui précisent celles de Collins. Les développements correspondants renforcent et spécifient un point implicitement suggéré par Collins dans son ouvrage, à savoir la forte asymétrie qui existe entre RTK d'un côté, et STK/CTK de l'autre. Dans un troisième temps, l'article s'emploie à prolonger et interroger dans de nouvelles directions la classification de Collins. Dans cet esprit, la possibilité de différents sous-types de RTK est introduite. L'un de ces sous-types pose la question d'une connaissance tacite individuelle et intellectuelle – cas qui ne semble pas avoir de place dans le cadre de Collins. La classification de Collins est également envisagée dans une perspective dynamique. Nous discutons en particulier la possibilité – non considérée par Collins – de transformations dynamiques entre certaines des trois catégories RTK, STK et CTK. Pour finir, nous faisons deux suggestions

en vue d'éviter les confusions et malentendus lors de l'utilisation des distinctions de Collins : s'agissant des affirmations selon lesquelles une connaissance *K* est explicitable, explicite ou tacite, toujours préciser *pour qui et quand* ; s'agissant des affirmations selon lesquelles une connaissance *K* est explicite ou explicitable, ne pas s'en tenir à affirmer cela *tout court*, mais toujours préciser *dans le(s)quel(s) des quatre sens* différenciés par Collins (élaboration, transformation, mécanisation, explication scientifique).

Abstract: In this paper, we discuss and extend the taxonomy of tacit knowledge proposed by Collins in his 2010 book, *Tacit and Explicit Knowledge*. First, we question the definition and the name of one of Collins's three categories of TK, namely *Relational Tacit Knowledge* (RTK). After having explained the true fundamental principle that individuates RTK as *one* category *distinct from the two others* (Somatic Tacit Knowledge STK and Collective Tacit Knowledge CTK), we suggest an alternative name for RTK, which fits this principle better. Second, our analyses identify a possible ambiguity in the interpretation of RTK, STK and CTK, and indicate how to avoid the related possible confusions. For this purpose, we introduce several notations that specify Collins's ones. The corresponding developments strengthen and specify a point implicitly suggested in Collins's book, namely the existence of a serious asymmetry between RTK on the one hand, and STK/CTK on the other. Third, the paper attempts to elaborate and complete Collins's framework. In this vein, we introduce the possibility of different sub-types of RTK. One of these sub-cases raises the issue of individual, intellectual tacit knowledge—a case that does not seem to have any place in Collins's picture. We also look at Collins's framework in a dynamical perspective, and discuss the possibility—not considered by Collins—of dynamic transformations between some of the three categories. Finally, we make two suggestions in order to avoid confusions or misunderstandings when using Collins's distinctions. When the qualities “explicit”, “explicable” or “tacit” are attributed to some knowledge, these qualities should always be accompanied by the specification *for whom* and *when*. Moreover, the attributions “explicit” and “explicable” should always indicate *which of Collins's four senses* is meant—elaboration, transformation, mechanization or scientific explanation.

1 Aim and contents

The aim of this paper is to discuss *from within* the taxonomy of tacit knowledge proposed by Harry Collins in his 2010 book, *Tacit and Explicit Knowledge* (hereafter TEK) [Collins 2010b].

In TEK, Collins divides the “territory of tacit knowledge” in three areas: Relational (or weak) Tacit Knowledge (RTK); Somatic (or medium) Tacit Knowledge (CTK); and Collective (or strong) Tacit Knowledge (CTK). To give a first rough idea of the principle that underlies Collins's taxonomy, as

well as of the content of each of its three constitutive categories, we quote Collins:

Collective Tacit Knowledge turns on the nature of the social,
Somatic Tacit Knowledge turns on the nature of the body, but
Relational Tacit Knowledge is just a matter of how particular
people relate to each other. [TEK, 86]

In the book, RTK, STK and CTK are presented as three distinct domains (although most of the time mixed empirically and hence difficult to isolate one from the other); moreover, the three domains are supposed to exhaust the whole territory of tacit knowledge. The weak, medium and strong terminology refers to the degree of difficulty encountered in attempting to make the tacit knowledge *K* explicit.

Our discussion of Collins's taxonomy starts with *Relational* (or weak) Tacit Knowledge; we aim to clarify its nature (section 2). In previous works, Collins distinguished different kinds of TK [Collins 2001]. He now considers these to be five sub-cases of RTK. We analyze these five sub-cases (section 2.1), and conclude that some of them are not adequately characterized as "relational". Next (section 2.2), we examine further what the five sub-cases really have in common: what links them together and confers to Collins's so-called "relational" TK its unity and identity. We propose the following answer: for all sub-cases of the RTK category, the reason why the knowledge *K* under scrutiny remains tacit is contingent with respect to the nature of *K*. This answer, we claim, is the most adequate and fundamental feature of RTK. We conclude that it is desirable to rename Relational Tacit Knowledge. "Contingent" (or "accidental" or "circumstantial") tacit knowledge would be better terminologies, but in order to maintain Collins already widely used initials, we suggest RTK should be read as: *Relative-to-factors-contingent-regarding-the-nature-of-K Tacit Knowledge*. To complete the clarification of RTK, we finally briefly discuss the relation between RTK and the social (section 2.3).

Having clarified the nature of RTK and what really defines the identity of the RTK category, we zoom out and consider Collins's three TK categories altogether, aiming to investigate further the differences and possible relations between them and, ultimately, to deepen our understanding of the principle of Collins's three-fold taxonomy (section 3). We begin to show (section 3.1) that, if we take Collins's text literally, nothing prevents the generation of strange, if not contradictory mixed kinds of categories of TK, such as relational-somatic tacit knowledge (i.e., weak-and-medium TK) or relational-collective tacit knowledge (i.e., weak-and-strong TK). Analyzing further what has enabled the generation of such conundrums in the first place, we come to reveal an ambiguity in Collins's classification and symbolic notations "RTK", "STK" and "CTK" (section 3.2.1). There are actually two possible ways to interpret the first letter of RTK, STK and CTK: as reasons for tacitness, or as location of the (tacit) knowledge. To avoid the ambiguity, and to prevent the generation of the mixed, apparently self-contradictory categories, we

must block certain, at first sight possible, interpretations. To indicate explicitly which of the two interpretations is involved, we introduce three conventions (section 3.2.2). By means of these conventions, we re-write and specify Collins's categories and symbolic notations in a way that is less ambiguous and more informative than his own conventions (section 3.3.1). This leads to a refined and extended mapping of the territory of tacit knowledge at a given time t (see Table 1, section 3.3.3). But since our mapping introduces categories that are not considered in TEK (section 3.3.2), this raises open questions (sections 3.3.3. and 3.3.4), not directly addressed by Collins in TEK, with respect to which Collins's position remains uncertain. The main one is the issue of the possibility of a *partial* explication of *Collective* Tacit Knowledge. Finally, in section 3.4, we consider the territory of tacit knowledge in a dynamic perspective. We examine how each category might evolve through time, and we discuss the possibility of a transformation of one category of TK into the other (see Table 2, section 3.4.3 for an overview).

2 Investigating Relational Tacit Knowledge

2.1 Questioning the fitness of the “relational” terminology

At the more general level, Collins gives the following characterization of RTK:

Weak, or Relational, Tacit Knowledge (RTK) [...] is knowledge that could be made explicit in the second sense of explicable [explicable by transformation] but is not made explicit. [TEK, 86]
A characteristic of weak tacit knowledge is that, in principle, with enough effort, any piece of it could be rendered explicit, [...even if...] not all of it can be rendered explicit at any one time. [TEK, 11]

This still says nothing about the reason why Collins calls this TK “*Relational*”. The “*R*” qualifies the kind of reason why a *K* that could have been made explicit is actually not made explicit but remains tacit. The main motivation of Collins for the choice of “relational” is expressed at [TEK, 86], as well as in several other passages:¹ “Relational Tacit Knowledge is just a matter of *how particular people relate to each other*” (our italics). This quote seems to give the crucial reason for the choice of the term *Relational* Tacit Knowledge.

1. For example: RTK is “knowledge that is tacit for reasons that are not philosophically profound but have to do with the relations between people that arise out the nature of social life. The reasons range from deliberate secrecy to failure to appreciate someone else’s need to know” [TEK, 11]; the *K* of RTK is explicated or not, “depending on the relationship of the particular humans who are in interaction” [TEK, 159].

As particular sub-cases of RTK, Collins comes back to kinds of TK he has distinguished in his previous work [Collins 2001]: concealed knowledge, mismatched saliences, unrecognized knowledge, ostensive knowledge, and logistically demanding knowledge. We are going to argue that not all of these cases are adequately called “relational” in the previous sense of “how particular people relate to each other”. This is, of course, not just a “matter of words”, not just a “verbal issue”. What is at stake, here, is the very identity of the category: what unifies the different sub-cases constitutive of the category; what is in and what is out; what principle enables to individuate the RTK category as *one* category distinct from other categories such as STK and CTK.

2.1.1 Unproblematic cases: Concealed knowledge and Mismatched saliences

Two of the five sub-cases of Collins's RTK are appropriately categorized as “relational” in the sense of “how particular people relate to each other”.

The first is concealed knowledge, such as for example secrets. This is clearly relational, because the fact that a K remains tacit or is explicated depends on the relation between two subjects (say A and B). Here the subjects might be identified with individuals or with groups of individuals: for example, individual A wants to hide K from B , because B is a scientific rival.

The second sub-case corresponds to mismatched saliences: K could be expressed but is not expressed because A does not realize that K needs to be revealed to B . Again this is clearly relational, because the fact that K is tacit or expressed depends on the relation between A and B . It depends on the way A conceives B and B 's knowledge, on what A presupposes about B , etc. For instance A does not express K because A believes that B already knows K .

2.1.2 Problematic case: unrecognized knowledge

One of Collins's five RTK sub-cases is problematic with respect to the “relational” terminology. It is the case of unrecognized knowledge.

Unrecognized knowledge corresponds to the situation in which K is expressible but is not expressed by A because K is not recognized by A . For example, an experimenter A does not recognize K as an actual or relevant parameter of his experiment (see Collins's introduction, section “Relational Tacit Knowledge”, p. 33, for an example). A is not conscious of the role played by K , or even of the very presence of K . Here, the reason why K is not expressed by A is that A is not aware of the presence or importance of K . This has barely anything to do with the relation of A to anybody else. It is just a consequence of the fact that K is not expressed *at all* by A , even to himself, and cannot be expressed until K remains not conscious or not recognized for A .

One might try to object that if there had been no B at all, to whom A wanted to communicate his knowledge K , then A would not even have been

thinking about trying to make his knowledge K explicit: so that the existence of some B to whom A wants to transmit something, and hence the existence of a certain kind of relation between A and some B , is involved here. This is true, but it is not an objection to our argument, since the existence of a relation between A and B called for by the objection, is only the *motivation* for A to try to make his knowledge explicit, but *not the reason why part of the knowledge of A , namely K , is actually not expressed to B* . Our conclusion reads therefore that the reason why an unrecognized K remains tacit has nothing to do with the way A and B relate to each other. Thus, in this case, the term “relational” is inadequate.

2.1.3 Two intermediate because mixed cases: ostensive and logistically demanding knowledge

The two remaining sub-cases of RTK, ostensive and logistically demanding knowledge, are intermediate cases, in the sense that the reasons why the K under scrutiny remains tacit are not *reducible* to *relational* reasons: relational reasons might play a role, but there are *additional reasons of a different kind*.

Take ostensive knowledge. A could express K to B (for example, where to find the spectrometer in the laboratory), but given what A assumes about B ’s knowledge and capacities (B has just arrived in the laboratory), *and given the contingent fact that B and A are in close proximity* (B is, here and now, in the same room as A), A judges that it is simpler and more efficient to show K to B (i.e., to point the right direction or simply go with him) rather than to tell K to B . The same holds for logistically demanding knowledge: K could be made explicit, but it is not, because given his relations to B , *and given the nature of the task involved and the available means*, A estimates that it is more efficient to execute the task by tacit means.

The term “relational” only partially catches what is at stake here, because the reason why the expressible K is not expressed involves a mix of relational and non-relational factors: “the choice of which way to go—stick with the tacit or go to explicit” [TEK, 95], and hence the reason why K remains tacit, depends on some relational aspects, but *also* depends on *other types* of factors—such as the contingent fact that A and B are in the same room, the available technological means, the economic situation and so on—which, clearly, are *not* relational factors.

2.2 Suggestion of an alternative definition and denomination for RTK

Since the word “relational” and the associated definition in terms of “how particular people relate to each other” do not appropriately characterize all previous RTK sub-cases, we suggest an alternative name and an alternative

definition. The five sub-cases are much better referred to as *contingent*, *circumstantial* or *accidental* tacit knowledge. Contingent (circumstantial or accidental) tacit knowledge is defined as follows: some K , which is perfectly explicable, is not explicated and remains tacit in a particular historical situation, because of reasons that could have been different historically and that are contingent with respect to the nature of K .

In this framework, Relational Tacit Knowledge becomes one *particular case* of contingent tacit knowledge. The way particular people relate to each other is *one kind of circumstance or contingent factor* with respect to the nature of K that is susceptible to prevent the expression of K in this or that historical situation. Since contingent-circumstantial tacit knowledge has the same acronym as CTK, we could favor “*Accidental* tacit knowledge” (ATK), but it is preferable to maintain Collins's initials RTK. Thus, we propose to read the “*R*” of RTK as: “Relative-to-contingent-factors-regarding-the-nature-of- K ” tacit knowledge.

Our alternative definition has several advantages. First and most importantly, it underlines what really constitutes the homogeneity of Collins's category and justifies individuating it as *one* coherent category. If RTK is defined by means of the relation between people, not all K that could have been explicated but remains tacit would be included in RTK. In particular, we would have to exclude unrecognized knowledge. Moreover, our definition of RTK explicates what delineates the RTK category from Collins's other kinds of TK categories. Contrary to Collins's definition in terms of relational factors, our definition of RTK as “Relative-to-contingent-factors-regarding-the-nature-of- K ” points at the central difference between RTK on the one hand, and *Somatic/Collective* TK on the other. RTK is tacit for reasons unrelated to the nature of K , whereas STK/CTK are tacit because of reasons that have to do with the *nature of the K* involved. This difference, which is acknowledged by Collins, will be developed in more details in sections 3.2. and 3.3.1.

Second, our definition fits better Collins's own characterization of RTK in TEK. Consider just one example. Collins writes:

Relational Tacit Knowledge is tacit because of the contingencies of human relationships, history, tradition and logistics. [TEK, 98]

Clearly, the “history, tradition and logistics” here explicitly mentioned by Collins just after “human relationships” exceed the “way particular people relate one to the other”.²

Third, to read RTK as Relative-to-contingent-factors-regarding-the-nature-of- K Tacit Knowledge, clearly stresses a special feature of RTK com-

2. Actually, after we wrote the first version of this paper, Collins told us that he first chose the expression “contingent tacit knowledge” instead of “relation tacit knowledge”, but finally opted for “relational”. In TEK, he sometimes characterizes RTK in terms of contingency (as in the quotation just given).

pared to STK and CTK,³ which will prove to be important below, section 3.4. Namely, that RTK, contrary to STK and CTK, has an essentially *contextual* character: the fact that a given piece of knowledge *K* remains tacit *here and now*, whereas nothing in the nature of *K* prevents *K* to be made explicit, obviously depends *on particular circumstances*. So “any piece of RTK” [TEK, 11] should be associated with determined spatio-temporal coordinates (x, t) , and the tacitness of *K* involved in this “piece of RTK” depends on the details of the particular situation corresponding to (x, t) . We can nevertheless also consider RTK as a category *independent of any determined context* in a given stage of the human history, as Collins does when he talks about “all of RTK” (cf. for example when he writes: “not all of it [RTK] can be rendered explicit at any one time”). In the latter quote, “all of RTK” refers to the totality of knowledge that has been articulated in a given stage of the human history but that could, in this or that particular situation, remain tacit for contingent reasons. To the extent that “all of RTK” refers to the *totality* of knowledge, “all of RTK” is a *global* category. To the extent that it refers to knowledge *that has been articulated* in a given stage of the human history, it is a *universal* category, in the sense of being explicable by any competent person at the period under scrutiny.⁴ So RTK can be considered according to two perspectives: either in a *contextual* perspective, and then, RTK refers to a piece of RTK associated to a given “here and now” (including some particular agents); or in a *global-universal* perspective, and then, RTK refers to “all possible pieces of RTK”, that is, to the totality of the available explicable knowledge at a given period, imagined as not explicated due to contingent contextual factors. In other words, the extension, in terms of knowledge, of global-universal RTK at a given period, coincides with the extension of “all explicit knowledge”, if the adjective *explicit* is to be understood—as it is often the case in Collins’s writings—in the universal sense of “explicable by some competent person” at the period under scrutiny. Fourth, our alternative avoids the risk of confusion between RTK and CTK. Since “relational” implies at least two persons and possibly more, “relational” might suggest a collective. To that extent, RTK and CTK might be confused, or at least, the borderline between the two might be blurred. This is relevant since Collins sometimes explains RTK *by means of the vocabulary of the “social”*. To help to avoid confusions and to understand better the difference between RTK and CTK, we are now going to investigate the relation between RTK and the social.

3. See, however, the qualifications made about this point at the end of the conclusion of this paper.

4. For a second sense of “universal”, see the end of our conclusion. Above, “universal” means what we call in the conclusion the “in-principle, generic sense” of “universal” (knowledge explicable by any *competent* person), as opposed to the in-practice sense of universal (knowledge explicable by any human being).

2.3 Relations between RTK and the social

When Collins explains RTK by means of the “social”, he contrasts RTK with CTK by stating that RTK has to do with “the way society *organizes* itself”, whereas CTK has to do with “the intrinsic nature of the social”.

The way human societies work plays a role in our understanding of the irreducibility of the tacit [of RTK]. In society as we know it there will always be secrets, mismatched saliences, and things that are unknown but may be about to become known. This fact has to do with the way society organizes itself rather than having anything to do with the intrinsic nature of the social. [TEK, 98]

CTK is tacit in virtue of “the ‘ontology’ of the knowledge” [TEK, 96] involved, namely in virtue of the collective nature of this knowledge. It has to do with the “*nature* of human society” [TEK, 86, our italics], and “with the way society is constituted” [TEK, 85]. In brief: CTK is tacit because *K* has an *essentially social* or *collective* character (in TEK, Collins uses “social” and “collective” interchangeably).⁵

In contrast, RTK is not tacit in virtue of the nature of the knowledge involved. It is tacit for reasons that are contingent with respect to this nature. This is what we mentioned above, section 2.1, and it is a strong reason to re-define the “*R*” in RTK as “Relative-to-contingent-factors-regarding-the-nature-of-*K*”. Thus, the reference to the “social” in relation to RTK must be understood as an extrinsic feature with respect to the knowledge involved: it is not *because* the knowledge is social in nature *that it is tacit*. It is just because of the contingent way this or that society organizes itself.

Consequently, the reason for explicable knowledge to remain tacit in a particular situation may have to do with the social, but it has only to do with “extrinsic characteristics” of the social, which Collins refers to as “the way society organizes itself”: RTK remains tacit because of “the contingencies of social life” [TEK, x]. This characterization obviously raises the question: What is the “intrinsic nature” of the social?

We are tempted to question the adequacy of Collins’s reference to the “social organization”, as an explanation of the reason why knowledge which could be explicated remains tacit. The main reason reads as follows. The social *organization* is not crucial for RTK. In particular, the specific nature of the relations between different human beings—which is a pivotal ingredient of Collins’s characterization of RTK and Collins’s primary motivation for the terminology of the relational—is certainly not reducible to social *organization*. The singular personality and the singular relations of the individuals certainly matter, even for a “collectivist” as Collins. When Collins defines the “*R*” of RTK as “how *particular* people relate to each other” [TEK, 86, our italics], the adjective “particular” seems to point to this singularity. This reflection shows

5. This might be criticized—see the contribution of S. Turner in this special issue.

the need for a clarification of the role of the individuals in Collins's collectivist picture. Clearly, the social plays the primary role in Collins's intuitions and readings of the reality under study. But the relations between the social level and the individual level remain unclear.

3 Clarifying the principle of Collins's three-fold TK classification

After having come to an alternative definition of RTK as “Relative-to-contingent-factors-regarding-the-nature-of-*K*”, we are now going to investigate the relations between *Relational* Tacit Knowledge on the one hand, and *Somatic* and *Collective* Tacit Knowledge on the other. We think the principle of Collins's three-fold classification needs clarification. Collins's text leaves room for two different readings, thus creating an important ambiguity. We experienced this ambiguity in the course of our reflection on Collins's book, since we successively endorsed two significantly different understandings of his classification. We finally retained what we think is the most charitable interpretation, which we assume to be Collins's position.

3.1 Revealing an ambiguity in Collins's classification

First, remember the interpretation of RTK we have adopted above: RTK is independent of the nature of the knowledge involved; the *R* of Relational TK means: not explained because of reasons that are contingent with respect to the nature of *K*.

Second, let us turn to the Somatic and Collective Tacit Knowledge, STK and CTK, respectively. Relying on Collins's text, STK and CTK have the following properties:

- (a) STK is knowledge located in the body (bodily skills, etc., hence the “*S*” of Somatic) and CTK is knowledge located in the collectivity (social skills, etc., hence the “*C*” of Collective)
- (b) both STK and CTK are not explicated (hence the “*T*”).

Let us start with Somatic Tacit Knowledge. One might reason as follows. Part of STK as just understood is indeed, according to Collins, explicable nowadays, in the actual stage of scientific development. This is for example the case for parts of the somatic knowledge associated with bike riding: Collins explicates parts of this knowledge in TEK (see for example [TEK, 101, box 11], where some STK associated with bike riding is explicated in sense 4: a scientific explanation of bike balancing is given). This part of STK is explicable, hence it could be explicated, but it happens that in some particular situation, it is not explicated and remains tacit. Consequently, this part of STK has not

been explicated for *contingent, circumstantial* reasons (reasons accidental with respect to the nature of the K involved), or, in Collins's terminology, for "relational" reasons. Hence it should be referred to as "Relational (Somatic Tacit Knowledge)", $R(STK)$.

The same way of reasoning applies to Collective Tacit Knowledge, which would lead to $R(CTK)$, *provided we accept the following assumption: parts of the collective knowledge acquired in the actual stage of scientific development is explicable, exactly as this is the case for parts of the somatic knowledge*. It is unclear whether Collins endorses this assumption. In the sequel (section 3.3.3) we will return to this issue and will discuss compelling reasons for accepting it. Meanwhile let us, for the sake of the argument, suppose that Collins endorses the assumption and that he treats STK and CTK symmetrically regarding their partial explicability.

At first sight, the idea of Relational (or contingent) Somatic/Collective Tacit Knowledge—which is not considered in TEK —appears problematic, if not paradoxical. It is problematic since Collins's categories are supposed to be mutually exclusive and collectively exhaustive. The problem turns to a paradox if we substitute the " R ", " S " and the " C " with Collins's alternative denominations "weak", "medium" and "strong". $R(STK)$ would result in a weak-and-medium tacit knowledge, and $R(CTK)$ in a weak-and-strong tacit knowledge.

3.2 Dissolving the ambiguity

3.2.1 Reasons for tacitness and locations of TK

To get rid of the apparent paradox just sketched and to dissolve the ambiguity which allowed for its generation, we must carefully distinguish between two possible interpretations of the first letter of the three categories in Collins's taxonomy. These two meanings are not entirely independent to one another, but they are not reducible to one another either.

- (1) The " R ", " S " and " C " may refer to *kinds of "causes" or "reasons"* that stop the knowledge being explicated (i.e., to kinds of reasons why K is tacit). This understanding is in accordance with Collins's explicit general statements about the principles of his categorization at the most fundamental level:

In this book, tacit knowledge will be analyzed and classified by reference to what stops it being explicated; there are three major reasons why tacit knowledge is not explicated; therefore, there are three major types of tacit knowledge. [TEK , 1]

- (2) The " R ", " S " and " C " may refer to *kinds of K by specifying the location of K* .

- (2a) As far as the *somatic* and the *collective* are concerned, this second understanding is, like the first one, also in accordance with Collins's explicit general statements about the principles of his taxonomy at the most fundamental level. In this vein, STK is characterized as “knowledge *stored in* the muscles, nerve pathways, and synaptic connections” [Collins 2010a], “knowledge *embodied in* the human body and brain” [TEK, 2], or knowledge that has to do with “the *nature* of the human body and brain” [TEK, x, our italics]. In a similar vein, CTK is described as “the domain of knowledge that is *located in society*” [TEK, 85], “knowledge “*embodied*” in society” [TEK, 2], knowledge that is “a *property of society* rather than the individual” [TEK, 11], or knowledge that “turns on *the nature* of the social” [TEK, 86]. In other words, “‘somatic’ and ‘collective’ qualify the ‘ontology’ of the knowledge” [TEK, 96]. They define the fundamental nature of the knowledge involved, and for Collins, to define the nature is to specify the “location” of this knowledge, such as the body or the society.
- (2b) But what about *Relational Tacit Knowledge as a location*? What would the second meaning imply for the “*R*” in RTK? Can we interpret the “*R*” of RTK as a location, and if yes, what would be this location?

Relying on the definition of RTK as “a matter of how particular people relate to each other”, we could be tempted, for reasons of symmetry, to locate the knowledge involved in RTK in the relation between people or groups of people, which would leave us with the task of explaining how knowledge can be located in a relation between people. But according to the understanding of RTK as we have proposed section 2,⁶ this cannot be the correct interpretation: RTK cannot be interpreted as a location *at all*. As explained before, RTK is independent of the nature of the knowledge *K* involved.

Consequently, the location of the *K* in “RTK” is completely open: it *might be anything*, and the “*R*” of RTK *does not indicate any determined location*. This is an additional reason to prefer the name “circumstantial tacit knowledge”—or still better in this respect, “contingent tacit knowledge”—to the expression “Relational Tacit Knowledge”, since “contingent” does not suggest any location, whereas “relational” might do so. We conclude that for the “*R*” of Collins's Relational Tacit Knowledge, only one of the two meanings (reason and location) applies: The *R* should be understood as a *reason*.

6. And in conformity to some explicit statements of Collins, for example : “Weak, or Relational, Tacit Knowledge (RTK) [...] is knowledge that [...] is not made explicit for reasons that touch on no deep principles that have to do with either the nature and location of knowledge or the way humans are made” [TEK, 86].

To sum up: the somatic “*S*” and the collective “*C*” can refer either to reasons or to locations, but the relational “*R*” can only refer to reasons. This shows an asymmetry between STK and CTK on the one hand, and RTK on the other.

3.2.2 Dissolution of the paradox and notations to avoid the ambiguities

A. A convention for specifying the reasons of tacitness

The previous discussion enables us to dissolve the apparent paradox related to $R(\text{STK})$ (or weak- and-medium TK) and $R(\text{CTK})$ (or weak-and-strong TK).

As soon as we distinguish between the two interpretations of “*S*” and “*C*” as reason and as location, and as soon as we realize that these two meanings are not equivalent, it becomes evident that:

- (a) the “*S*” and the “*C*” in $R(\text{STK})$ and $R(\text{CTK})$ should be read *only* as two locations and *not* as two *reasons*, and
- (b) the “*R*” should be interpreted according to its only possible reading, viz. as a reason.

The expressions $R(\text{STK})$ and $R(\text{CTK})$ only appear paradoxical if the “*S*” and the “*C*” are interpreted *both* as locations *and as reasons*. Interpreting “*S*” only as a somatic location and “*C*” only as a collective location prevents any substitution of “*S*” by “medium” and “*C*” by “strong”. This is because “medium” and “strong” unambiguously refer to the *force of the resistance* with respect to attempts of explication. Hence “medium” and “strong” cannot be understood as two locations. Consequently, the generation of paradoxical expressions such as weak-and-medium TK or a weak-and-strong TK is avoided.

To preclude the generation of the expressions $R(\text{STK})$ and $R(\text{CTK})$, we must block one of the two meanings of the “*S*” and the “*C*” that appear in “STK” and “CTK”. More exactly, we must prevent the “*S*” and the “*C*” to be read *as location only*; the “*S*” of STK and the “*C*” of “CTK” *must be read as reasons*. To specify explicitly the right kind of reading, and to prevent confusions between reasons and locations, let us introduce a first convention. To indicate explicitly that we understand the letter which points to a kind of TK *as a reason*, we will associate the subscript “*r*” to this letter.

Convention 1: If R , S or C are used as *reasons for the tacitness*, we write:

$$R_r, S_r \text{ and } C_r$$

Using convention 1, we translate our claim, according to which S and C should not be read as location only, as follows:

$$\text{STK} = S_r\text{TK},$$

which means that the “*S*” in STK must be understood as the reason why *K* is tacit and that this reason has to do with the somatic nature (and hence with the location in the body) of *K*.

Similarly,

$$CTK = C_rTK,$$

which means that the “*C*” in CTK must be understood as the reason why *K* is tacit and that this reason has to do with the collective nature (and hence with the location in the society) of *K*.

Finally,

$$RTK = R_rTK,$$

which means that the “*R*” in RTK must be understood as the reason why *K* is tacit, and that this reason has to do with factors that are contingent with respect to the nature of *K*, such as, for example, some particularities of the relation between people.

In short: “*S_r*”/“*C_r*” indicate that something in the somatic/collective nature of *K* creates a specific difficulty with respect to the task of explicating *K*; “*R_r*” indicates that something in the contingent circumstances of the historical situation—something which has no essential relation to the nature of the *K* involved—makes *K* to remain tacit.

B. A convention for specifying the location of the knowledge

As mentioned at the beginning of section 3.2.2, the two meanings of *S/C*—i.e., *S/C* as reasons and *S/C* as locations—, although not being reducible to one another, are not independent. Obviously, *S/C* as reason (i.e., according to convention 1, *S_r/C_r*) implies *S/C* as location. If the reason why *K* is tacit “has to do with” the fact that *K* is some bodily/social *K* (some bodily/social skill, knowing-that, commitment, etc.), then necessarily, the location of this *K* is determined and corresponds to *S/C*. But of course, the reverse does not hold: *S/C* as location does not necessarily imply *S/C* as reason: the reason why a *K* is not explicated might have nothing to do with the location of this *K*.

To have a means to specify explicitly, and to represent schematically, the cases in which the reason for *K* not being explicated and the location of *K* are different, we need two different notations, one to indicate the location, and another one to indicate the reason. The reason for tacitness is indicated by means of our convention 1. To indicate the location, we introduce a second convention, which associates to *K* an index that specifies the location of *K* (i.e., the kind of *K* involved).

Convention 2: If *K* is of the kind *N* (or equivalently: if *K* is located in *N*), we write: *K_N*

Using convention 2, *K_S* indicates that *K* is located in the body, that *K* has a somatic nature. Similarly, *K_C* indicates that *K* is located in the society, that *K* has a collective character.

C. A convention for distinguishing the tacit as not explicated and the tacit as not explicable

We still need a third last convention to fully clarify Collins's RTK, STK and CTK categories. The usefulness of this convention will become clearer in sections 3.3 and 3.4. This convention provides *a concise explicit means* to refer to an important distinction *which is already present and elaborated in TEK*: the difference between tacit-as-not-explicable and tacit-as-not-explicated.

In TEK, this distinction enters in the very definition of the tacit:

The tacit is that which has not or cannot be made explicit.
[TEK, 85]

Collins points out that, in the literature, the neglect of this difference has often been a source of confusion. Moreover, he introduces eight different types of “cannot” [TEK, 90] and four different meanings of “explicable” [TEK, 81], to which he relates each of his three kinds of TK. But despite the welcome introduction of all these clarifying fine-grained distinctions in TEK, Collins's three main notations, “RTK”, “STK” and “CTK”, remain unspecified with respect to the important difference between “is not” and “cannot”. To make such a specification explicit is the aim of our convention 3.

Convention 3: T_{ed} means tacit as not-explicated, and T_{able} means tacit as not-explicable

Following convention 3, $T_{ed}K$ means that K is not explicated, and $T_{able}K$ that K is not explicable.⁷

Of course, T_{able} logically implies T_{ed} : if K is not explicable, *a fortiori* it is not explicated.

3.3 Specification of Collins's classification by means of our distinctions and notations

3.3.1 Specification of Collins's three tacit knowledge categories

Combining our distinctions and conventions, and applying them to Collins's three categories of tacit knowledge, we come to the following interpretation and symbolic expressions, which contain more information and are less ambiguous than Collins's ones:

STK should be specified as: $S_r T_{able} K_S$.

7. To be even more precise, we could add a number to T_{able} which would specify which of Collins's four meanings of explicable is involved. Here we will not do so.

This means: K is inexplicable, and hence not explicated, in the present stage of our knowledge, for reasons that have to do with the somatic nature of K . The fact that K is located in the body creates special difficulties with respect to the task of explicating K .

CTK should be specified as: $C_r T_{able} K_C$.

This must be read as: K is inexplicable, and hence not explicated, in the present stage of our knowledge, for reasons that have to do with the social nature of K . The fact that K is located in the society creates special difficulties with respect to the task of explicating K .

One might object that the two subscripts “ S ” and “ C ” in $S_r T_{able} K_S$ and $C_r T_{able} K_C$ are redundant, since $S_r TK$ implies K_S and $C_r TK$ implies K_C . This is true, of course. We have two reasons, however, to keep the K -indices. First, the redundancy is obvious only at the end of our analysis, after having distinguished S/C as reason and S/C as location, and after having examined the logical relations of these two meanings. Second and much more important, the redundancy does *not* apply to *Relational* TK: as we have seen, the “ R ” must be interpreted as a reason (R_r), but this does not imply any particular location, and therefore any definite index for K . So taking into account the *complete* taxonomy of tacit knowledge, the two indexes—the index added to the first letter of each acronym and the index added to the K involved in the same acronym—are *not* redundant. Hence for *each* category, we need to specify in two different ways the reason for tacitness and the location of the tacit K . The reason/location distinction must be explicit in all the symbolic expressions used, despite some redundancies in certain categories of TK.

The previous remarks related to the difference between STK/CTK on the one hand, and RTK on the other hand, become evident when we re-express RTK using our three conventions:

RTK should be specified as: $R_r T_{ed} K$

The latter means: a piece of knowledge K that is explicable in the present stage of our knowledge, is not explicated in one or another particular situation, because of reasons contingent with respect to the location of K (i.e., reasons that have nothing to do with the nature of K).

Our conventions make explicit and clearer the following similarities and differences between Collins’s three TK categories:

- The “ R ”, “ S ” and “ C ” of Collins’s RTK, STK and CTK must always be read as reasons as why K is not explicated in some particular situation.
- Whereas the tacit in RTK *only* points at local contingencies explaining why K is not-explicated in some particular situation, the tacit in STK/CTK points at stronger reasons, viz., reasons as to why K is not explicable in the present stage of our knowledge. For STK/CTK, in contrast to RTK, the fact that K is not explicated is a consequence of the fact that K is not explicable.

- The reason why the “ K ” in STK/CTK is not explicable is its location, namely the body and the society, respectively: The “ S ” in STK and the “ C ” in CTK refer to two kinds of reasons as to why K is inexplicable at the present time, and these reasons are the location in the somatic and the location in the collectivity. By contrast, the “ R ” in RTK does not refer to any determined location.

3.3.2 Three conceivable sub-cases of RTK

As the “ K ” involved in RTK is not associated with any specific location, the corresponding K might have different locations. In particular, nothing seems to prevent this “ K ” to be located in the body or in the society. Consequently, at first sight, we have three conceivable sub-cases of RTK, not considered explicitly by Collins:

- $R_r T_{ed} K_S$, which abbreviates: some explicable knowledge K located in the body (an explicable somatic resource K_S) is not explicated (T_{ed}) for reasons that have nothing to do with the somatic nature of K (but for reasons Relative-to-contingent-factors-regarding-the-nature-of- K : R_r). This corresponds to $R(\text{STK})$ introduced in section 3.1.
- $R_r T_{ed} K_C$, which abbreviates: some explicable knowledge K located in the society (an explicable social resource K_C) is not explicated (T_{ed}) for reasons that have nothing to do with the collective nature of K (but for reasons Relative-to-contingent-factors-regarding-the-nature-of- K : R_r). This corresponds to $R(\text{CTK})$ introduced in section 3.1.
- $R_r T_{ed} K_N$, where N refers to any kind of K which is neither somatic, nor collective—if such exists.

3.3.3 The Refined map of the territory of tacit knowledge at a given time t

Table 1 maps the territory of TK at a given stage of knowledge (say at t), using the three conventions introduced above.

Table 1 gives a static representation of explicit and tacit knowledge at time t . In section 4, the situation will be considered in a dynamical perspective. But before that, let us comment shortly on what might be Collins's position with respect to some constituents of the static table.

A first question arises in relation to K_N . Are there other locations than the somatic and collective locations involved in Collins's characterization? In common ways of thinking, if something X is neither somatic nor collective/social, this strongly suggests that X is intellectual and individual. What about the idea of intellectual individual tacit knowledge? It makes sense intuitively, and it seems to be missing in Collins mapping of TK. Take for instance the elaboration of a new mathematical method by an individual mathematician, and

	Explicable		Not explicable
Location of knowledge: Somatic	Explicated Explicated $K_S(t)$	Not explicated $RTK(t)$ $= R_r T_{ed} K_S(t)$	$STK(t)$ $= S_r T_{able} K_S(t)$
Location of knowledge: Collective	Explicated Explicated $K_C(t)$	Not explicated $RTK(t)$ $= R_r T_{ed} K_C(t)$	$CTK(t)$ $=$ $C_r T_{able} K_C(t)$
Location of knowledge: N (neither somatic, nor collective)	Explicated Explicated $K_N(t)$	$RTK(t)$ $= R_r T_{ed} K_N(t)$	

Table 1: The territory of TK in a given stage of knowledge at t .

suppose that the corresponding know-how involved has not been explicated. Would this know-how not be a case of an individual, intellectual tacit-as-not-explicated knowledge? More generally (leaving the intellectual dimension aside), what about *individual* tacit knowledge in Collins’s framework? Should we not categorize as such the (intellectual and/or somatic) tacit knowledge involved in the pioneering contributions of individual scientists? Is there a place for an *individual* “contributory expertise”?

Let us turn to $R_r T_{ed} K_S$. As already stressed in section 3.1, Collins should be ready to allow for $R_r T_{ed} K_S$, since some of his examples are of this kind. “Something called ‘the rules of bike [...] balancing’ can be told in sense 4 of explanation” (scientific explanation), writes Collins in [TEK, 100]:

Furthermore, these rules, or some set of rules, could, in principle, be programmed into a mechanical bike balancer with elaborate feedback circuits—so they are also explicable in sense 3

(explicable as mechanization, i.e., we can build “mechanical bike balancers”). According to these quotations, some STK is clearly explicable. Hence according to the particular circumstances, this STK could be explicated or not. Collins provides a (fictional) situation which may serve as an illustration.

If we rode our bikes on the surface of a small asteroid with almost zero gravity so everything happened much slower, we ourselves could probably use Polanyi’s rules [i.e., the scientific explication of bike balancing] to balance. [TEK, 100]

In such a situation, a bike teacher could choose either to tell the scientific rules to the novice, or to use other ways in which the somatic knowledge required would remain tacit (for example, just show him).

The more difficult question, that we are going to address in the next section, is whether Collins is ready to allow for $R_r T_{ed} K_C$ in his framework.

3.3.4 Is Collective Tacit Knowledge partly explicable?

One reason to doubt that Collins would allow for $R_r T_{ed} K_C$ is his insistence that the collective is special and fundamentally different from other kinds of realities. Applied to the reasons as to why knowledge is tacit, the collective character of K may introduce an extremely strong resistance of a unique kind which would hamper any explication. Nevertheless, Collins dedicates many pages of TEK to explicate what it is for a westerner to drive in Beijing in contrast to drive in other countries more familiar to her. He expresses many characteristics about the knowledge that must be mastered to enable one to drive in Beijing, and his explanations are perfectly understandable. Thus, Collins explicates parts of the ordinarily-tacit resources used by Chinese or non Chinese people who are able to feel at home and drive competently in Beijing's traffic. Since these resources seem to be both collective/social in an essential sense, and since they are *de facto* explicated by Collins, it apparently follows that Collins makes room for $R_r T_{ed} K_C$, and even provides instances of this category.⁸

It should be stressed, however, that according to Collins, such explications are, and will remain in any foreseeable future, partial and insufficient. Partial because a substantial part of the social skills needed to drive in Beijing is still inexplicable, today and in any foreseeable future; and insufficient because it is this inexplicable part which is responsible for "social fluency", i.e., for the specifically human ability to act flexibly and relevantly in ever-changing social contexts. Hence, the explicated K_C will never be enough to build machines that act as humans in this sense. Still, if our interpretation of Collins's Beijing driving writings is correct, part of the Collective Tacit Knowledge K_C located in the Beijing society has been explicated, and therefore part of this collective knowledge K_C is explicable.

Does our interpretation correspond to Collins's position about CTK? We wait for a clarification of this point, but it seems difficult to deny the conclusion that part of the collective knowledge K_C of a society is explicable. Refusing this conclusion would entail, for example, rejecting claims such as "our scientific paradigms are in part explicable". Yet, *part* of a scientific paradigm—the

8. It is worthwhile to note in this context that in various places in the world (Nevada, Florida, California and Berlin) autonomous or driverless cars have been finding their ways in normal traffic situations. The cars have done so autonomously on highways and in cities using radar, GPS, computer vision and optical remote sensing technology. (http://en.wikipedia.org/wiki/Autonomous_car; http://en.wikipedia.org/wiki/Google_driverless_car)

On Tuesday September 25th 2012, Jerry Brown, the governor of California, changed the law by signing a bill that legalizes driverless cars in the street of California (the *New York Times*, September 25 2012). If Jerry Brown did not change the law in vain and Paul Marks is right in saying that driverless cars are there "ready to hit our roads", to find their ways within major metropolises making less accidents than human drivers [Marks 2012], then either Collins should delete his Beijing driving example or should accept that some CTK is explicable.

propositional part—is *explicit in an uncontroversial sense*. For example we find, in handbooks, the expressions of the laws of the paradigm under scrutiny. Such scientific expressions are usually taken as the very prototype of explicit knowledge. If this is not explicit knowledge, then what is? Providing moreover that scientific paradigms are *collective*—something we assume Collins would not deny—, it seems that we have here a prototypical example of a partial explication of collective knowledge. Obviously, the previous discussion depends on the conceptions we endorse of the collective/social, and on an analysis of what is collective/social and what is not. In TEK, Collins does not elaborate these matters. He repeatedly stresses the mysteriousness and the shallowness of our understanding of the socialization process; he makes the CTK acquired through a socialization process responsible for the human ability to act flexibly and relevantly in varying social contexts; but his analysis mainly relies on an intuitive, tacit understanding of what is the collective/social.

Whatever Collins thinks about $R_rT_{ed}K_C$, the distinctions and conventions introduced above enable us to express the difference between two conceivable kinds of Collective Tacit Knowledge: on the one hand, a Collective Tacit Knowledge which is not explicable because of the collective nature of the knowledge involved (Collins’s CTK, specified as our $C_rT_{able}K_C$); on the other hand, a Collective Tacit Knowledge which is not explicated for accidental reasons—for reasons that have nothing to do with the nature of the knowledge involved (our $R_rT_{ed}K_C$, not considered in TEK).

3.4 The dynamics of RTK, STK and CTK

In this final section, we explore the temporal evolution of Relational, Somatic and Collective Tacit Knowledge. To do so, we need to be able to refer to the difference between today and the future. To that end, we let t refer to today in the sense of “nowadays”, and t' refer to some later time in the future. A systematic representation of our conclusions about the dynamics of RTK, STK and CTK is given in Table 2.

3.4.1 The temporal evolution of STK and its transformation into RTK

Let us first consider STK. According to Collins, at least some knowledge K located in the body and not explicable at a given time t for reasons that have to do with the somatic nature of K (i.e., $S_rT_{able}K_S(t)$), can *become explicable* at t' due to scientific progress. In other words, some $S_rT_{able}K_S(t)$ can become somatic *explicit* knowledge, $K_S(t')$, in the future. This in-the-future-explicable $K_S(t')$ might be explicable in different senses (at least in the two senses of scientific explanation and mechanization, see section 3.3.2).

Suppose now that some at- t -inexplicable somatic knowledge, $S_rT_{able}K_S(t)$, becomes at- t' -explicable but remains, at t' in some particular situation, not

explicated *for reasons that are contingent with respect to the somatic location of K* . According to our conventions, this configuration corresponds to $R_rT_{ed}K_S(t')$. Hence, when time progresses from t to t' , part of $S_rT_{able}K_S(t)$ can be transformed into $R_rT_{ed}K_S(t')$. In Table 2, this transformation is represented by the dark arrow. This transformation implies that, “all other things being equal”, in the course of time, STK diminishes and RTK increases in the same proportion.⁹ In the last sentence, the *ceteris paribus* clause means that: (a) from t to t' , no new somatic knowledge, either tacit or explicit, has been produced; (b) all somatic knowledge possessed at t , either tacit or explicit, is conserved from t to t' —i.e., no somatic knowledge is lost through time. Of course these two conditions are unrealistic, but we use them for the sake of analytical clarification. Hereafter, we will refer to them as the “no-production and no-losses” clause.

Let us now consider what might happen at the “ideal end of scientific research” (say at t_{end}). Suppose that at t_{end} , all somatic previously-tacit knowledge has been explicated and is therefore explicable (at least in the sense of scientific explanation or mechanization). In our notations: $S_rT_{able}K_S(t_{end}) = \emptyset$. This is not impossible according to Collins.¹⁰ In this hypothesis, at t_{end} , all the tacit knowledge located in the body would be tacit only for *contingent* reasons, and *not* for reasons essentially related to the fact that this knowledge is located in the body; all the previous $S_rT_{able}K_S$ would be transformed into $R_rT_{ed}K_S$.

3.4.2 The temporal evolution of CTK and its relation to RTK

Let us turn now to CTK and its evolution through time. The difference, between the STK case discussed above and the CTK case, is that in the CTK case, Collins's position about the possibility of a partial explication of CTK is unclear (see section 3.3.3). Two interpretations of Collins's position are possible: either (i) CTK is not at all explicable, even partially, and it is so for any foreseeable future; or (ii) parts of CTK are already explicable nowadays, and others parts could be explicated further in the future. Let us examine the dynamical behavior of CTK with regard to each of these two possible interpretations.

9. This holds for RTK considered as a global-universal category: for “all of RTK” (see section 2.2).

10. Collins does not talk in terms of the “ideal end of research”, but he claims about STK that “this kind of tacit knowledge is continuous with that possessed by animals and other living things. *In principle it is possible for it to be explicated*, not by the animals and trees themselves (or the particular humans who embody it), but as the outcome of research done by human scientists (the third meaning of explicable [i.e., mechanization]). It is *possible to foresee, therefore, that we will one day be able to mimic animal behavior with machines* [sense 4 of explicable]. The same goes for humans-as-animals” [TEK, 84, our italics].

- (i) If CTK is fully inexplicable, today and in any foreseeable future, then no part of $C_rT_{able}K_C(t)$ can be transformed into $R_rT_{ed}K_c(t')$. This means that in Table 2, the light arrow with the question marks, which represents the transformation of $C_rT_{able}K_C(t)$ into $R_rT_{ed}K_c(t')$ from t to t' , does not correspond to any real process and must be suppressed. Under the “no-production and no-losses” clause, CTK would remain the same through time: $CTK(t) = CTK(t') = CTK(t'') = \dots = CTK(t_{end})$.
- (ii) If at least parts of CTK are possibly explicable, then similar reasoning to that we have applied to the evolution of STK in section 3.4.1 applies to CTK. Parts of $C_rT_{able}K_C(t)$ can become explicable at t' , and if a piece of at- t' -explicable- K_C remains, at t' , tacit for accidental reasons—reasons that are contingent with respect to the collective location of K —, this corresponds to a piece of $R_rT_{ed}K_c(t')$. Hence, just as with STK, in the course of time $C_rT_{able}K_C(t)$ is transformed into $R_rT_{ed}K_c(t')$. Under the clause of no CTK production or losses, CTK diminishes over time and is progressively transformed in RTK as long as more and more parts of the inexplicable content of CTK are made explicit. In Table 2, the light arrow represents an existing process and must be maintained.

3.4.3 Comparing the dynamical behaviors of STK and CTK

Besides the similarity just sketched, the dynamics of STK and of CTK differ in an important other respect. The difference concerns the asymptotic behavior of the temporal evolution of the two kinds of knowledge.

As mentioned in section 3.4.1, Collins’s writings suggest that at t_{end} , all STK might be fully explicated at least in the sense of “scientific explanations”. If this were the case, STK would vanish in the end: $STK(t_{end}) = S_rT_{able}K_S(t_{end}) = \emptyset$. In contrast, Collins clearly denies that CTK will ever be fully reduced in this manner: Collins’s writings stress that CTK will not be explicable in any foreseeable future. This suggests that even if Collins was ready to accept the possibility of a partial explication of CTK at t and an increase of this explicated part in time, he would nevertheless maintain that an essential part of our collective knowledge would still remain tacit at the hypothetical “ideal end of research” t_{end} : $CTK(t_{end}) = C_rT_{able}K_C(t_{end}) \neq \emptyset$. We would never reach a stage in which CTK would be empty. Whereas $S_rT_{able}K_S(t)$ could be integrally transformed into $R_rT_{ed}K_S$, $C_rT_{able}K_C(t)$ would never be integrally transformed in $R_rT_{ed}K_C$ at t_{end} . This is the main difference between the evolution of CTK and the evolution of STK, due to the special nature of the social compared to the somatic—or more exactly to the special kind of resistance that a collective K_C offers to explication attempts regarding any of Collins’s four meanings of “explicable”.

t nowaday	Explicable	Not explicable		t' future	Explicable	Not explicable
Location Somatic	<i>Not explicated</i> $RTK(t)$ $= R_r T_{ed} K_S(t)$	$STK(t)$ $= S_r T_{able} K_S(t)$		Location Somatic	<i>Not explicated</i> $RTK(t')$ $= R_r T_{ed} K_S(t')$	$STK(t')$ $= S_r T_{able} K_S(t')$ $\rightarrow \emptyset$ at t_{end}
Location Collective	<i>Not explicated</i> $RTK(t)$ $= R_r T_{ed} K_C(t)$	$CTK(t)$ $= C_r T_{able} K_C(t)$		Location Collective	<i>Not explicated</i> $RTK(t')$ $= R_r T_{ed} K_C(t')$	$CTK(t')$ $= C_r T_{able} K_C(t')$ $\neq \emptyset$ at t_{end}
Location: N (neither somatic, nor collective)	$RTK(t)$ $= R_r T_{ed} K(t)$			Location: N (neither somatic, nor collective)	$RTK(t')$ $= R_r T_{ed} K(t')$	

Table 2: Dynamical behaviors of the different kinds of TK

Conclusion

Let us summarize the main conclusions of our analysis of Collins's tacit knowledge framework. These conclusions concern four points: (a) The definition and the name of one of Collins's three TK categories, namely *Relational Tacit Knowledge*; (b) Some profound differences between *Relational Tacit Knowledge* on the one hand, and *Somatic/Collective Tacit-Knowledge* on the other; (c) Extensions of Collins's categorization, through the consideration of *additional* categories and the *temporal evolution* of the different categories; (d) Collins's suggestion that *RTK*, *STK* and *CTK* are mutually exclusive categories which, taken altogether, exhaust the territory of TK.

- (a) Our investigations showed that one of Collins's sub-cases of *Relational TK*, viz., unrecognized knowledge, is not relational at all. The reason for it not being explicated has nothing to do with the relations between people. Along the same line of reasoning, ostensive knowledge and logistically demanding knowledge are only *intermediate* cases of *Relational Tacit Knowledge* in Collins's sense, since beyond reasons related to the particular relations between people, they involve *additional* reasons of a *different kind*. The fundamental principle that defines *RTK* and individuates the *RTK* category as *one* category *distinct from* the two other categories of *STK* and *CTK* is the following: *RTK* remains tacit for reasons *unrelated to the nature of the knowledge K* involved. Once this is recognized, Collins's *RTK* category is much more exactly characterized as *contin-*

gent tacit knowledge or as “Relative-to-contingent-factors-regarding-the-nature-of- K ” Tacit Knowledge.

- (b) Our analyses recognized a possible ambiguity in the reading of the first letter of Collins’s acronyms RTK, STK and CTK, and specified of how to avoid the related possible confusions. Relying on Collins’s writings, we may be tempted to read the R , S and C both as reasons for the tacitness of K , and as locations (or nature) of K . We showed that on penalty of becoming entangled in paradoxes, the R should be interpreted *only as a reason*, whereas the S and the C should not only be read as reasons but also as locations. These findings strengthened a point implicitly suggested in Collins’s text, namely the serious asymmetry between RTK on the one hand, and STK/CTK on the other. A first source of asymmetry is that the tacit in S/C TK means “not explicable at t (and *a fortiori* not explicated at t)”, whereas the tacit in RTK means “explicable but not explicated at t for contingent reasons”. This difference is present in Collins’s text, but we made it more salient thanks to the introduction of our third convention. A second asymmetry lies in the fact that contrary to the S/C of STK and CTK, the R of RTK must be read only as a reason and not as a location: the R says nothing about the location, or in other words about the nature, of the K involved. This difference is not stressed as such by Collins. Finally, a third aspect of the asymmetry is the fact that RTK is primarily a contextualized or local concept, whereas S/CTK are global or “universal” ones. STK and CTK are tacit *for any human being* (in a given stage of knowledge). Whereas RTK is tacit *relatively to a given “here and now”* and because of the contingencies of this “here and now”. True, we can also consider RTK globally and talk about “all of RTK”. But in that case, what we actually do is to extrapolate to an indefinite multiplicity of possible “here and now”, and to imagine that in each, bits of the totality of our explicable knowledge (in a given stage of development) could remain unexplicated. Taken altogether, our analyses have strengthened and explicated more fully the asymmetry between RTK and S/CTK, perhaps even to such an extent that we should conclude that the RTK category is at right angles to the S/C TK categories.
- (c) A third set of results pertains to our endeavors to elaborate and complete Collins’s framework. First, we elaborated the category of RTK, by introducing the possibility of different sub-types of RTK. After having recognized and stressed that the tacit in RTK had nothing to do with the nature (or location) of the knowledge K involved, it was almost inevitable to consider the possibility of several distinct locations for RTK. In this respect, we first took into account the two locations put forward by Collins in his book, namely the body and the collectivity. This led to the idea of some knowledge K localized either in the body or in the collectivity, but tacit for reasons that have nothing to do with these locations. In this way, we generated the idea of two possible sub-types of RTK not considered by

Collins, namely $R_rT_{ed}K_S$ and $R_rT_{ed}K_C$. Next we raised the question of other additional sub-types, noted $R_rT_{ed}K_N$, which would be located elsewhere than in the body or in the collectivity (for example “in the mind” of an individual scientist).

Besides the elaboration of the statics of Collins's framework, we completed his work by looking at the possible dynamics of his categorization. In TEK, Collins only considers the internal dynamics of each category. For instance, he discusses the question under what circumstances we may rightly claim that some STK has become explicated in time. Nevertheless, he does not consider the possibility of dynamic transformations between different categories. Let us recap our intermediate conclusions about dynamic transformations—much more should be done to come to more definite conclusions. For STK, relying on Collins's writings, we should accept, first that over time some parts of STK can become RTK, second that at the “ideal end of scientific research”, all STK may become extinct (providing we accept, for the sake of the argument, the condition of “no-production and no-losses” of somatic knowledge). For CTK, things are much less clear. The text of TEK leaves us with the question whether *some parts* of CTK are explicable and whether some *new parts* might become explicable through time. If the answer is positive, *some parts* of CTK could be transformed into RTK in the course of time. However, Collins's text is clear with respect to the claim that essential parts of CTK will remain inexplicable in any foreseeable future. Thus CTK, contrary to STK, will not become integrally explicated. In one word, the asymptotic behavior of STK differs from that of CTK.

- (d) Collins's text suggests that the three TK categories form a taxonomy, in the sense that RTK, STK and CTK are mutually exclusive and collectively exhaustive sets, and therefore partition the entire field of tacit knowledge. Due to (a), (b) and (c) above, our analysis challenges both claims. First, Collins's categories are only mutually exclusive if considered at one specific time. Through time, one can be transformed into another. This is at least the case for *Somatic Tacit Knowledge*. From t to t' , when science advances, some inexplicable somatic TK at t may become explicable at t' . If this at- t' -explicable somatic TK is, in some particular situation at t' , not explicated for contingent reasons, then, $STK(t)$ has been transformed into $RTK(t')$. Second, Collins's categories are not obviously collectively exhaustive. What about the *not-somatic* and *not-collective* tacit knowledge of collectively acknowledged experts? What about the contributory *intellectual* expertise of an *individual* scientist who would be, according to the practitioners of the field, the only one to be able to accomplish a certain task? Nothing in Collins's framework seems to prevent such a situation occurring. This becomes the more urgent when recalling Collins's emphasis on the restricted size of the “core sets” of competent scientists with regard to some important scientific issue [Collins 1981]. In TEK, Collins does not consider the issue of the individual, intellectual tacit knowledge

of collectively acknowledged experts. It is unclear where we should put this kind of tacit knowledge in his framework.

Finally, let us make a last comment associated with two suggestions. We cannot develop them here, but they are important enough to be at least mentioned, in the hope that they will prompt further investigation. In section 2.2. as well as in point (b) of this conclusion, we have presented the local character of RTK “as a special feature of RTK *compared to STK and CTK*”. This is true as far as Collins’s current uses of STK and CTK are involved. As we understand TEK, somatic and collective knowledge are said to be tacit/explicit in reference to something like a “universal subject of knowledge at a given time”, or put differently, in reference to “a given stage of human development”. For example, the human somatic knowledge that must be mastered in order to be able to balance on a bike is described as explicable and explicit, as soon as “we”, human beings, are able to build a mechanical bike balancer (in which case the somatic human knowledge is explicable and explicit in sense 3 of “mechanization”, see section 3.3.3 for quotations), or as soon as “we” have a scientific theory of bike balancing (in which case the somatic human knowledge is explicable and explicit in sense 4 of “scientific explanation”, see section 3.3.3 for quotations).

However, beyond Collins’s uses in TEK, we think it would be preferable—this is our first suggestion—to distinguish carefully between the *global-universal* sense and the *contextual* sense of explicable/explicit *somatic* knowledge and (provided that such things exist) explicable/explicit *collective* knowledge, and to specify systematically which sense is used. More precisely, analysts interested in issues involving tacit knowledge should care about the answer to the question: explicable/explicit *for whom and when?* This is required, since obviously—using the bike balancing example again—not all human beings are, nowadays, concretely able to build mechanical substitutes of the somatic human skills involved in bike balancing, or concretely able to master the scientific theories about bike balancing that could work as theoretical substitutes to the somatic human skills involved in bike balancing if we lived on “a small asteroid with almost zero gravity” (see section 3.3.3). So *in practice*, somatic knowledge about bike balancing is explicable/explicit in senses 3 and 4 *only for certain individuals* (or sub-groups of the whole humanity) and not for others. The universal “we” to which the words “explicable” seems to refer most of the time in Collins’s developments related to somatic or collective knowledge, is universal in an in-principle, generic sense, but is *not* universal in-practice in the sense of “*for all individuals*”. Moreover, in case some somatic/collective knowledge *K* is explicable by a given person, it might be, in a given particular situation, either explicated or not by this person. In the later case, although *K* is explicable *in a universal* (generic) sense *and* moreover explicable in the *contextual* sense of explicable *for this S*, *K* remains tacit in the particular situation under scrutiny: *K* is contextually tacit in the sense of “tacit-now”. Thus the universal “we” to which the word “explicit” often refers in

TEK, in relation to somatic/collective knowledge, is not universal in-practice in the sense of “for all situations”.

That is not all. Not only should the explicable/explicit/tacit character of somatic and collective knowledge K be specified in terms of “for whom and when”; but moreover—this is our second suggestion—we should also specify systematically in which of Collins’s four sense(s) K is explicable/explicit or not. Otherwise, strange effects occur. Let us continue to illustrate these effects with bike balancing. Take for granted that bike balancing is, nowadays, explicable and explicit in senses 3 and 4 and in a universal sense (i.e., “we”, human beings today, are able to explicate, in sense 3 and 4, the human somatic knowledge required to balance on a bike). It remains, however, that until further notice, nobody knows how to describe/express in words the somatic human skills actually involved in the human realization of bike balancing. As Collins insists (especially through the comparison of the way humans and computers play chess successfully), mechanical and scientific devices are just functional substitutes which are able to produce the same end-product called “knowledge” (say, for chess, to win, and for bike balancing, to go from a point to another without falling). They cannot be equated with descriptions of the bodily skills actually involved in the human realization of the task. So we can have situations in which a knowledge K is globally-universally explicable/explicit in senses 3 and 4, but is nevertheless globally-universally *not* explicable/explicit in senses 1 and 2. If we sum up the situation just by saying that the STK involved in the activity of bike balancing is explicable/explicit *tout court*, this is puzzling. Indeed, it remains that nobody is able to tell in words what he knows (his somatic skills) when he succeeds to go from point A to point B by bike without falling, and this is precisely what is usually meant by the traditional claim that Somatic Tacit Knowledge is irreducibly tacit (i.e., will never be fully explicable in sense 1 or 2). If we claim that all STK could be explicated *tout court*, as Collins does, we suggest that the we have surmounted the later impossibility whereas we have not; or worse, we suggest that the invention of some mechanical device or new theory might change something to the subjectively experienced impossibility to express (even to ourselves) things that we are convinced to know (for example how to balance on a bike).

To conclude, we would like to thank Harry for having offered us, through his original and insightful mapping of the territory of tacit knowledge, a renewed occasion to deepen our understanding of tacit knowledge. His proposal has worked as an important source of inspiration and a powerful tool with respect to our own attempts to analyze the nature of tacit aspects of scientific practices [Soler 2011a,b]. We hope that our endeavours to explore his framework from the inside, and our critical reflections and suggestions of extensions, will prompt further refinements and developments.

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