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Looking at and seeing objects: Instructed vision and collaboration in the laboratory

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Abstract
This article studies a type of object-centred sequences common in biochemistry labs: scientists jointly orienting to a problematic object of work, manipulating it, inspecting it, talking about it, to see the same features of it, agreeing on their problematic character, and aiming to progress the scientific task with this object. Focusing on the early phases of these object-centred sequences, we identify and describe instructed vision, a process through which scientists build a common perception of an object, where manipulations and talk about the object are inseparable. From the moment a common perception is established, biochemists can look for new knowledge in and of the object. The article discusses the conventional dichotomy between mere seeing and scientific interpretation of the visible features of objects of knowledge.

Keywords: scientific practice – laboratory studies – ethnomethodology – conversation analysis – multimodality – visual perception – objects in interaction.

German Abstract
Dieser Artikel untersucht eine Art von gängigen objektorientierten Sequenzen in Biochemielabors: Wissenschaftler wenden sich einem problematischen Arbeitsgegenstand zu, handhaben ihn, untersuchen ihn und sprechen darüber, um seine Merkmale zu ermitteln und sich über deren problematischen Eigenschaften zu verständigen, mit dem Ziel, die wissenschaftliche Aufgabe bezüglich des Objekts voranzubringen. Mit Schwerpunkt auf den frühen Phasen dieser objektorientierten Sequenzen identifizieren und beschreiben wir das angeleitete Sehen, einen Prozess, durch den Wissenschaftler eine gemeinsame Wahrnehmung eines Objekts erlangen, die untrennbar mit der Handhabung des Objekts und den Gesprächen darüber zusammenhängt. Vom Zeitpunkt des Erreichens der gemeinsamen Wahrnehmung an können Biochemiker nach neuen Erkenntnissen über das Objekt suchen. Der Artikel bespricht die konventionelle Dichotomie zwischen reinem Sehen und der wissenschaftlichen Interpretation der sichtbaren Funktionen von Erkenntnisobjekten.

Keywords: wissenschaftliche Praxis – Laborstudien – Ethnomethodologie – Gesprächsanalyse – Multimodalität – visuelle Wahrnehmung – Objekte in der Interaktion.

Knowledge is (...) not anybody's knowledge, since it becomes available in the organizing sensibility of inquiry and the very features of the objects under investigation. (Lynch 1982:502)

1. Introduction

Transforming objects through procedures and experiments is scientists' overarching concern in the everyday practice of biochemistry. This article focuses on specific object-centred sequences where two biochemists in everyday interactions look at, manipulate and talk about an object of work. The findings are based on observations and video recordings, analysed in an ethnomethodological perspective and with the methods and tools of multimodal conversation analysis. When they work in copresence, it is commonplace for biochemists to draw each other's attention to an object they are currently working with, thus initiating an object-centred, collaborative sequence about it. During the subsequent interaction, colleagues focus on and coproduce the object and its qualities, by showing the object, inspecting it together, talking about its visible features, moving it, building and establishing a common vision and assessment of it, that is, a common perception, and devising what to do next with it to advance the experiment or procedure. The findings describe the interactional work of 'instructed vision' whereby biochemists build and establish a shared perception of the object. A common perception involves seeing the same features, but also agreeing on these visible features as problematic. Then, we show that biochemists can engage in creating new knowledge about objects of work by looking for some yet-unseen feature, beyond the common perception previously established. These sequences, by interweaving visual perception, problem solving and knowledge of objects play a part in the everyday advancement of scientific work. With these findings, the article aims to shed light on the organization of face-to-face interactions, on lab studies and scientific practice, and on the special issue's topic: object-centred sequences.

The first ethnographic observations of scientists at work were provided in the late 1970s and onwards in laboratory studies (e.g., Latour/Woolgar 1979; Garfinkel et al. 1981; Knorr-Cetina 1981; Lynch 1985; Barley/Bechky 1994). On the one hand, some of these studies, limited by their critical distance, tend to consider technical procedures and the resulting inscriptions as the core of science *per se*, and the source of its particular authority. Consequently, they reduce everyday interactional activities to mere social residues and disqualify them as proper scientific work. On the other hand, the conceptual efforts in laboratory studies still provide grist to the

mill to conduct ethnomethodological investigations, to try and understand how scientists "find their ways through singular troubles, vernacularly organized discussions, and embodied routines of inquiry, […] as an unremarkable competency with 'the facts of daily life'" (Lynch 1983:207). For example, Amann and Knorr-Cetina (1988a, 1988b), studying a molecular genetics laboratory with much resemblance with the one we studied, remark that shop talk is often "not just, as much talk is, about an object; it is directed to a concrete material object which participants hold in hand" (Amann/Knorr-Cetina 1988b:10). The authors also describe shop talk as "a production device for generating knowledge out of the manual and technical dimensions of laboratory work" (ibid.:11). But in another article discussing three practices whereby biochemists visually inspect materials (Amann/Knorr-Cetina 1988a), the same authors assert that "manual enhancement" practices are "treated as unproblematic displays of visual objects" and act as "observation at a glance" (ibid.:138). In other words, a biochemist looking at an object of work with naked eye immediately is assumed to *see* what s/he intended to see, or to check. She/he does not take time to *look at* or inspect it in order to interpret what s/he sees with her scientific expertise. However, since shop floor is said to be a production device for generating knowledge about objects, how can one assert that some instances of object inspection do not involve interpretation?

On the basis of our findings, we argue that the dichotomy between instances of "primary recognition" and "interpretation of a situation, account for a phenomenon" (Knorr-Cetina 1981:50) is a conceptual artefact. With this article we aim to demonstrate that every single time scientists look at objects in the lab, from the most ordinary to the most refined object, they always and inescapably engage with their professional skills to visually perceive and discriminate objects. Our data comprise a variety of manual enhancement practices, especially instances of "holding a test tube against the light to assess the progress of a biochemical reaction" (Amann/Knorr-Cetina 1988a:136). We show that processes of instructed vision, the build-up of a common perception of the object, sometimes followed by an upgraded involvement in joint inspection, achieve full-fledged and essential scientific work.

Biochemistry is a hands-on occupation involving many objects, ordinary ones like aluminium foil, specialized tools like pipettes and beakers, and specialized objects of work such as solvents or bacteria. Knorr-Cetina (1997) calls the latter "objects of knowledge", at the core of experiments, on which scientific publications depend, and to which scientists have a special relationship. An example of this is physicists' subjective involvement with objects which Ochs, Gonzalez and Jacoby (1996) studied through grammar in talk-in-interaction. They constantly monitor their status to evaluate their progress, not only through technologically-assisted means but also, pervasively, through direct inspection, with their hands and naked eye. These objects can and should have varying visible aspects throughout the scientific procedures or experiments they are embedded in, so that biochemists expect them to have a specific aspect in each particular phase.

As we will show in the analyses below, when biochemists handle and talk about objects together, various dimensions of their professional know-how can become relevant, such as theoretical knowledge of biochemical reactions, manual skills to handle the object, visual perception trained to identify specific phenomena (Goodwin 1994), and local information about the object. Biochemists also perceive the

object in the light of how an interactional project is made recognizable, is recognized and is reshuffled in the course of the interaction.

Particularly relevant to the present line of investigation is a series of studies on the mutual constitution of objects and methods in surgical operations. They have shown, for example, how surgeons and novices rely on and refer to the stepwise procedure to look for and identify anatomic elements (Koschmann et al. 2011; Koschmann/Zemel 2011, 2014). Like many of C. Goodwin's studies, these studies use instructional activities as data, where participants verbalize and account for their actions. In this way, practical reasoning in action is more visible and amenable to analysis than in most other types of activities. Likewise, while peer biochemists do not spontaneously explicate their actions in the lab, the object-centred sequences studied in this paper stand out in this respect. The sequence starts with an asymmetry between the biochemist initiating interaction about the object she/he is at grips with, and her/his colleague. As we develop in Section 3.2, a necessary achievement in the first phase of the following interaction is to build and establish a common perception of the object, and thereby balance the initial asymmetry. The work of instructed vision, observable in the initiation and early phases of object-centred sequences, is thus a conspicuous setting to study biochemists' perception of objects, or vision and knowledge in scientific practice. Additionally, the present study is a contribution to the very few video-based studies of laboratory work (Sormani et al. 2017; but see Alac 2008; Sormani 2014, 2016).

Criticising orthodox psychological approaches to perception, Gibson's ecology of perception (1986) shows that a theory of the mind is not necessary to conceive of perception processes, and relocates perceiving bodies in a co-evolving environment. Criticizing Gibson in turn, ethnomethodology warned against an all too direct conception of perception, reminding instead that perception is also mediated and framed by the activities we are involved in (Nishizaka 2000, 2006). Indeed, seeing is an active process inseparable from meaning and environmental affordances, or possibilities for action, so that we see 'more than meets the eyeball' (Coulter/Parsons 1991; Sharrock/Coulter 1998). Visual perception is never immediate, it is inseparable from practices and thus embedded in a complex web of material, temporal and interactional processes. C. Goodwin applied this fundamental idea to study vision in professional practice, with empirical data. The notion of 'professional vision' (Goodwin 1994), which has since become popular across disciplines, refers to actors' practices to isolate meaningful objects in their material world for the specific purposes of joint, ongoing streams of activities. It involves the use of coding schemes, the use of highlighting practices, and the articulation of graphic representation.

Professionals know not only how to look at objects but also how to make objects visible to others in a specific perspective. The manipulation of objects is often central to highlighting practices, like C. Goodwin's geochemist taking a fibre out of its bath to "highlight[ing] and position[ing] it for perception" in order to determine whether it has reached the specific black colour indicating that the chemical process is complete (1997:125). The assessment, with naked eyes, ought to be accurate for the whole experiment to succeed. In the case of biochemistry, scientists recurrently inspect substances contained in, for example, a microtube, a beaker or a microplate, by holding them in front of a light source, at a certain distance from their eyes.

Through these delicate, expert and yet non-standardisable manipulations (cf. Sormani 2016), biochemists can see for example how a dissolution process progresses, or whether bacteria cells have broken and moved from the centre to the borders of a microplate. In other words, those instances where biochemists take a close look at their objects are integral and critical to biochemistry work.

Thus, building on the existing literature and focusing on a specific type of object-centred sequence, the present article aims to offer new insights into objects in interactions, the mutual constitution of objects and technical procedures, vision as a practical accomplishment, laboratory studies and scientists' relationship to objects of knowledge.

2. Data and method

The first author stayed in a biochemistry laboratory in Finland for about two months over a two-year period, to observe activities, talk with scientists, and collect video recordings of their everyday (inter)actions. The corpus totals 120 hours of video recordings. The standard installation was two cameras in the main laboratory room and two cameras in the shared office. At times, some cameras were moved in other, specialized rooms, such as the ones for cell culture or microscopy. All the data used in this article are from the main laboratory room. Fieldwork also included numerous informal conversations with the biochemists. The researcher having no qualification in their domain – adding to each scientist having a specialty in a vast area of her/his own – fieldwork aimed at a general understanding of scientists' activities in the recorded stretches of (inter)action.

The multidisciplinary research group under study originates in a six-year funding obtained by two professors bringing together their respective domains of expertise, namely cellular biology and protein crystallography. They hired several PhD students and postdoctoral researchers from both fields, with another expertise of their own. The team was international, with members from France, Lebanon, Finland, Poland, and Iran. The languages spoken in the laboratory were English as a lingua franca, Finnish and French.[1] Besides their different career stages, the team members also had different levels of experience and skills. All these characteristics played an important role in everyday work, because, as the members themselves said, they were all likely to learn from each other.

From the video corpus, we built a collection of eight instances of co-present biochemists establishing joint attention to an object at hand and thereby becoming involved in an object-centred sequence. The low number of examples does not correctly reflect the ordinariness and frequency of the practice in the biochemistry lab. This low number is mainly due to the fact that activities in such a large workplace are difficult to video record. Consequently, many occurrences of the focus phenomenon escaped our cameras, taking place at times in another room, just outside the camera frame, or only partially in the scope of the cameras and microphones. In other words, the collection includes very few of the practice's occurrences in the period of the recording. Nevertheless, the examples we fully have at our disposal concur with fieldwork observations, and the collection is robust enough for a sound

[1] The transcriptions are produced in the original languages, and an English translation is provided below the original versions.

investigation of the practice. All instances were transcribed following Jefferson's (2004) conventions for talk and Mondada's (2018) conventions for embodied actions. Throughout the transcripts, BC1 refers to the biochemist initiating the sequence, and BC2 to her/his recipient. Therefore, the article also builds on recent developments in conversation analytic research on multimodal interactions using video data (Streeck/Goodwin/LeBaron, 2011).

3. Empirical analyses and findings

In this empirical section, we analyse in detail six examples from the data. Section 3.1 focuses on how co-workers create and establish joint attention to the object (Kidwell/Zimmermann 2007) and initiate an object-centred sequence. Section 3.2 focuses on how co-workers engage in and achieve 'instructed vision': jointly and collaboratively, they build and establish a shared perception of the object (Nishizaka 2014). BC2 observably turns from *looking at* to *seeing* the object (Heinemann 2016), and more specifically: to *seeing this visible feature as problematic.* Lastly, we show in Section 3.3 that scientists can, once shared perception is established, continue to look at the object, and thereby engage in the collaborative search for an explanation of the problem by looking for new features of the object. These findings provide further understanding of two dimensions that are particular to biochemistry work: material objects are central and made accountable through the features that biochemists jointly elaborate in copresent interactions; and the perception of objects of biochemistry is an interactional and progressive achievement inseparable from the scientific task at hand, and integral to the advancement of scientific work.

3.1. Creating joint attention to an object of work: Initiating an object-centred sequence

After first greetings, biochemists, like many workers in shared premises, spend most of the day in a continuing state of incipient talk (Schegloff/Sacks 1973:262; Szymanski 1999; Szymanski et al. 2006). A biochemist at grips with an object often takes the co-presence of a colleague as an opportunity to engage interaction about this object (see also Licoppe/Tuncer this volume), and thus to recruit (Kendrick/Drew 2016) the colleague in her/his current task. Excerpt 1, in which the participants are speaking French, is one of the three examples in our collection occurring in a continuing state of incipient talk. Before the transcript begins, BC2 entered the lab room where BC1 is working at her bench with microplates, and went to his refrigerator to take some of his microplates. The transcript begins as he is heading to his side of the bench next to BC1 and walking behind her, looking at and manipulating his microplates (Figure 1).

Excerpt 1 - Ça m'énerve là à chaque fois (Mon6Lab1-008 04''10)

01 #(4.0)
fig #Fig1

Figure 1

02 BC1 #Ça *m'é↑nerve↓ là à chaque fois ^qu'tu mets au frigo:=#
It annoys me there every time you put in the fridge,
fig #Fig2 #Fig3
bc1 *brings plate closer to her eyes, turns to BC2-->
bc2 ^turns head to plate, balances body left

Figure 2

Figure 3

03 BC1 =ça fait *plein de:, *plein d'eau comme ça là,#
=it makes tons of:, tons of water like this here,
bc1 *----------*transfers plate from right to left hand
fig #Fig4

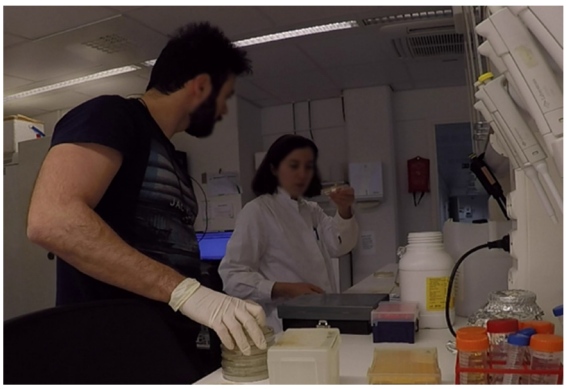

Figure 4

While BC2 places his microplates on his bench (Figure 2), BC1 initiates talk with *Ça m'é↑nerve↓ là à chaque fois qu'tu mets au frigo:ça fait plein de:, plein d'eau comme ça là,* ('It annoys me there every time you put in the fridge, it makes tons of:, tons of water like this here', lines 2-3). Projecting a complaint ('it annoys me') occasioned by something happening to her now ('there'), BC1 can be heard as recruiting BC2 in her current problem with this object. She also accounts for soliciting him by framing the problem as recurrent ('every time') and as a shared concern since it is likely to be experienced by any biochemists (impersonal 'you'). During her turn, BC1 turns the upper part of her body and slowly moves the microplate towards BC2 while following it with her gaze. BC2 turns his head to the microplate after 'every time' and balances his body from right to left, thus coming closer to the microplate so that they are both looking at it at the end of line 2 (Figure 3). BC2 thus makes himself available now and displays his involvement in the incipient interaction about this microplate.

These object-centred and collaborative sequences are systematically initiated with the same multimodal move: BC1 initiates talk about the object while proffering or orienting to it. The object itself can remain unexplicated, like in Excerpt 1; it can also be referred to with an indexical element (e.g., 'this one', in Excerpt 3 below), or even named (e.g., 'manganese', as in Excerpt 3 below). Similarly with gestures that point towards an object or a feature of the environment (see e.g. Hindmarsh/Heath 2000; Mondada 2007), the movement with the object is launched before talk, and reaches its apex during the turn. The recipient responds by turning her/his head and gaze towards the object early on during the first turn-at-talk and by moving her/his body closer to the object, as the latter reaches its apex.

While three examples in our collection occur in a continuing state of incipient talk, five of them occur during a conversation in an environment where a sequence is formally complete and initiating a new sequence is possible. Consider Excerpt 2, in which the colleagues speak Finnish. A few seconds before the transcript starts, BC1 has entered the lab room and launched a conversation with BC2, asking whether he has read some papers. BC1 is holding strips of glass containing a sample, of the sort to be placed in a microscope. BC2 has been working at his bench for some time, and while participating in the conversation he continues his task. Following BC2's turn 'pretty good' (line 1) referring to the papers previously mentioned, BC1 initiates an object-centred sequence about the sample he is currently manipulating (line 2).

Excerpt 2 - Siin on (March 3rd Cam 2 006 14''50)

```
01  BC2   Aika* hyviä.#
          pretty good
    bc1       *extends arm holding object-->
    fig               #Fig5
```

Figure 5

```
          (0.6)
02  BC1   ^Siin on,^#
           here is
    bc2   ^--------^turns face to sample
    fig             #Fig6
```

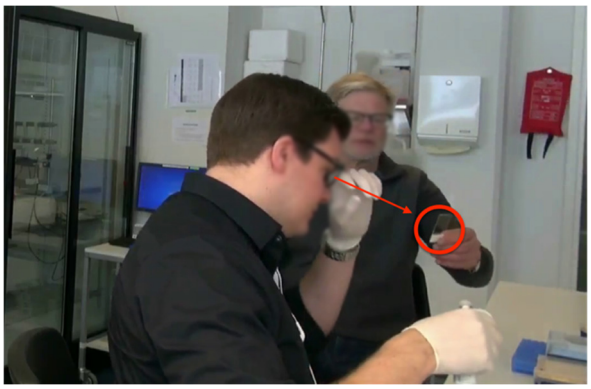

Figure 6

```
03  BC1   (.) pitäs (.) nähä (.) tuo, nii onkohan modifioitu,
              one needs to see that, whether it has been modified,
04        ^katopa vähä.
           have a quick look
    bc2   ^bends closer to sample
05        (1.0)
```

During BC2's closing turn in line 1, BC1 brings the sample closer to BC2's visual field (Figure 5). As BC1 holds the sample in that position, BC2 re-directs his gaze so that he is looking at the sample by the end of BC1's turn *Siin on,* (Here is,) introducing the object (line 2, Figure 6[2]). The initiating move is very similar to the one in Excerpt 1, except for the fact that BC1 first makes the object visually salient by proffering it, and when BC2's gaze is on the object, BC1 initiates talk and secures joint orientation. BC2 bends closer to the object during BC1's subsequent turn *(.) pitäs (.) nähä (.) tuo, nii onkohan modifioitu, katopa vähä* ('one needs to see that, whether it has been modified, have a quick look', lines 3-4). The turn is an explicit request for BC2 to look at and assess a specific feature of the object. With the initial

[2] With his left hand, BC2 is repositioning his glasses.

move and BC2's immediate shift of attention in response, joint attention is achieved and an object-centred, collaborative sequence is on its way.

In this section, we have shown how biochemists initiate object-centred sequences in the laboratory. As they jointly focus on an object of work, they engage in some sort of problem solving and commit to achieve something. Whether the sequences are initiated in a continuing state of incipient talk or during an interaction, they do not emerge out of the flow of a stepwise progression (Button/Casey 1985). Their initiation breaks with the ongoing activity. Besides, the interactional move is self-explicative as to its placement: as a biochemist at grips with an object of work draws a colleague's attention to it, the latter can reasonably infer that a problem is being brought up, along with a request of some sort. In the next section, we show that once joint attention to the object is created, the next step for biochemists is to see the same features and establish a common perception of it, by going through what we call 'instructed vision'.

3.2. Instructed vision: Seeing the same problematic features in the object and establishing a common perception

The objects biochemists manipulate are containers, such as microplates, beakers, microtubes, and samples, so that the actual objects of work are the substances they contain. They are looked at and/or inspected in the light of professional know-how, including for example formal knowledge of biochemistry, local knowledge of the procedure the substance is going through, local indications from inscriptions on the container, and embodied knowledge of how to manipulate the object and expose specific aspects of the substance. Among the most pervasive embodied practices associated with professional vision (Goodwin 1994, 1997), highlighting and positioning for perception are pervasively, recurrently at play in the biochemistry lab.

Processes of instructed vision are organized in a specific, recurrent fashion. In general, BC1 provides a first, candidate description of a specific phenomenon or a feature of the object, through more or less explicit, indexical or embodied means, indicating in which perspective BC2 should look at the object. Then, BC1 and BC2 collaborate for the latter to align to the former's initial perception of the object. Excerpts 3 and 4 are examples of two sets of practices of instructed vision: BC1 can provide indications through talk and bring BC2 to see the phenomenon at a glance; or BC1 can accompany BC2 in looking at the object in a more extended and careful way, while producing verbal indications and moving the object, for her/him to progressively perceive these features. Instructed vision closes when BC2 exhibits understanding (Hindmarsh et al. 2011) or displays that s/he has turned from *looking at* the object to *seeing* (Heinemann 2016) the same features as BC2. Although this may not always be the case, in our data seeing the same features goes along with sharing an assessment of these visible features as a potential topic of talk because they are problematic for the practical purposes of the scientific experiment or procedure.

In general, instructed vision involves not only seeing the same features of the object, but also agreeing on an assessment of these features as problematic: these two aspects form a common perception of the object. *Seeing* means seeing *that the object does not look the way it should,* and therefore seeing that *there is* a problem with this object, which accounts for initiating interaction about it. The latter also

implies that BC1 is stuck in her/his scientific task because of this problem, so that BC1's move is understood as recruiting her/his colleague in the problem, or requesting some form of help to resolve it. In most cases, BC1 does not specify what sort of help (Excerpt 2 is an exception), a point we discuss below in relation to the object's physical availability. The public, witnessable establishment of a common perception of the object is a turning point in the object-centred sequence. In a majority of cases, it is the moment biochemists stop looking at the object.

Shortly before the beginning of Excerpt 3, the colleagues have entered the lab while talking. Their conversation fades out while BC1 prepares to engage in a task by putting on gloves. In line 1, BC1 reformulates her previous turn from the vanishing conversation with quiet voice and falling intonation.

Excerpt 3 - J'ai un problème avec le manganèse (March 1st Cam 1 009 12''10)

```
01  BC1   °No:n, mais j'en referai (d'toute façon je:).°
          °No, but I'll make some more (anyway I:).°
02        (0.5)*(0.8)
    bc1        *turns head to object
03  BC1   #J'ai un *problème avec le manganèse, ^c'est que::,#
          I have a problem with manganese, it's tha::t
    bc1           *turns head mid-way between the object and BC2
    bc2                                        ^turns head to object
    fig   #Fig7                                          #Fig8
```

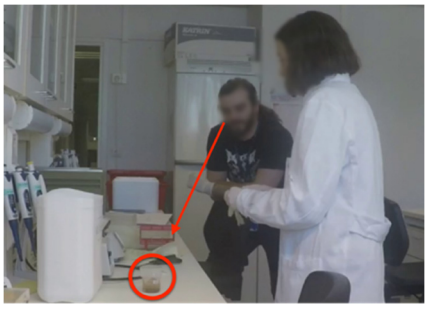

Figure 7

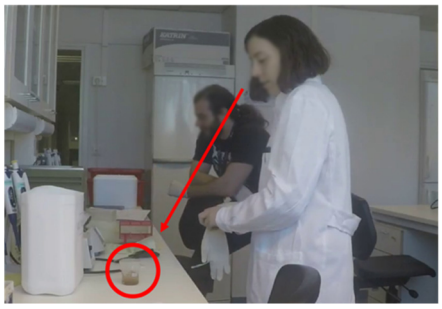

Figure 8

```
04  BC1   *la solubilité c'est à:, (un cinq) mole par litre,
           the solubility is at (one five) mole per litre,
    bc1   *turns head to BC2
05        (0.7)
06  BC1   et là j'suis à *un mole# par *litre,
          and here I'm at one mole per litre,
    bc1                 *sudden gesture with both hands to object
    bc1                             *turns head to object
    fig                       #Fig9
```

Figure 9

```
07          (0.2)*(0.2)
      bc1         *takes object
08    BC1   #e:*:t,*# e:::*:t,#
            a::nd, a:::nd
      fig   #Fig10
      bc1      *lifts object
                  *stops object in front of her eyes, turns towards BC2-->
      fig          #Fig 11
      bc1               *stops object close to BC2's visual field
      fig                    #Fig12
```

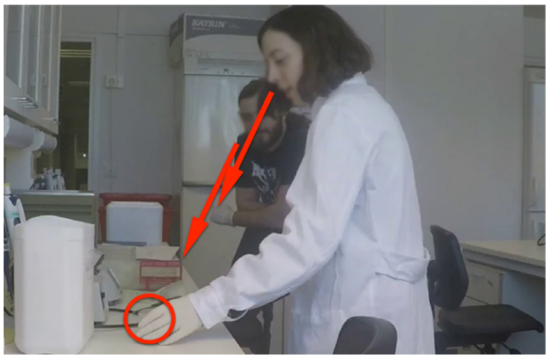

Figure 10

Figure 11

Figure 12

```
09    BC1   °Ça marche pas°.=
            °It doesn't work°
10    BC2   =Nor*maleme:nt t'ajoutes, eu:h pfff-
             Normally: you add e:r pfff
      bc1       *turns the product and her body away from BC2
11          (1.8)
12    BC2    T'ajoutes- eu:h du: HCl,
            You add e:r so:me HCl,
```

During a silence (line 2), BC1 turns her head to the beaker (Figure 7). Then, she initiates a new sequence with an extended TCU in a louder volume than her previous turn: *J'ai un problème avec le manganèse, c'est que::,* ('I have a problem with the manganese, it's tha::t', line 3). Similarly to Excerpt 1, this turn raises a problem and projects its explication. At this point, BC2 is looking away, his upper body half turned to BC1 (Figure 7). After BC1 has turned her gaze away from the beaker early in her turn, BC2 turns his gaze to it (Figure 8), displaying his understanding that she is referring to this beaker. BC1 is looking at BC2 as she progresses her telling: after naming the substance ("*manganèse*"), she tells what she knows about the normal solubility ratio (*la solubilité c'est à:, (un cinq) mole par litre;* the solubility is at (one five) mole per litre, line 4) and then the current concentration of solvent in

the sample at hand: *et là j'suis à un mole par litre,* ('and here I'm at one mole per litre,', line 5), stressing *un* (one, line 6) to emphasize that the proportion of manganese is even lower than it should be. In other words, although she has not fully formulated the problem (yet), the premises she has just set out make it fully understandable: considering what she has done, the manganese should now be dissolved, but it is not. As she shifts from manganese in general to this beaker here and stresses *un*, she makes a two-hand, palm-open pointing gesture towards the beaker (Figure 9). Shortly after she turns her head to it, takes it from the bench during a brief silence (Figure 10), and while uttering *e::t,* ('a::nd', line 8) she lifts the beaker and brings it closer to her eyes, probably to check the solution's aspect now (Figure 11). She then turns to BC2 and brings the beaker closer to his eyes, while uttering another extended *e::::t,* ('a:::nd', Figure 12). She stops the beaker in BC2's sight, turns her head to him and, on lower volume, produces a generic problem formulation: *Ça marche pas.* ('It doesn't work.', line 9).

In response, BC2 proposes a standard procedure as an alternative: *Normaleme:nt t'ajoutes, eu:h pfff—(1.8) T'ajoutes eu:h du: HCl*, ('Normally: you add e:r pfff- You add e:r so:me HCl,' line 10-12). That he can see, or whether or not he can see the same feature of the object is not mentioned. He treats BC1's move as framing visual perception and assessment of the substance as a settled issue, and not as a request to inspect it. Meanwhile, BC1 moves the beaker away from his view: BC2's previous response is aligned and sufficient so that embodied, joint orientation to the object is no longer relevant. Although the achievement itself remains implicit, they have built and established a common perception of this substance. They no longer look at the object together, but they remain involved in the object-centred sequence by talking about other potential solutions.

This excerpt exemplifies one possible organization of instructed vision. While the object is visually available and oriented to by both parties, BC1 engages in a complete problem presentation through talk. Thus, she first tells what features of the substance BC2 should see, and then brings it into his close view for him to see them at a glance.

A different organization can be found in Excerpt 4, the continuation of Excerpt 1. First, BC1's embodied conduct and the indexicals in her turn-at-talk invite BC2 to look at the object in order to see what she is talking about. Second, the initial absence of response from BC2 is treated as a display of *not* seeing, leading to an expansion of the joint inspection and manipulation of the object. Instructed vision is more progressive than in Excerpt 3, and the establishment of a common perception of the object is also more visible.

Excerpt 4 - Ça m'énerve là à chaque fois (Mon6Lab1-008 04''10)

```
01          (4.0)
02  BC1     Ça *m'éɬnerve↓ là à chaque fois ^qu'tu mets au frigo:=
            It annoys me there every time you put in the fridge,
    bc1       *brings plate closer to her eyes, turns to BC2-->
    bc2                                    ^turns head to plate, balances
                                            body left
```

03 BC1 =ça fait *plein de:, *plein d'eau comme ça là,#
=it makes tons of:, tons of water like this here,
bc1 *----------*transfers plate from right to left hand
fig #Fig13

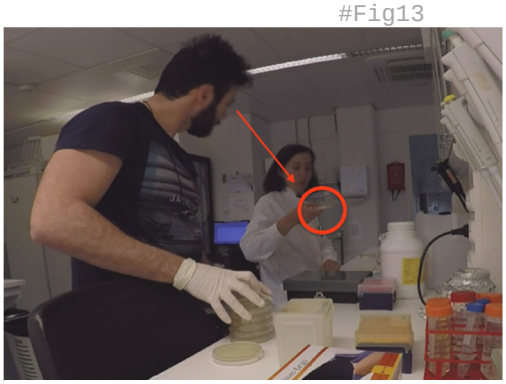

Figure 13

04 BC1 Je sais pas si *c'est ^>normal,
I don't know if it's >normal,
bc1 *looks at BC2's plates
bc2 ^bends to look closer at plate
05 =toi< ça# ^l'*fait aussi,* ou pas.
=you< it does it too, or not.
bc2 ^straightens up, walks closer
bc1 *looks at BC2
bc1 *looks at her plate
fig #Fig14

Figure 14

06 (0.6)
07 DIA Tu vois ^l'eau# dessous? (.) Dans le couvercle?#
You see the water underneath? (.) In the lid?
bc2 ^approaches hand to plate, bends to look from the side
fig #Fig15 #Fig16

Figure 15

Figure 16

```
08          (0.7)
09  FRE     ^Oua::h, ^ha *ha::.#
             Wa::h, hah haa::.
    bc2     ^--------^turns to his own plates, grabs one
    dia                 *turns to BC2's plate
    fig                       #Fig17
```

Figure 17

Framed as a complaint and making the problem purportedly shared, BC1's initial turn *Ça m'énerve là à chaque fois qu'tu mets au frigo: ça fait plein de:, plein d'eau comme ça là,* ('It annoys me there every time you put in the fridge, it makes tons of: tons of water like this here', lines 2-3) is indexical and displays little knowledge about the phenomenon, specifying mainly that there is too much water in her microplate. In line 3 (Figure 13), she transfers the microplate from her right hand to her left hand, thus bringing it closer to BC2's visual field, and then holds it in a tilted position: she *shows* the microplate so that BC2 has good visual access to it through a specific angle. In other words, the indexicals "like this here" combined with BC1's embodied conduct invite BC2 to *look at* the object in order to understand and *see*, at the same time, what she is talking about.

She verbalizes her lack of knowledge about the problem: *Je sais pas si c'est >normal,=* ('I don't know if it's >normal=', line 4), and continues with the question *=toi< ça l' fait aussi, ou pas.* ('=you< it does it too or not', line 5). Asking whether BC2 experiences the same phenomenon with his microplates assumes that he has understood and seen the problem she is referring to. However, during the question, BC2 bends closer to the microplate (Figure 14), a movement she responds to as a display of not yet seeing the quality of the problem. She provides a further indication of the phenomenon, its location, in two parts: *Tu vois l'eau dessous? (.) Dans le couvercle?* ('You see the water underneath? (.) in the lid?', line 7), but BC2 still does not answer and keeps looking at the microplate. Since an answer is expected, he is committed to keep looking until he can see the problematic phenomenon and they can establish a common perception of the object.

Just before the question on line 6, BC2 brings a hand to BC1's hand holding the microplate, and without actually touching it, he guides her movement in order to see the microplate from different angles (Figures 15 and 16). Then, with the response cry *Oua::h, ha ha::.* ('Wa::h, hah haa::.', line 9) while turning away from BC2 (Figure 17), he shows that he has seen the phenomenon. The marked response cry also assesses the phenomenon as remarkable. BC2 turns to his own microplate, in order to answer BC1's initial question: whether he has experienced the same problem in his microplates. They do not look at BC1's microplate any more, and

BC2 answers that he does not have the same phenomenon, and shortly after he will suggest a potential explanation for BC1's problem (not shown in the excerpt).

In Excerpt 4, instructed vision is organized in such a way that BC1 brings BC2 to see the object in the same perspective by making it visually available to BC2 from the onset and guiding him through verbal indications and manipulations. The phenomenon is not visible at a glance: it requires careful and extensive inspection of the object. A comparison between Excerpts 3 and 4 suggests that whether joint inspection occurs or not, and its duration, may be influenced by how BC1 shapes the problem presentation. In situations such as Excerpt 4, where BC1 does not name the phenomenon, biochemists can rely on the object's physical presence and the possibility to inspect it together to overcome the naming problem and progress interaction and the scientific task anyway. In Excerpt 3, on the other hand, BC1 explains in some detail what procedure the substance has been through for BC2 to see at a glance that its visible aspect is problematic.

Excerpts 3 and 4 are examples of the most common trajectory where biochemists put away the object once they have established a common perception of it. They remain involved in the object-centred sequence until something has been achieved, but with the physical object no longer the focus of joint attention, this is achieved mainly through talk. In Section 3.3, we address a different trajectory: once a common perception of the object is established, the colleagues not only remain jointly oriented to the object but also engage in a second, upgraded inspection phase.

3.3. Re-engaging in joint inspection once common perception is established: Problem solving and the creation of new knowledge of objects

Once it is established *that* something has gone wrong, biochemists can remain involved in inspecting the object, or even upgrade their involvement, in order to see *what* can possibly have gone wrong. In other words, object-centred sequences of this sort can also aim at creating new knowledge of objects of work, a work of interpretation using the technical means of manual enhancement only.

In Excerpt 3 above, we showed how BC1 brings BC2 to see that the manganese in the present beaker has not dissolved, although it should have, considering the proportions of manganese and solvent in the beaker. Later the same day, she initiates another object-centred sequence with BC2, bringing up the developments of same problem. A few seconds before the excerpt starts, Elsa, a PhD student newly arrived in the team, has come in the lab room to ask a piece of information from BC2. BC1 participates in their conversation while also pursuing her tasks. She manipulates a measuring cylinder containing brown substance, regularly looking at and moving it (Figure 18). As the transcript begins, BC2 is turning pages in his notebook, looking for an answer to Elsa's question.

Excerpt 5 - What I'm going to do with that (March 1st Cam 1 010 04''40)

01 BC1 W- It should be::- u:::h# o:- e- on the shelf at H,=
fig #Figure 18

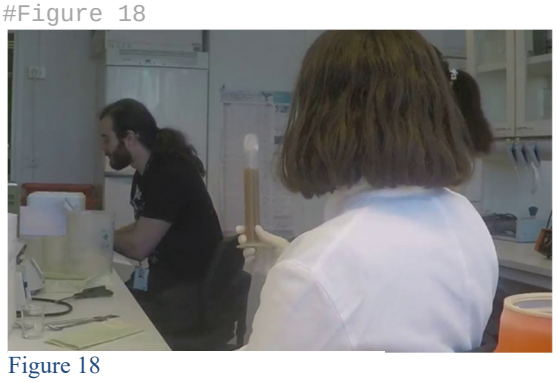

Figure 18

02 BC1 =but I, I (.) don't remember I've seen this.
(1.4)
03 BC1 Fuck, ↑what I'm going to do with ↓that. ^Freddie.# hih ↑heh.
bc2 ^turns head to BC1
fig #Fig19

Figure 19

04 ^(0.4)*(0.6)#(1.0)
bc2 ^turns upper body-->
bc1 *puts second hand on tube, moves it upside down
fig #Fig20

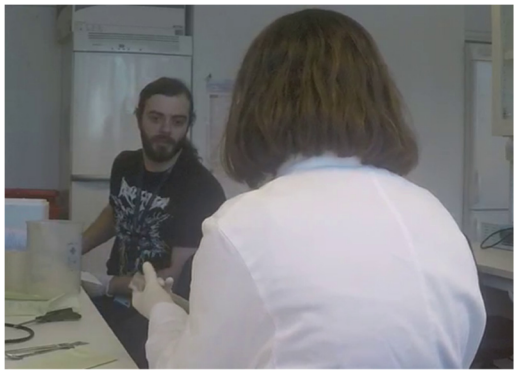

Figure 20

05 BC1 Mmmmmm. ((whining sound))
06 BC2 Mm t-*
bc1 *stands up, walks to BC2
06 (1.3)
07 BC1 (° I just wanted-°) (.)*
*holds tube horizontally close to BC2

```
        ^(0.5)^#(2.0)^(0.6)^(0.3)
    bc2 ^-----^turns to BC1, repositions arms
    bc2               ^-----^raises left hand and takes tube
    fig         #Fig21
```

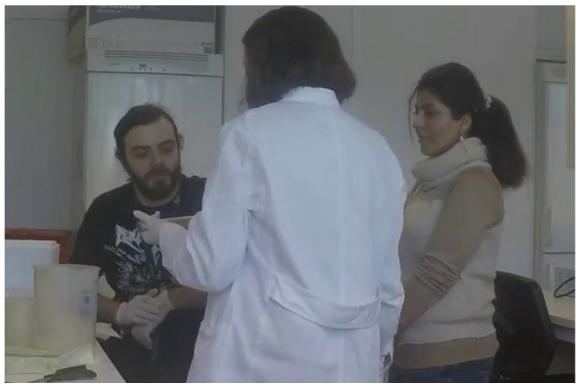

Figure 21

```
07  BC1   I wanted to filter, but in fact^ it wasn't# (  [     )]
    bc2                                   ^holds beaker with both hands-->
    fig                                          #Fig22
08  BC2                                            [I (  )], yeah.
```

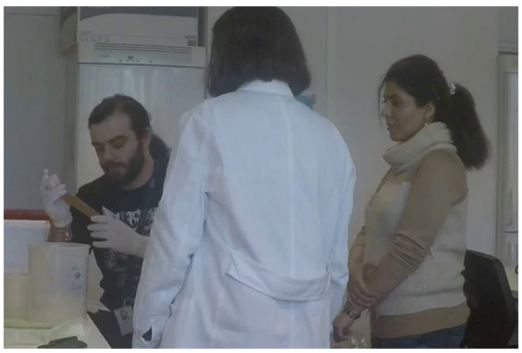

Figure 22

```
09        (4.0)
10  BC1   ^S:hould I just# leave it (.) like this?
    bc2   ^shakes the tube upside down-->
    fig                 #Fig23
```

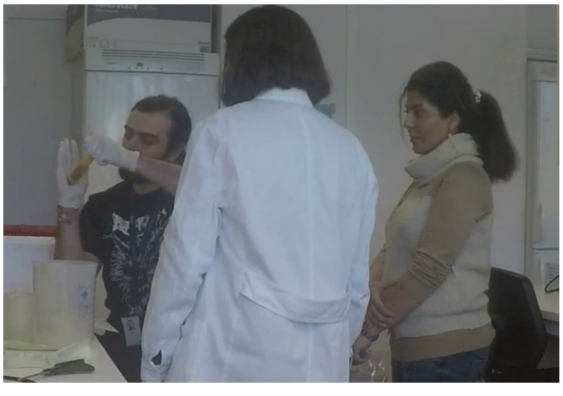

Figure 23

```
11        (4.2)
12  BC2   Check on the ^other (   *      ).
    bc2               ^takes one hand off the beaker
    bc1                          *moves arm to beaker
```

```
13          (0.4)
14  BC1     (°Yeah.°)
15          (0.3)*(2.3)
    bc1          *takes beaker, turns away from BC2
16  BC1     Okay,* let's check the (          ).
    bc1          *puts beaker back on bench
17  ELS     (          ), you are in the middle of your ↑work, ↑hunh?
```

On lines 1-2, BC1 answers Elsa's enquiry with *W- It should be::- u:::h o:- e- on the shelf at H, but I, I (.) don't remember (where) I've seen it*. Then, she breaks with the ongoing conversation by initiating a new sequence, addressing BC2 only, on a different topic: *Fuck, ↑what I'm going to do with ↓that. Freddie.*[3] *hih ↑heh*" (line 3). The swear word, the vocative and the nervous laughter contribute to making this turn hearable as a call for help. BC2 immediately turns his head to the cylinder (line 3, Figure 19), and at the end of BC1's turn, he moves in the same direction with his upper body. Thus, he demonstrably understands that BC1 is referring to the cylinder in her hand, and visibly disengages from his current task to attend her call for help.

During the ensuing silence (line 4), BC1 moves the cylinder upside down (Figure 20), stirring the liquid for BC2, showing him that the substance is not properly dissolved. This common perception of the same object has been previously established, and BC2's tacit alignment shows that he still relies on it. He also seems to understand that BC1 still has not solved her problem despite other attempts since their previous interaction about the substance. BC1 reinforces her complaint with a whining vocalization (line 5). Then, she stands up, walks to BC2 and moves the cylinder closer to his visual field in a horizontal position, thus inviting him to look at it with more than a glance. With his gaze constantly on the cylinder from the start, BC2 pivots his chair (Figure 21) and takes the cylinder, indicating he is going to inspect it manually. He manipulates it, looks at it closely from different angles, and sets the substance inside the cylinder in motion. By taking the cylinder, BC2 also displays his further involvement in trying to help BC1 solve her problem (Tuncer/Haddington, in press).

BC2 holds the cylinder in a sideway position (Figure 22) and looks at it for about 8 seconds. He then blocks the upper opening with the palm of his hand and moves the beaker upside down, to let the substance flow and display its texture (Figure 23). Meanwhile, BC1 reports on her previous, abandoned attempt (line 7) and asks *S:hould I just leave it (.) like this?* (line 10): they are jointly trying to find a solution, relying on the possibility that BC2 sees new features of the substance. A 4.2-second silence follows, after which BC2 suggests where she should look for information: *Check on the ( ).*[4] (line 12). Meanwhile, he turns his gaze away from the beaker and gives it back to BC1 who puts it on her bench while agreeing to the suggestion with *Yeah. (2.) Okay, let's check the (.)* (lines 14-16). Thus, she treats BC2's suggestion as a sufficient response to her initial call for help, making possible the closing of the object-centred sequence. Elsa enters the floor again (line 17), and soon after BC1 leaves the room (not shown), heading to the suggested information source. BC2's inspection of the object does not result in the perception of new features of it, but while looking at it, BC2 makes a suggestion that directs BC1 towards a yet unexplored source of information about the object.

---

[3] Freddie is the pseudonym we chose for BC2.

[4] We were able to show the recordings to BC1, she told us that BC2 most probably suggested she looked at an online resource, although she was not able to remember or hear what he says exactly.

Excerpt 6 shows a similar trajectory, where BC2, after the colleagues have established a joint perception of the object, takes the latter to inspect it. However, in this example BC1 orients to BC2 as more knowledgeable about the substance they examine. BC1 and BC2 have been working at their respective benches for some time, in a continuing state of incipient talk, with their backs turned to each other. BC2 is wearing earphones. Before the beginning of the transcript, BC1 approaches BC2 from behind, looking at a microtube and holding it away from his body in a proffering gesture. When BC1 takes the floor on line 1, BC2 moves his upper body backwards and turns his head to the microtube (Figure 24).

Excerpt 6 - Is it normal that Hoechst is like this?

```
01          (12.1)
02  BC1     #Is it no:rmal that Hoechst is like this?
    fig     #Fig24
```

Figure 24

```
03          ^(0.7)
    bc2     ^removes earphones-->
04  BC2     ↑° Mmmm?° ^
    bc2       ----->^
05          (0.5)
06  BC1     *Is it no:rmal* that *it's::-
    bc1     *-------------* shakes the tube
                               *turns to BC2, freezes
07          (1.2)
08  BC2     °What is it?°
09          (.)
10  BC1     Hoechst.
11          (1.3)
12  BC2     Yea:h. (.) I think normally it's-
13          (0.7)
14  BC2     it's- (.) yellow.
15          (0.5)*(0.5)
    bc1           *turns head to tube
```

```
16  BC2   [(       )]
17  BC1   [No, I mean *it]'s::::#, usually it's more liquid.
    bc1               *raises left hand to tube, hits tube, turns it
                                                      upside down-->
    fig                          #Fig25
```

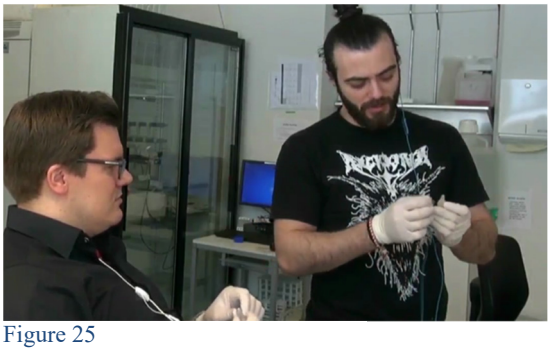

Figure 25

```
16          (1.0)*(0.5)
    bc2          *extends arm-->
17  BC2   °Yeah, that's true.°
18        (0.5)*(0.5)#(4.5)
    bc2          *takes the tube
    fig                #Fig26
```

Figure 26

```
19  BC2   Yea:h. (.) Well, it should be fifty percent alcohol.
```

As soon as BC2 has turned to the microtube, BC1 initiates talk with the question *Is it no:rmal that Hoechst*[5] *is like this?* (line 1). He names the substance and addresses BC2 as more knowledgeable about it, but with the indexical *like this* the question is unspecific as to which feature it refers. Meanwhile, he makes some features visible and highlights them by moving the microtube upside down and turning it around in his hand. After BC1 has repeated the name of the substance at the end of a repair sequence (lines 6 to 10), BC2 provides an answer: *Yea:h (.) I think normally it's- (0.7) it's- (.) yellow* (lines 12 to 14). He treats the question as referring to the object's colour, and grounds his assessment on what he knows is the normal colour of Hoechst. This answer is at odds with what BC1's overall move projects, namely that there is a problem with this substance. Then, BC1 initiates a new process of instructed vision. He turns his head to the microtube again, thus inviting BC2 to take another look at it, rejects the answer and treats it as misaligned with *No* in

[5] Hoechst is a cell-staining substance commonly used in biochemistry. Laboratories receive a base substance which is dissolved by scientists in various concentrations to produce a set of substances they will actually use.

initial position (line 17). Then, with *No, I mean it's::::, usually it's more liquid.* (line 18), he specifies which feature he was referring to: texture instead of colour. At the same time, he raises his other hand, hits the microtube with one finger, and turns it upside down with both hands (Figure 25): he sets the substance in motion for BC2 to *see* the texture, a feature which becomes visible in movement only. Like in Excerpt 4, BC1 guides his colleague to see particular features of the object through verbal instructions and manipulations. In other words, instructed vision is achieved in a multimodal, collaborative and progressive fashion. Achieving a joint understanding of the specifics of the object's features requires not only manipulations of the object but also sometimes misunderstandings and corrections by which BC1 specifies the object's features relevant for the inspection.

A common perception of the substance is established as BC2 confirms BC1's candidate assessment with °*Yeah, that's true.*° (line 17). Similarly to Excerpt 5, instead of turning away from the object, BC2 takes the microtube, indicating he is going to inspect the substance manually and more carefully (line 18). While the microtube is within BC2's reach from the beginning, he takes hold of it only after they have established a common view of the problem with the substance. Consequently, he takes the tube only after it becomes relevant for him – as the participant who is treated from the beginning as more knowledgeable about this substance – to provide his expert contribution to the issue by spotting details in the substance BC1 cannot see on his own. Similarly to Excerpt 5, this new phase aims to create new knowledge about the object, through upgraded, more detailed and self-administered inspection.

Holding and viewing the microtube so as to let light through it, shaking and moving it, BC2 inspects the substance (Figure 26) for 4.5 seconds. He resumes talk with *Yea:h. Well, it should be fifty percent alcohol* (line 19), drawing on his prior, theoretical knowledge of Hoechst. Later, he gives the microtube back to BC1 and suggests he should wait a little more until the substance has reached the ambient temperature and completely melted (not shown in the transcription). Thus, the second, self-administered inspection leads him to see that the undissolved matter in this sample of Hoechst may be due to temperature, which finally provides BC1 with a suggestion that helps solve the problem.

4. Conclusion

In this article, we have demonstrated through empirical analyses that biochemists discussing objects' visible qualities in their everyday interactions involves fundamental interpretative, discovery work. The objects and substances of biochemistry are intricately embedded in, and therefore always and inescapably perceived from within, the lived activity of scientific procedures and experiments. With these findings, we argue that Knorr-Cetina's assertion according to which materials "appear unproblematically readable" (1981:136) in practices of manual enhancement should be nuanced, if not discarded, along with the radical dichotomy between primary recognition and "interpretation of a situation, account for a phenomenon" (1981: 50). The analyses of different trajectories show that neither the type of object nor the initiating move determine what biochemists will *look for*, as they engage in an object-centred sequence and *look at* an object of work.

The findings were presented in three sections. First, we showed how these sequences are initiated: the initiations break with the ongoing activity, they project problem presentation and even complaints, and they draw attention to a physically present object. Second, we focused on the process of instructed vision: starting from no or little shared background about an object at hand, colleagues jointly and collaboratively build a common perception of it, that is, they come to see the same features and agree on them as problematic. We showed that instructed vision could be achieved in at least two different ways, involving either extended verbal problem presentation and late showing of the object, or joint inspection of the object combined with verbal, indexical indications on how to look at it.

In the last section, we showed that biochemists can engage in a second, upgraded inspection of the object after they have established a common perception of it, to look for a potential solution in yet-unseen features of the object: these objects can disclose more than what has been established. The upgraded inspection and engagement in a joint scientific endeavour involve BC2 taking the object and looking at it while manipulating it, which are decisive moves for the solicited party to engage with a colleague's problem. In other words, while it is generally unclear what sort of help BC1 expects from BC2, while the object's physical availability is a resource for BC1 to initiate interaction without being seen as enforcing BC2 into collaboration, it is also a resource for BC2 to commit in solving the problem. Collaboration in a shared workspace critically relies on physical objects as resources for colleagues to negotiate their engagement in emergent collaboration.

Also, building and establishing a common perception of an object can be critical, in local situations, to make sense of experiences and procedures, but also to collaborate on a daily basis in a shared workplace. These local episodes contribute to the making of professional relationships as fundamentally object-mediated. But while the analyses focused on interactional achievements and trajectories, the findings also shed light on seeing objects of knowledge in scientific practice as a practical accomplishment, and as practical reasoning. The findings have shown that biochemists can perceive different relevant aspects of the same object at different moments and as their practical purposes with the object change. The same features of an object can be seen at a glance, as well as inspected at length to look for new details and better understand these features. Perhaps constitutive of professional vision in scientific practice is this guiding principle that one has never exhausted the relevant features visually available in an object of knowledge. What one can extract and isolate from an object's visible presence is endless, and so is the possibility to understand and discover scientific characteristics of an object of knowledge through careful inspection. The work of biochemistry is inseparable from a material world, it progresses along with the creation of knowledge in commonplace episodes of workplace (inter)actions.

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6. Appendices

Transcript conventions

* * ^ ^	Gestures and descriptions of embodied actions are delimited between two identical symbols (one symbol per participant) and are synchronized with correspondent stretches of talk/silences.
---> ---->*	The action described continues across subsequent lines until the same symbol is reached.
bc1	Participant performing the embodied action
#Fig #	The exact moment at which a screenshot has been taken is indicated with a specific sign showing its position within the turn at talk

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