

Situated abstraction: From the particular to the general in second-order diagnostic work

Discourse Studies

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DOI: 10.1177/1461445613514674

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Abstract

The present study examines the work of a group of medical scientists as they identify interpretative ‘pitfalls’ – recurrent sources of error – in the use of a new radiographic technique, formulate suggestions on how these pitfalls can be avoided and communicate their findings in the form of a scientific publication. The analysis focuses on a session in which previously diagnosed cases are discussed, and demonstrates the ways in which a certain source of diagnostic error gradually emerges as a taken-for-granted in the interaction. An increased sense of recognition, recurrence and typicality is discernible in the treatment of the cases. Talk characterized by expansions and

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elaborations, displays of understanding in the form of reformulations, understanding checks, and so on, leave room for brief typifications and reifications of interpretative difficulties in characteristics of the imaging technique. Topical treatment of perception and interpretation, as well as embodied engagement, become decreasingly salient. It is argued that the abstracted formulations in the published text rely on the case-by-case working up of generality from particularity; from individualized accounts of why 'I' interpreted the image in a certain way to proffered generalizations achieved through articulated perceptions of a generalized 'one'. If these proffers are ratified, a potential ground is established for the consensual formulation of a pitfall. The formulation of novel instructions is consequently made relevant, projecting a re-instructed diagnostic practice.

Keywords

Conversation analysis, ethnomethodology, radiology, scientific work, visualization

Introduction

Medical practice effectuates orientations of and to the bodies of patients that are distinct from the orientations that occur in the attitude of everyday life. The difference is not only a reduction in the scope of perceptual and practical attention, as when surgeons zero in on the manipulatory sphere of an incision site, for instance. The difference also concerns the ways in which the broader significances of the body are backgrounded and rendered inconsequential (Hirschauer, 1991) in favor of a praxiological refraction appropriate to the relevancies of medical work. As Hirschauer notes, 'in an operation, the patient is transformed from a person into a body, and from an everyday-body into an anatomical one' (1994: 336). Some medical specialties imply even further distancing from everyday orientations to the body. Pathologists, for instance, work with processed samples physically removed from the living tissue. Radiology, the field of the case analyzed in the present study, represents an additional abstraction, as the body of the patient is subjected to various imaging technologies and thus becomes available to practitioners only in the form of visualizations. However, radiologists' work concerns identifying very real bodily entities. As previous studies have shown, working with visualizations of the body implies recruiting not only conceptual knowledge of anatomy (Prasad, 2005), but also embodied reasoning (Alac, 2008). Radiological practice thus represents an intersection of *embodied* and *mediated* diagnosis, illustrating the uncertain border between diagnostic work understood as visceral, interpretive and reliant on disciplined perception and practices privileging technological and discursive modalities (Büscher et al., 2010a).

It has repeatedly been shown that established practices of diagnostic work and mediated seeing become problematic as new forms of visualizations are introduced (see e.g. Burri, 2008; Prasad, 2007). Innovation in medical imaging technologies actualizes a need to learn anew how to see the body through the representation and makes communicating about experiences and findings beyond the local context relevant. As Lachmund observes, only by 'forcing a translocal orchestration of the doings, sayings and material objects that make up the texture of scientific/medical work [do] particulars become transformed into universals' (1999: 422). The present study examines the work of a

group of medical scientists who, as part of an innovative application of a radiographic technique known as tomosynthesis (TS), identify potential interpretation problems caused by the new technology, and communicate their experiences in the form of a scientific publication: ‘Learning aspects and potential pitfalls regarding detection of pulmonary nodules in chest tomosynthesis and suggested related quality criteria’ (Asplund et al., 2011). Our analytic interest, building on previous analyses of the setting (Rystedt et al., 2011), lies in examining the practices through which an interpretative pitfall is found and formulated. This research interest situates the study in extant initiatives to examine diagnostic work, not as a product of individual cognition but as socially situated, embodied and material practice (Büscher et al., 2010b). The particular case also extends this interest to consider the *second-order diagnostic work* of interpreting arrays of first-order diagnoses to account for recurrent sources of error. Several questions are addressed: How is a certain aspect of TS identified as a pitfall? How are accounts of error formulated and inscribed, interactionally in the session as well as in text? What is the relation between the lived scientific work and the necessarily brief formulations of that work that appear in the published account?

In the analyses, we demonstrate how the limited depth resolution of TS emerges and comes to be treated as a recurring source of error. We focus in particular on the work of moving from the particular to the general descriptions of ‘this image’, for example, to characteristics of ‘tomosynthesis’ in general, and from characterizations of individual error and subjectively experienced difficulties to articulations of the seeing of a generic ‘one’, what ‘one’ finds difficult and so on. The interactive accomplishment of such movements, we argue, forms the necessary basis for the subsequent textual accounts. Publicly recognizable accounts of error furthermore establish even erroneous analyses as disciplinarily rational ‘instructed actions’ (Garfinkel, 2002), and thus make relevant the formulation of remedial instructions.

The case: Chest tomosynthesis and pitfalls in detecting pulmonary nodules

Tomosynthesis refers to the technique of acquiring multiple low-dose radiographs of a patient within a limited angular range, and using these radiographs to reconstruct an arbitrary number of section images. The new technology was introduced at the studied university hospital because TS was considered a promising alternative to standard X-ray imaging (projection radiography and computed tomography (CT)) in detecting *pulmonary nodules* (small, rounded, potentially cancerous objects) in the parenchyma (lung tissue). Compared to projection radiography, TS results in an improved visualization of anatomy and pathology, whereas compared to CT, TS produces section images at a substantially lower radiation dose (although with a lower depth resolution). In an initial study, the group of radiologists and medical physicists working with these technologies showed that detection of pulmonary nodules was substantially improved for TS compared to projection radiography, even if the radiologists had limited experience (six months) with TS (Vikgren et al., 2008). It was expected that the detectability would improve as clinical experience of the technique increased, but a follow-up study conducted a year later did not show such an improvement (Zachrisson et al., 2009). Several

strands of research activities were initiated to address this issue. In particular, a study was conducted aiming at understanding the limitations of TS for detecting pulmonary nodules, as well as investigating how observers could improve their performance in detecting nodules. In the study, a group of observers first individually assessed a number of TS cases for the presence of pulmonary nodules. Suspicious findings were marked, and the observer's confidence in each marking was rated. Subsequently, a 'learning session' was organized, in which the observers as a group reviewed and discussed all images and markings, expanding in particular on the reasons for the diagnostic errors (as judged against CT scans of the same patients). Apart from investigating whether the group's performance could improve as a result of participating in the learning session, the group wanted to understand why certain errors had been made, to learn how to avoid making similar mistakes in the future. The group wanted to identify pitfalls, particularly problematic aspects of the images, and find ways of avoiding them. Apart from identifying a need for learning on the part of the staff, the group also found it relevant to communicate their experiences of using TS to the radiological community at large. Since this group was one of the first groups of professionals to use TS for this particular purpose (detecting pulmonary nodules), making the local learning that took place at the hospital useful for others was an important goal. For this purpose, the group documented their discussions, and reported their findings in the radiology journal *Acta Radiologica* (Asplund et al., 2011). In the article, the work that is to result in identifying pitfalls and explaining erroneous analyses is described in the following way:

All authors participated in the collective session and discussed each mark. The observers – six of the authors – gave their reasons for making false-positives (i.e. falsely marking structures that were not nodules), making false-negatives (i.e. missing true nodules) or giving low ratings to true nodules. The reasons for making analysis errors were compiled and [. . .] used to formulate suggestions on how to avoid pitfalls in tomosynthesis regarding detection of pulmonary nodules. (p. 506)

One notable characteristic of this account is its brevity, and the seemingly straightforward character of the work described. The observers, the account says, 'gave their reasons' for making various errors; these reasons are 'compiled' and then 'used to formulate suggestions on how to avoid pitfalls'. In the condensed prose of a medical publication, the work of the learning session results in the realization that:

false-positives and false-negatives had often been made near pleural borders. Hilar and mediastinal lymph nodes and skeletal changes, including costochondral calcifications, had occasionally been interpreted as nodules. In some cases, nodules situated close to vessels had been misinterpreted as part of the vessel itself, especially at branching points. (p. 507)

These findings are compiled in a chart (see Figure 1), where each pitfall is paired with a suggestion for avoiding it. For this study, the references to the pleural border are the most important. Reminiscent of a camera lens with a narrow depth of field, TS generates images in which structures at a certain depth are reproduced clearly, while structures situated at other depths appear as blurred forms (which, again, is what creates the interpretative difficulties). Structures that are part of the pleura (e.g. protrusions,

Table 2. Suggestions on how to avoid potential pitfalls regarding nodules in chest tomosynthesis

False-positives		False-negatives	
Pitfall	Solution/comment	Pitfall	Solution/comment
Subpleural and pleural changes may often be misinterpreted as nodules because of their proximity to pleural borders, where skeletal structures overlap anatomy and pathology	This may possibly be prevented by relating the location where the ribs are in focus to the position of the suspicious finding	Nodules situated close to the pleural border may often be misinterpreted as pleural or subpleural changes, because skeletal structures may overlap nodules at such locations	This may possibly be prevented by relating the location where the ribs are in focus to the position of the suspicious finding
Lymph nodes may sometimes be misinterpreted as nodules close to hilar and mediastinal node stations	Even though the probability is high that the structures are lymph nodes, it is not possible to characterize them	Nodules located closely to vessels, especially at branching points, may appear as part of the vessel itself	These nodules are usually too small (<5 mm) to properly be distinguished from the vessel that they are close to
Skeletal changes, including costochondral calcifications, may be misinterpreted as nodules, especially those located posteriorly and anteriorly	This may possibly be prevented by relating the location where the skeletal structure is in focus to the position of the suspicious finding	Very small nodules (2–3 mm): sometimes discharged by radiologists as unspecific findings	It is important to bear in mind that small nodules may be very well depicted with tomosynthesis

Figure 1. Reproduced from Asplund et al. (2011).

plaques) are therefore easily interpreted as nodules in the parenchyma. Conversely, nodules close to the pleura appear as pleural structures for the same reason. In addition, the other pitfalls (e.g. skeletal changes) are problems of the same general kind. Structures that are not strictly part of the lung appear as part of the lung in images with limited depth resolution (and vice versa). Suggestions for avoiding the pitfalls form an important part of the article. Mistakes made at pleural borders (misinterpretations of pleural and subpleural changes), for instance, are avoidable ‘by relating the location where the ribs are in focus to the position of the suspicious finding’. Just what such relating consists of, as a practical order of affairs, is not specified, as it is trusted to be understood by readers. The following analyses examine the work upon which this and similar formulations are based.

Data and analytical approach

The materials analyzed in the present study include video recordings of the ‘learning session’, the published article in *Acta Radiologica* and intermediary documents and annotations made throughout the session and later stages during the group’s work (in the form of a spreadsheet listing each nodule, the group’s markings and comments about the difficulties experienced). The focus of the analyses is the video recordings. The analytic approach of the study is informed by ethnomethodological studies of work, a program of studies initiated by Garfinkel (1986) aiming to ‘put the spotlight on the local production of work and organization’ (Luff et al., 2000: 21). This concern with local production, moreover, is shaped by a participant’s perspective in the sense of treating the observable orientations of members, displayed in action, as the primary topic of investigation. Post hoc reports by members are treated as topics of inquiry. Thus, ethnomethodology is ‘a way to investigate the genealogical relationship between social practices and accounts of those practices’ (Lynch, 1993: 1).

In the present study, the genealogical relationship of interest is that between the work of identifying a pitfall, via the interactive accomplishment of movements between particularized and generalized orientations, and abstracted textual accounts in spreadsheet annotations and published text. Furthermore, analytic interest is directed at the ways in

which the pitfall is established as a ‘taken for granted’ (Hopper, 1981a) on the level of discourse. From the perspective taken, formulations of conclusions, and indices of agreement, formality, closure, etc., constitute the development of ‘consensual seeing and knowing’ (Lynch, 1988) in the learning session. The intention is thus to highlight the ways in which ways of seeing the body through the representation become re-established through articulations of a) the particular ways in which the technology renders and dissolves bodily structures and entities and b) how those renderings are interpreted based on established diagnostic expertise.

Eight of the participants appear in the transcripts: Tom (experienced medical physicist), Eve (experienced radiologist), Ada (physician in the radiology department, non-expert in thorax radiology), Mae (experienced radiologist), Sue (experienced radiologist), Ann (experienced radiologist), Pam (medical physicist) and Mia (experienced radiologist). Transcription conventions follow the general conversation analytic format (see e.g. Sacks et al., 1974) and include non-verbal action on separate lines (see Mondada, 2011). The timing of the non-verbal action in relation to the verbal stream is shown through enclosing simultaneous talk with *. . *. At points, superscript numbers are used to separate different actions/gestures occurring in the same line of talk. Non-verbal action continuing over subsequent line(s) is marked with -->. Further conventions: *evH* = Eve, hand gesture (including use of laser pointer); *evG* = Eve, gaze; *miC* = Mia, computer-based action (e.g. manipulations of images).

The lived work of the learning session

The video-recorded learning session is structured around the cases (patients) reviewed, and the markings of the nodules made in each case. These markings consist of true positives, false positives and false negatives. Each observer’s rating is displayed alongside the TS image. On an adjoining screen, a CT scan of the same patient is displayed (see Figure 2). These scans have been used to establish what is treated as the ‘correct’ answers (i.e. the presence or absence of nodules in the lung).

The list of cases and nodules gives the session a recurrent structure that can be roughly outlined as follows. The TS image is displayed, along with the marking (a crosshair at the point where a nodule was marked). Errors are noted. Typically, the person responsible for the error (e.g. missing a nodule that everyone else saw or marking something as a nodule that was not seen on the CT scan) self-selects to provide an account. These accounts are often collectively produced, especially when more than one person made the same mistake. Others fill in, and the conversations topicalize a number of interrelated issues: Why was this error made? Why was this case difficult? Why does the TS image look the way it does (to invite erroneous interpretations)? For false positives, what anatomical structure is really represented (this is often resolved by turning to the CT scan)? What general lessons can be drawn? Although the focus typically is on errors, cases where no mistakes were made are sometimes highlighted, and surprise is expressed over the absence of errors; that is, why did we *not* miss this (Figures 3 and 4)?

During the discussion, notes are made regarding each case and each marking, summarizing and recording initial reflections on the potential pitfalls of chest TS. Tom, one

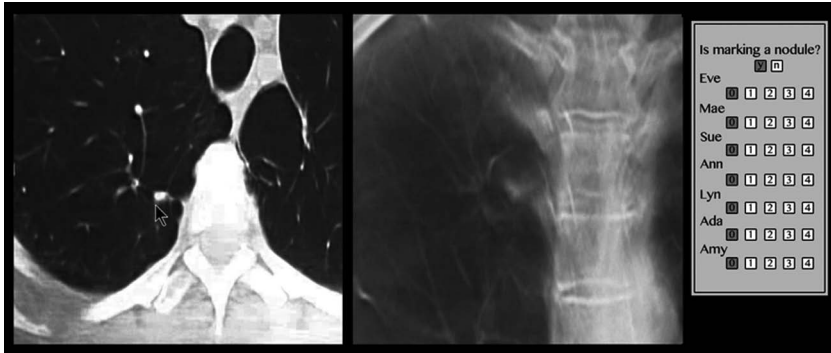


Figure 2. CT (left) and TS scan (right). At the center of both images, a nodule can be seen. The ‘correct’ answer is displayed (far right, top) along with the group’s ratings (far right). This case represents a false negative, a nodule that none of the scientists marked.



Figure 3. Operators’ desk (bottom) and projections; CT (left) and TS (right).

of the medical physicists in the group (and the project leader), is responsible for taking notes, and regularly halts the discussion to ask questions and elicit formulations of what one can ‘learn’ from the case.

In the following, the work conducted regarding three markings (from different patients/cases) in the beginning and middle of the session is analyzed. Then, this work is



Figure 4. The participants. Tom (far left) takes notes. The operators are to the right.

contrasted with brief extracts from the later stages of the session. The contrast shows progression in the work. In the beginning, protracted discussions accompany each new marking. When the problem of the pleural border is mentioned, it is done so with markers of novelty, tentativeness and explorativeness. Later on, the pleural border is talked about as a *type* of error. In the later phases of the session, errors are quickly categorized as ‘the same’ and hardly discussed at all. The annotations also change character from relatively developed, if condensed, formulations to brief notes (e.g. ‘pleural change’), suggesting a decreased sense of novelty in the group’s interpretations of their difficulties.

Patient 1, marking 2: A nodule that everyone missed

The second nodule discussed was one that the entire group missed. The nodule was situated close to a rib and was therefore hidden in the insufficiently resolved representation of the skeleton (see Figure 2). The annotations made during the session regarding this nodule read:

Mistaken as belonging to the skeleton (transition between transverse process and rib).

A later addition:

The tomosynthetic image is blurry in this area. Also calcified which contributes to the impression that it’s part of the skeleton.

Excerpt 1.1

- 101 Mae: **that one, no that one I didn’t see. that one I wouldn’t have seen**
den, nå den såg ja inte. den hade jag inte sett
- 102 **now either so to speak, that I don’t think**
nu heller så att säga, det tror jag inte
- 103 Sue: **so eh::**
så att eh::

- 104 (1.2)
- 105 Eve: **[cause it's situated-**
för den ligger-
- 106 Ada: **[one thinks that it's the rib there=**
man tror att de e revbenet där
- 107 Eve: **=yes [exactly exactly**
a precis precis
- 108 Mae: **[yeah**
a::
- 109 Mia: **mhm**
m::
- 110 (0.3)
- 111 Ann: **what does it look like in the CT**
hur ser den ut på CT:n
- 112 (0.8)
- 113 Mia: **>that-< *tha:t one*=**
de- **den**
*miC *points with cursor to nodule on CT scan**
- 114 Ann: **=yeah,**
=a::,
- 115 (1.0)
- 116 Mia: **and I'll try to get out e::h**
å så ska ja försöka få ut e::h
- 117 Ann: **just scroll a bit up and down**
bara skrolla lite upp och ner
- 118 Mia: **m:**
m:
- 119 Eve: **and then *one experiences that image as blurry also right***
å sen **upplever man väl att den bilden är suddig också**
*evH *moves palm oriented parallel to screen back and forth**
- 120 Mae: **[ye:s**
ja::
- 121 Eve: **[in some way it's not sharp there and that also**
makes one
på nått sätt de e inte skarpt där å de gör ju också
att man blir
- 122 **more hesitant to whether or not it is**
mer tveksam till om de e
- 123 (1.6)
- 124 Mae: **it's blurry there yes=**
den e suddig där ja=
- 125 Eve: **=it's such extensive *drawn out [shadows***
=de e såna väldiga **släpskuggor**
*evH *waves up and down, twice**
- 126 SEV: **[yeah**

a::

127 (2.1)

128 Sue: **and that may be because of the calcification (0.6) perhaps**
 å de kan bero på kalken (0.6) kanske

In this extract, two aspects should be emphasized in particular: the relation between individualized and particularized perceptions and generalized ones and the sequential characteristics of the interaction working toward expansion and elaboration rather than conclusion. Together, these aspects reflect and constitute the epistemic landscape in which the work is conducted. As this is one of the first cases reviewed, the group is not yet clear about what their difficulties, generally speaking, have been.

The first formulation once the missed nodule is shown is one emphasizing the difficulty of the case, tied to individual perception ('I', line 101). After a pause during which the image is scrutinized, two other people self-select to produce overlapping accounts of the difficulty. Although their initial wording differs (one references the position of the nodule, and one articulates how the structure is categorized (as 'the rib')), a strong sense of agreement is achieved by Eve's repeated 'exactly' (line 107). Mae and Mia fill in with agreement tokens of their own (lines 108–109). Within the period of just a few turns, then, the sources of the error are produced as identified and agreed upon.

Although there is no attempt to generalize across cases (the talk concerns this particular nodule), a generalized 'one' is nevertheless invoked: first, in articulating the conflation of the nodule with 'the rib' (106); second, when referring to the experience of blurriness connected to 'that image' (119); and third, to being 'hesitant' (122). It should be noted regarding the translation that in English, the generalized 'you' would probably have been used in these circumstances. In Swedish, however, 'one' (Sw., *man*) provides a way of lexically emphasizing 'a depersonalized, general discourse stance' (Ragnarsdóttir and Strömquist, 2005). The formulation of a generalized perception provides the grounds upon which a conclusion distanced from individual perception can be produced: 'it's blurry there yes' (124). In a sense, references to 'one' place formulated perceptions under the orienting frame of a 'reciprocity of perspectives' (Schütz, 1953), but do so in a way that allows monitoring by others of the presumed or suggested reciprocities. A kind of adjacency pair structure is built by which a formulated reckoning of 'one' makes relevant a ratification or challenge in the next turn.

As noted, the sequential structure of the interaction is one working toward expansion. Eve's contribution in line 119, for instance, is explicitly formulated as adding empirical detail to what is already known: it is prefaced by 'and' and concluded with 'also'. 'And' prefaces have been shown to perform several functions in discourse, with the two most salient the expression of coherence with previous turns (or a reconnection with a previously abandoned line of talk) and a forward movement from what has been said before (Heritage and Sorjonen, 1994; Schiffrin, 1986; Turk, 2010). A brief expression of agreement (Mae: 'yes') is followed by a further expansion by Eve regarding the image's lack of sharpness. This expansion is hedged with 'in some way', which could be heard as marking the limits of Eve's claim to further knowledge of the matter and providing for the relevance of further exploration of the issue.

Eve's use of gesture should be mentioned briefly. In indicating the blurriness of the image, Eve moves her palm back and forth in the direction of the screen. As we will see,

the participants, throughout the session, use this gesture when they refer to the depth dimension of the lung, depth resolution and movements through the stack of TS images. This gesture appears to be a locally conventionalized gesture for indicating phenomena pertaining to the three-dimensionality of the lung or the virtual three-dimensionality of the visualization. Next, after a brief note regarding calcification, the participants turn yet again to the CT scan, this time displaying the coronal view of the same location.

Excerpt 1.2

- 129 Mia: °let's go and, ah that was image forty-four° *coronally
ska vi ta å, de va bild fyrtiofyra *koronalt
miC *begins preparing for display of coronal view on CT-->
- 130 ((two lines omitted))*
- 131 Mia: *that's how it looks in the [coronal-*
så ser den ut på den koronala
miC *cursor circles nodule on CT*
- 132 Mae: [one should have caught that one
den borde man ju faktiskt ha fångat
- 133 Eve: yeah °one would think so°
a: kan man tycka
- 134 (1.1)
- 135 Mae: *but it's like you say* the tomosynthesis image is not sharp
men de e som du säger tomosyntesbilden är inte skarp
maG *turns to Eve, then back toward Mia*
- 136 in that area
I de området
- 137 Mia: no
nä
- 138 Mae: *one experiences it as very (0.5)* blurry
man upplever den väldigt (0.5) suddig
maH *palms placed vertically opposite each other in front of face*
- 139 Sue: yes
ja
- 140 Mia: m
m
- 141 Eve: *and then right when one exits it* this
å sen när man precis kommer ur den så kommer de här
evH *holds pointing gesture toward screen, tilting head*
- 142 [*rib comes the [transverse process*
revbenet transversalutskottet
evH *finger moves slightly, tracing orientation of rib*
- 143 Sue: [*ba:ndy* [more yes
stråkiigt mera ja
suH *pointing, moves hand slightly horizontally*
- 144 Mae: [exactly
precis
- 145 Eve: whatever it is so one thinks that it (.)
va de nu e för nåt så tror man att det (.)

- 146 Mae: [***that it connects to that yes***
 att de hänger samman me de ja
 maG *gaze Eve*
- 147 Eve: [***that it is something in the skeleton right***
 att de e nått i skelettet va
 evG *gaze Mae*
- 148 (1.7)
- 149 Sue: **.yeah**
 .hja
- 150 Eve: **m**
 m
- 151 Mia: **very knotty when it's so close to,**
 våldigt lurigt när de e så nära,
- 152 Tom: **what did you say Eve the transition between the rib and what**
 va sa du nu Eve övergången mellan revbenet och vad
- 153 Eve: ***transverse process it is right that goes there where it**
 *transversalutskottet e de väl som kommer där där de
 evH *first repeats point as in 145, then uses two-handed gesture to
 indicate the joining of transverse process and rib-->
- 154 **joins against that,* and it gets e::h (.) extra tricky**
 ledar mot de,* så blir de ju e::h (.) extra knöckligt

The coronal CT view, in which the nodule is clearly separated from the nearby rib, leads Mae to state ‘one should have caught that one’ (line 132). Eve agrees in the next turn. Mae, however, then turns back to the TS image and challenges her own statement by re-introducing the non-sharpness (line 135) and blurriness (138) of the image, explicitly tying back to Eve’s earlier description (‘but it’s like you say’, line 135). Latching on to this account, Eve produces another ‘and’-prefaced turn referencing the movement through the stack of tomosynthetic section images as one ‘exit[s]’ the area where the nodule is located and immediately reaches the edge of the fourth vertebrosteral rib and the connecting transverse process of the fourth thoracic vertebrae. The transition from the nodule to the rib is easily missed, and the nodule is therefore taken as belonging to the skeleton. In Excerpt 1.1, the participants concluded that ‘one thinks that it’s the rib’ (line 106). Here, however, this articulation of a (faulted) perceptual-propositional attitude is re-specified as a conclusion of a sequence of lived work. ‘Exiting’ and ‘reaching’ do not indicate passive perceptual categorization of images, but an active ‘ambulatory vision’ of virtual movement within the visualized body. Note also that this enactment of failed diagnostic work is produced as the actions of a generic ‘one’. This enactment is thus proffered not as an account of individual perception, but as a recognizable and shared experience.

Reflecting the proffered enrollment of her interlocutors in the articulated experience, Eve’s talk is interspersed with overlapping contributions from Sue and Mae, producing, again, an evident sense of agreement (e.g. ‘exactly’, line 144) and displays of shared understanding. See, for instance, the simultaneous alternative formulations ‘that it connects against that yes’/‘that it is something in the skeleton right’ (lines 146–147). As Sacks (1992) notes, this kind of collaborative sentence completion provides a powerful way of showing agreement as well as a ‘technique of affirmation’ (p. 147). In connection

with this, however, it might be worth expanding briefly on the interactional import of the fact that explicit displays of understanding in the form of reformulations are produced here, rather than more restricted *claims* of understanding (such as minimal continuers, head nods and the like; see Macbeth, 1994). An explicit display of understanding, in offering a potentially repairable formulation, displays an orientation to the non-taken-for-granted character of relevant understandings. Although displaying agreement, then, this agreement is treated as non-self-evident. A point is made of the affirmation of reciprocity; it is not simply presumed.

A contribution formulating the reason for an interpretive difficulty is thus not met with silence and head nods but with further elaborative talk, articulated implications and so on. As Hopper (1981b) observes, the taken for granted is notoriously difficult to analyze on the level of discourse, precisely because it is ‘physically absent’. A contrastive situation such as this sequence, however, conversely displays that the talk concerns issues that are *not* taken for granted by participants; that is, an actor who elaborates on a prior claim is orienting to certain aspects of the matters at hand as issues that still need ratification.

In conclusion, the discourse in this sequence (Excerpts 1.1–1.2) is marked, in several ways, as explorative and not yet settled. Hedging (‘in some way’) is an example. In addition, instead of closure-relevant markers such as ‘so’, or other techniques of moving a topic to a close, participants contribute with intensified reformulations of previous talk, ‘and’-prefaced expansions and ‘but’-prefaced challenges to previous talk that by their very form make further talk conditionally relevant. The sequence is, in a sense, driven toward expansion by a locally configured ‘epistemic engine’ (Heritage, 2012). The explorative state of the work at this point provides warrants for expanded articulations, since very little can be assumed about others’ experiences and reasoning. The recipients, conversely, explicitly articulate their understandings as they cannot treat what they make of a prior turn to be presumed by others. The relevance of post-expansion is thus fuelled by the relative lack of taken-for-granted information (Heritage, 2012).

Regarding the substantial contribution of this sequence to the overall goal of the learning session, consensual recognition has been produced of a misinterpretation of parts of the transverse process. Reasons why this conflation is done have also been articulated, and a potentially more finely tuned interpretation of tomosynthetic shapes and shadows has been generated. It was noted in relation to Excerpt 1.1 that no generalization across cases was as yet made. Note, however, Mia’s contribution in line 151: ‘very knotty when it’s so close to’. Although truncated, the formulation sets up a conditional relation of diagnostic difficulty, distanced from individual perception and the individual case, indicating that ‘closeness’ is correlated with errors.

Patient 1, marking 3: A true positive, but marked with varying degrees of confidence

This nodule was marked by everyone, with Mae, Sue and Ann giving it a rating of 3 (4 is the highest degree of certainty) (Figure 5). The annotations read:

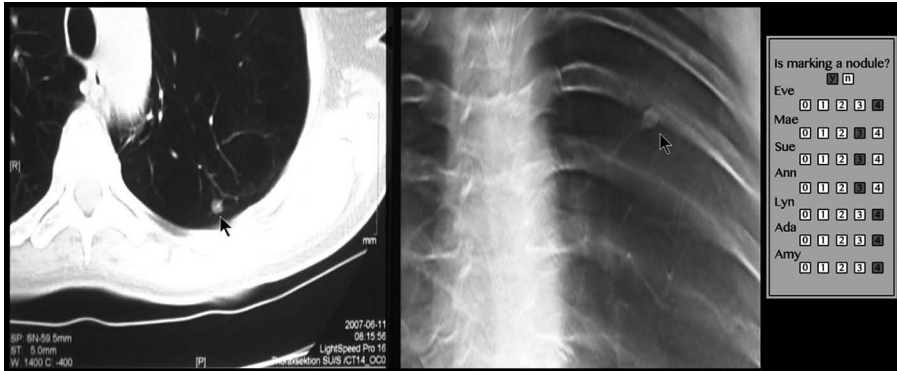


Figure 5. Nodule indicated with cursor arrows on the CT (left) and TS scans (right). The ratings are far right.

Everyone saw it clearly. Close to the pleural wall, can therefore be mistaken for a pleural change (with knowledge of the limited z-resolution of tomosynthesis)

A later addition reads:

Well defined and round, therefore quite certain. Can be mistaken for a pleural change since it's close to the rib.

Excerpt 2

- 201 Mae: **yea::h (.) it's like here I believe, I mean I I have**
 a:: (.) de som här tror jag, ja menar ja ja har
- 202 **apparent- apparently marked a three myself and I think that's**
 tydligge- tydligen själv satt en trea å de tror jag e
- 203 **because I have considered if this is a pleural thing right**
 för att jag har funderat på om detta (.) e en pleural historia va
- 204 Mia: **m:: it's so close**
 m:: de e så nära
- 205 Mae: **since it's so close and then over the rib there**
 eftersom den ligger så pass nära å över revbenet där
- 206 Eve: **m:**
 m:
- 207 Mia: **it's not (.) strange**
 de e inte (.) konstigt
- 208 Mae: **no**
 nä
- 209 (4.5)
- 210 Mia: **okay**
 jaha

- 211 Eve: **but that we're so *certain* must still be because it's so**
 men att vi e så pass *säkra* e väl ändå just att den e så
 evH **pointing gesture outlining the vertical row of ratings**
- 212 ***1very well defined*. *2one so to speak sees all the contours**
 väldigt välavgränsad. *2man så att säga ser alla konturerna
 evH **1point shifts to left, then traces a small circle* *2thumb and index**
- 213 **and then one feels that that [must-***
 å då känner man att de där måst-
 evH *finger form a circle, hand held in line of sight**
- 214 Mae: **[there is something that's clear**
 de e nånting de e alldeles klart
- 215 Eve: **yeah**
 a::
- 216 Mae: **but *the question was since***
 men *frågan var då i å me att*
 maH **raises finger in the air**
- 217 **[*it's so far back if it was [pleural or not***
 *den e så långt bak om den va pleural eller inte
 maH **points toward screen, gaze toward Eve**
- 218 Eve: **[m: m: [m::**
 m: m: m::
- 219 (2.3)
- 220 Mia: **m:**
 m:
- 221 (3.8)
- 222 Mia: **right (0.7) but those were (0.4) the true,**
 'ha (0.7) men de va ju (0.4) dom sant,
- 223 Pam: **yeah should we move on to the false [positives**
 ja ska vi gå över till dom falskt positiva
- 224 Mia: **[m:**
 m:
- 225 Mae: **[yes**
 ja
- 226 Tom: **I think so. >sorry can I just< what you're saying Mae is**
 tycker ja. >ursäkta får jag bara< de du säger Marianne de e
- 227 **that, *because you know that the tomosynthesis***
 att på grund av att du vet att tomosyntesen
 toH **touches chest w. palms, fingers pointing toward each other**
- 228 ***1has such limited resolution* and that it *2was so close to***
 1har så begränsad upplösning och att de *2va så nära*
 toH **1moves right hand back and forth* *2extends right arm**
- 229 ***the pleural wall* [than you thought it could be,**
 pleuraväggen så tänkte du att de kunde va,
 toH **distinct beat w. palm, position still held**
- 230 Mae: **[*then it could have been pleural yeah***
 så kan den ha varit pleural ja
 maG **gaze Tom, nods**
- 231 Tom: **right**
 okej

- 232 (3.1)
 233 Mae: ***at least one might think I reasoned that way***
 man kan åtminstone tro att jag resonerade så
 maG *gaze toward operators, then toward Tom*
 234 Tom: **yeah yeah that's good**
 a:: a: de e bra
 235 SEV: **((laughter))**

The concern here is not that a nodule has been missed, but that two participants were less than certain that the nodule was indeed a nodule. Mae provides a hedged account of her rating based on the possibility of the nodule being a pleural structure. She *believes* (Sw., *tror*) so, at any rate, a weakened epistemic position signaling some difficulty in recreating the exact reasoning behind the rating. 'Pleural' is emphasized in her production of the account, indicating that some newsworthiness is tied to it. The account is ratified (lines 204, 206) and normalized (line 207), but not immediately expanded or challenged. After a pause in which no one contributes further talk on the topic, Mia (the operator) says, 'okay' (Sw., *jaha*), indicating a readiness to move on (see Beach, 1993). Eve, however, interjects with a 'but'-prefaced problematization of the previous talk. Only the *uncertainty* expressed by the two people's ratings has been accounted for, and not the certainty expressed by the rest of the group. Eve's utterance is accompanied by gestures. The first indicates the group's displayed 'certainty'. She then highlights the well-defined roundness of the nodule with a circling pointing gesture and then by forming her hand into a circle. Note that while Mae's account was produced as an explanation of her individual rating, Eve uses first 'we' and then 'one' in accounting for the certainty with which the group as a whole rated the nodule. This contrast potentially positions Mae's hesitation as an idiosyncratic product of individual perception and reasoning, as opposed to the confident rating of the generic 'one'.

The challenging nature of the utterance is reflected in the interrupting rejoinder, which positions Eve's turn as elaborating on the obvious. 'There is something that's clear' (line 214) seems to function similarly to how an 'of course' as an answer to a polar interrogative challenges the presupposition of askability (Stivers, 2011). Only here, the implied objection in Eve's contribution is challenged. Mae then restates the gist of her previous turn: 'the question was [. . .] if it was pleural or not' (line 217). Mae effectively clears up any uncertainty about her detection of the 'well-defined' structure and emphasizes instead the professional rationale behind her hesitation in rating the structure as a nodule. In some circumstances, hesitation is advisable (and increased carefulness in near-pleural areas is included in the published recommendations).

At this point, participants are still exploring the local relevancies tied to the pleural border. It is invoked in an ad hoc fashion in the face of evident errors. Mae presents the pleural proximity as the 'best guess' behind her hesitation in this case. The non-self-evident character of this line of reasoning is further expressed in Tom's understanding check (line 226), which is produced as an embodied display of understanding. Through a series of gestures, the resolution of the depth dimension in the lung is indicated and the pleural wall is highlighted with a distinct beat. This check is produced in the interest of textual formulation. Since Tom is responsible for taking notes, his work makes relevant the production of formulations that can function as indexes to the

discussion after the session. Although Tom's check is formulated as an interpretation of what Mae 'thought', as an individual, her reply recasts the reasoning enacted by Tom as an account of what 'one' could conjecture regarding her reasons for hesitating. Thus, the issue for participants is the intersubjective construction of reasonable accounts, rather than direct reports of individuals' previous reasoning.

Following the treatment of patient 1, marking 3, a false positive is discussed for the same patient. It is dealt with quite quickly, as only one participant (Ada, who is a clinician and non-expert in thoracic radiology) marked it as a nodule. The discussion should be briefly described, however, as it contains several interesting formulations. Ada characterizes the case as 'one of those' in which she did not know whether to categorize the finding as a pleural structure or a nodule, and then says that she 'thinks' it 'generally has been difficult with the changes close to the pleura'. This assessment of personal difficulty is followed by a second assessment by Mae, who generalizes this difficulty: 'that is difficult'. A move away from individuals' perceptions and toward characterizations of lesions and anatomical structures is proffered in this turn; the changes close to the pleura are 'difficult'.

Patient 4, marking 17: A false positive, marked by two persons

Marking 17 in patient 4 represents a false positive. Eve had given a rating of 2, and Ann had given a rating of 1 to a structure that was not seen as a nodule on the CT scan (Figure 6). In the spreadsheet with annotations regarding this case, one can read the following:

Thickening of the interlobar fissure. In the tomosynthesis it looks like you have several cm parenchyma outside. Check later! Shows the limitations of tomosynthesis. Can one in some way compare with how well the ribs are in focus?

A later addition reads:

The ribs are quite focused, so one can suspect that one is close to the pleura.

As the annotations suggest, the discussion of this case concludes that the structure that Eve and Ann had seen as (potentially) a nodule was in fact a thickening of the interlobar fissure. This is thus a prime case of the pitfall of concern here: pleural or near pleural structures are difficult to interpret due to the limited depth resolution. Realizing that the structure was a thickening of the interlobar fissure took some time and extensive discussions. These discussions will not be analyzed here (see Rystedt et al., 2011). Instead, we look closer at the work that ensues after the correspondence between the mistaken nodule and the interlobar fissure is identified, which focuses on the reasons behind the error and possible ways of avoiding it. These interactions engender the annotations following the identification of the false positive (i.e. 'In the tomosynthesis it looks . . .') and the addition starting with 'The ribs are quite focused.' Although the identification of the represented anatomical structure is closely related to regular radiological work practice (to determine what is shown in radiological images), the latter formulations directly concern the specific work of the learning session: identifying and formulating interpretative pitfalls. They reference the 'look' of things in the image, how these appearances are caused

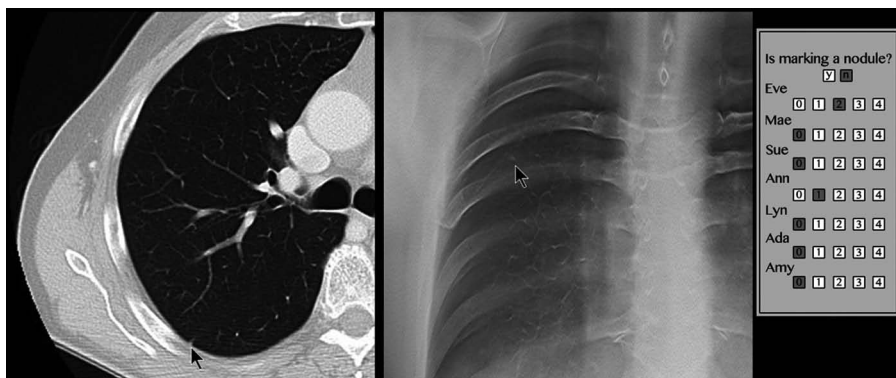


Figure 6. CT and TS views of the false positive (thickening of interlobar fissure). Cursor arrows indicate the suspected nodule.

by the technology, and strategies for avoiding mistakes. These two forms of work make evident the identifying characteristic of the learning session as consisting of two levels of interpretive activity: *first-order diagnostic work* of examining radiographic images to determine the anatomical/pathological correlates of elements in the images, and *second-order diagnostic work* directed at discernible regularities in the first-order diagnoses made before the session.

Excerpt 3.1

- 301 Eve: **but that's what I mean that *this is so difficult to understand***
 men de e de ja menar att *de här e ju så svårt å fatta*
*evH *laser-point circles suspected nodule on TS image**
- 302 **that one is *out in- in- the edge of* the lung**
 att man e *ute I kanten på* lungan
laser-point circles suspected nodule on CT scan
- 303 ***since one has so much lung on the si-***
 eftersom man har så mycket lunga vid sid-
- evH *laser-point outlines distance between pleura and suspected nodule on TS image**
- 304 Tom: **yeah**
 a::
- 305 Ann: **m:: yeah**
 m:: a::
- 306 Eve: **outside there so,**
 utanför där så,
- 307 Ann: ***it's the s- it's the same type of error*** [we could say
 de e s- de e samma typ av fel kan vi ju säga
*anG *gaze Eve**
- 308 Mae: **[yes**
 ja

- 309 Sue: [m::
m::
(sequence omitted))
- 310 Ann: ***it's difficult this with zed- I [mean the depth***
*de e svårt de här me zä- alltså djupled
anH *back of hand held parallel to the screen, moving back and forth*
- 311 Mae: [it's really difficult
de e jättesvårt
- 312 Mia: m:

After the group decides that the mistaken structure was a thickening of the interlobar fissure, Eve provides a summary and conclusion, formulating the preceding interaction as a case of 'what she means'. This formulation in itself offers a sense of repetition to the content of the talk; it is *another* instance of something encountered and formulated at an earlier point. She specifically highlights the difficulty of understanding that 'one is out in the edge of the lung' in this particular case, using the laser pointer to precisely indicate the appearance of distance between the pleura and the marking, shifting between the CT scan and TS image to make her point. This difficulty, moreover, is recognizable, and indeed in ensuing turns recognized, as 'the same type of error' (by Ann in line 307) – that is, recognizable and recognized as pertaining to the perception of depth in the tomosynthetic image, now furnished with a sense of typicality, as belonging to a *type* of mistake due to the perceived recurrence. Precisely in the *categorization* of error, in the achieved subsuming of cases under a generality, one can speak of a pitfall in the ways in which TS reproduces the body. The way in which the typification is phrased differs to a degree from the more colloquial 'one of those' in the last marking of patient 1 (related above). A 'type of error' places the generality in a formal frame; thus, the formulation has the quality of closure relevance to it, as 'formality indexes interactional closure' (Iedema, 1999: 49). However, for the categorization to function as the basis for the formulation of generality, it must not be discardable as an idiosyncrasy of individual perception. Indeed, the sequence plays out as an interactive achievement, with five people in different ways contributing to the sense of recognition and generality that permeates the significance of the mistake. The 'it's difficult' (line 310) is repeated (note the locally conventionalized depth gesture), and intensified: 'it's really difficult' (line 311). At this point, no one says, '*I think* it's difficult.' Instead, the copular form seems to stabilize in the participants' references to the depth dimension.

Excerpt 3.2

- 313 Eve: **so mo:ve through *that one once more***
så åk i *den en gång till*
evH *laser-point circles suspected nodule on TS image *
((12 lines omitted, manipulations of CT and TS images))
(1.8)
- 314 paC *performs movement through TS image, the suspected nodule appears
and disappears*

- 315 Pam: **yes**
ja
- 316 Ann: **>.yes<**
>.hja<
- 317 Eve: **yeah because there one tricks oneself because *there one**
ja för där lurar man ju sig för *där tycker man ju
*evH *laser-point circles suspected nodule on TS image-->*
- 318 **thinks that one still has lung [on both sides right?***
att man fortfarande har lunga på ömse sidor va
- 319 Mae: **[yeah**
a::
- 320 Mia: **[m**
m
- 321 Eve: **[*eh::***
eh::
*evG *gaze Mae/Ann**
- 322 Ann: **[m::**
m::
- 323 Eve: **like that.**
så
- 324 Mia: **m**
m
- 325 Eve: **so that's the criteria I used I put a number two right**
så de e ju kritieriet ja har gått efter ja satte väl en tvåa
- 326 **on that one so I was pretty convinced that that was a dot and**
på den så ja va ganska övertygad om att de där va en prick å då
- 327 **then when I went through the answers I thought oh and why**
sen när ja gick igenom facit så tänkte ja jaha varför
- 328 **isn't that a dot when *hh. the ohh.ther ones,***
e inte de en prick när *hh. dom hh. andra,*
*evG *gaze Mae**

Having agreed that the case was difficult, and difficult due to the general problematic (the depth dimension), Eve introduces a new project: that of ‘moving through that one once more’ (line 313), recreating the stepwise traversal of the stack of tomosynthetic images in the depth dimension involved in the work of (mistakenly) categorizing (what was only just now identified as) a thickening of the interlobar fissure as a nodule. ‘That one’ is specified through the use of a laser pointer as the mistaken nodule on the TS image. As the operator (Mia) performs the backward movement through the stack, during which the nodule appears and disappears, two people respond to the visual details of the image with ‘yes’ (lines 315, 316). Thus, based on the displayed movement through the suspected nodule, Eve can recreate and formulate a ‘reason’ behind her mistaken interpretation. Interestingly, she uses the generic one (Sw., *man*) in saying ‘because there one tricks oneself’ and ‘there one thinks’. A generalized viewer is implicated in these suggested errors and reckonings. Accordingly, the group acknowledges their recognition of the contribution (Mia, Mae and Ann in lines 319, 320, 322). The production of the second ‘there’ is timed to just after the nodule, yet

again disappears in the TS movement and coordinates with a laser-point circle around the location where the nodule was just visible. Thus the ‘there’ indicates not only a location in the displayed image, but also a point in the three-dimensional space of the lung as it is rendered visible as the stack of section images is traversed (see Ivarsson, 2010). ‘There’ is thus also a point in a temporally extended procedure through which normally positions of findings are determined.

Eve, in her concluding turn, sums up with a reference to ‘the criteria’ she used in rating the nodule. The error is thus rationalized through the recruitment of a sensible criterion (the fact that there appears to be lung tissue in front of as well as behind the structure suggests that it is situated in the parenchyma). Phrased otherwise, Eve articulates her previous diagnostic action as an instructed action (Garfinkel, 2002), rationally undertaken based on the evidence at hand and informed by consensually recognized methods of inquiry. If sensible criteria fail, then, the source of the error can be placed in the disruptions of established interpretative practice introduced by the new technology. The criteria invoked are themselves technologically coupled, which means that any actions instructed by the criteria in an altered technological context will be potentially problematic.

Eve’s account may seem to be a return to an individualized orientation. The reference to ‘criteria’, however, comes only after – and indexically relies upon (‘that’s the criteria’) – an articulation of diagnostic work, which is, first, *generalized* by the speaker (through the use of ‘one’) and, second, *ratified* by the group. Generalization and consensual ratification of perception thus precede the invocation of the criteria in this case, and more generally provide the basis upon which more durable accounts, for example textual inscriptions, are made.

Before the next excerpt, a sequence has been omitted, in which the issue of the interlobar fissure is reactualized. After this, the participants return to questioning the technology and the potential ‘lessons’ that can be drawn from the case.

Excerpt 3.3

- 329 Sue: **but it’s yet again *the technology here, Tom?**
 men de e återigen alltså tekniken här, Tom?
 suG **leans forward, gaze at Tom-->*
- 330 Tom: **yes**
 ja
- 331 Sue: **that does this***
 som gör detta
- 332 Tom: **yes sure absolutely it is, then the question is what we can**
 ja visst absolut de e de ju, frågan e ju då vad vi kan dra
- 333 **learn from this what is there in *this image* that e::h**
 för lärdomar av de vad finns de I *den här bilden* som e::h
 toH **points to screen**
- 334 **can make us understand that we’re not in the paren[chyma**
 kan få oss att förstå att vi inte är i parenkymet
- 335 Sue: [m:
 m:
- 336 [and that-
 och att-

- 337 Tom: **[for example that e:h the rib is *(.)* as focused here as it**
 till exempel att e:h revbenet e *(.)* så fokuserat som de
 toH **holds hand in line of sight, thumb and index finger briefly held*
 about 1 cm apart*
- 338 **still is *here***
 ändå e ju *här*
points to screen
- 339 Mae: ***exactly**
**precis*
 paC **begins moving back and forth on TS-->*
- 340 Tom: **that means that one th- understands that we are**
 det betyder att man tr- förstår att vi är
- 341 **probably *a bit further back than what we think* and then**
 nog *lite längre back än vad vi tror* å då
 toH **leans back, makes back-and-forth palm gesture toward chest**
- 342 ***shouldn't- then it's probably just (0.6) eh:***
 borde vi int- då e de förmodligen bara (0.6) eh:
- toH **holds both hands in line of sight**
- 343 Mia: **but we will still not be able to (.) say [with certainty=**
 men vi kommer fortfarande inte att kunna (.) säga med säkerhet=
- 344 Sue: **[to know**
 att veta
- 345 Tom: =no:: surely not but eh maybe,
 =nä: säkerligen inte men eh kanske,
- 346 Ann: **you learn all the time**
 man lär sig hela tiden
- 347 Tom: **eh yea:h**
 eh a::
- 348 Pam: ***but here's for [example in focus very much**
 *menhär e ju en exempel i fokus väldigt mycket
 paC **reaches depth on TS image where the rib is in focus*
- 349 Eve: **[but what you said about focus on- cause**
 men de du sa om fokus på- för
- 350 **[*there the rib is ve:ry sharp***
 där e ju revbenet vä:ldigt skarpt
 evH **laser-point circles rib above suspected nodule**
- 351 Pam: **[*e::h the rib***
 e::h revbenet
 paC **cursor circles rib above suspected nodule**
- 352 Eve: **there[*¹fore this probably lies* in *²that plane* because then**
 allt*¹så ligger den antagligen* i *²de planet* för sen=
 evH **¹ laser-point circles suspected nodule* *²moves laser point*
 vertically from suspected nodule to rib and back*
- 353 Tom: **[yeah**
 a::
- 354 Eve: =it gets blurry and then I see-
 =blir de suddigt å sen ser ja-

Here, the concerns of the learning session materialize in two explicit questions: is it the technology that does this? What can we learn? Although the former question is answered swiftly in the affirmative, the latter is answered collaboratively by the questioner Tom and the other participants, with a suggestion that one could use the possibility of moving through the stack of images to see how the position of the suspected nodule is related to the point where the rib is most sharply in focus. If these points coincide, then the finding ‘probably lies in that plane’ (line 352); that is, then the suspected nodule is most likely in the same plane as the rib, probably part of the pleura, and consequently not a nodule.

The collaborative production of this suggestion relies on multimodal contributions by at least three people. Tom, who poses the initial question regarding what to ‘learn’, gesturally elaborates the sharpness of the rib (line 337) and the position of the finding (341) ‘further back than what we think’. Meanwhile, Pam has begun moving through the TS stack and reaches a point where the rib is in focus. She indicates this point with ‘here’ (348) and circles the rib with her mouse cursor. At the same time, Eve uses the laser pointer to highlight the same location, circles the mistaken finding and indicates a vertical line between the rib and the finding, emphasizing their alignment.

Returning to the cited annotations from the spreadsheet, the interaction in excerpt 3.3 can be seen as the lived work inscribed in those brief formulations. During the session, Tom writes ‘can one in some way compare with how well the ribs are in focus?’. A less hedged conclusion is added later. Versions of these formulations also, as can be seen in Figure 1, make their way into the published report. The treatment of marking 17, patient 4, clearly illustrates the ways in which embodied and material resources are engaged in the lived work of producing textual instructions, as well as the movement from particularity to generality so salient throughout the analyzed material. From an observation that ‘the rib’ and the suspected nodule are simultaneously in focus, an experience of ‘understanding’ of a generalized ‘one’ is articulated, and subsequently ratified and re-enacted by Eve and Pam.

Four later cases: Patient 9, markings 33, 34, 35 and 36

After two hours, the group takes a break for lunch. Before the camera is turned off, one participant predicts what can be expected when the group reconvenes: ‘then it’ll probably be repetitions of these things that we have done wrong, I mean these areas with pleural eh sub-pleural changes’. The predictive formulation of errors to come itself signals a quite solidified notion of a pitfall, and the definitive reference to ‘areas with pleural [. . .] changes’ further emphasizes the expectedly shared status of the trouble (Wilkes-Gibbs and Clark, 2004). Several people concur. The second part of the session has a markedly different pace and rhythm from the first part, when the group’s interpretive troubles were being explored and made sense of as something new and not yet established, ‘not yet naturalized in a reportable just-so story’ (Garfinkel et al., 1981: 136). A few cases serve as an illustration. Starting around 38 minutes into the after-lunch session, a number of nodules are dealt with quickly.

Excerpt 4

- 401 Mia: **but the principle with this patient is**
men principen hos den här patienten e ju
- 402 (1.0)
- 403 Mia: **it's principally similar difficulties as with a patient**
de e principiellt likartade svårigheter som med en patient
- 404 **with pleural plaques**
med pleuraplack
- 405 Mae: **yes**
ja
- 406 (1.5)
- 407 Sue: **m:**
m:
- 408 (0.4)
- 409 Mia: **because it is,**
för att de e,
- 410 Mae: **it's the pleural changes [that disturb the image**
de e dom pleurala förändringarna som stör bilden
- 411 Pam: [m
m
- 412 Mia: [yeah
a::
- 412 (0.4)
- 413 Mia: **pleura proximal changes**
pleuranära förändringar
- ENDOFMARKING33-----
- ((three lines omitted))
- 414 Mia: **we move on. or? [did we have any more cases tha-**
vi går vidare. eller? Hade vi några fler fall so-
- 415 Ann: [m
m
- 416 (0.7)
- 417 Pam: **we had (.) many more here**
vi hade (.) mycke fler här
- 418 (0.3)
- 419 SEV: **((laughter))**
- 420 Pam: **here we had something**
här hade vi nåt
- 421 (9.0)
- 422 Mae: **it's very,**
de e väldigtt,
- 423 Mia: **it's a kindred spirit=**
de e samma andas barn=
- 424 Eve: **=it's the same (x)-**
=de e samma
- 425 Mae: **yep**
japp
- 426 Eve: **[it's me who saw and marked something**
de e ja som sett å markerat något

- 427 Mia: **[the same take the next one**
 samma ta nästa
 -----ENDOFMARKING 34-----
 ((17 seconds of searching omitted))
- 428 Mia: **there**
 där
- 429 (1.7)
- 430 Mia: **it's a kindred spirit**
 de e samma andas barn
- 431 Mae: **yep**
 japp
- 432 (1.1)
- 433 Mia: **°then we can take the next one again°**
 °då kan vi ta nästa igen°
 -----ENDOFMARKING 35-----
 ((32 seconds of searching omitted))
- 434 Pam: **another one**
 en till
- 435 (0.5)
- 436 Eve: **I beg for forgiveness**
 ja ber om ursäkt
- 437 SEV: **((laughter))**
 -----ENDOFMARKING 36-----

In this sequence, which lasts around 90 seconds, four markings are discussed. Mia introduces the notion of a principle (line 401) and ‘principally similar difficulties’ without hedges (‘it’s principally similar difficulties’). Her comments are met with a brief ‘yes’ and an acknowledgment token ‘m’. Mia’s beginning elaboration is concluded by Mae, who, again without hedges or hesitation markers, states: ‘it’s the plural changes that disturb the image’. This formulation is interesting, as it makes no reference to interpretation and perception but stays within the objective features of the interface between anatomical/pathological structures and the imaging technique. The formulation is not saying that something is difficult, but that something disrupts the image. The reason for erroneous analyses is thus distanced from the idiosyncrasies of individual interpretation and perception and connected instead to objective features of images: deviations from an ideal reproduction of the section caused by nearby plural structures. This move is possible only against a background of experienced recurrence and sharedness. A mistake made only once by the group, or recurrently by a single individual, could not similarly be reified as a product of the interaction between anatomical feature and technology.

At this point, then, the group swiftly categorizes new cases as instances of a known pattern, and trusts these categorizations are consensually understood. Compared to the protracted discussions about the early cases, it is striking how fast some of these later errors are collated as cases of the same underlying principle, and even dismissed as uninformative and uninteresting other than as material with which to corroborate the emerging understanding of the pitfalls of tomosynthesis. The sequence of extracts presented here thus clearly constitutes an illustration of the development of new disciplinary knowledge, in the basic sense of showing how the initially vague and unknown

difficulties – which call for extensive sense-making work on the part of the participants – gradually acquire a status as ‘one of those’, ‘another one’ and ‘a kindred spirit’. Regarding sequence organization, the use of ‘a kindred spirit’ (Sw., *samma andas barn*), for instance, can be seen in terms of the closure relevance of figurative expressions. These expressions regularly occur in the termination of interactional sequences, activities or topics of talk, signaling summary attendance to the previous talk in formulating its gist or upshot, but simultaneously refraining from adding further empirical detail to which the interlocutors would have to somehow respond (Drew and Holt, 1998). This sequential structure can be illustratively compared to Excerpt 1, where, for instance, repeated ‘and’-prefaced turns marked the continuation and expansion of previous talk in the production of incrementally developed explorative accounts. The epistemic relations driving sequences of interaction in the learning session are differently configured at this point (see Heritage, 2012), as the interpretation of tomosynthetic images and the ways in which reasons for the errors are understood are increasingly taken for granted and shared.

Furthermore, there are no attempts at unpacking what is meant by ‘a kindred spirit’, for example. The expression is trusted to rest for its sense on the assembled indexical ground of the learning session thus far. The expression’s meaning is taken for granted. Schütz (1967) discusses the taken-for-granted as those ‘levels of experience’ that are judged to be ‘not in need of further analysis’, and adds:

Whether a level of experience is thus taken for granted depends on the pragmatic interest of the reflective glance which is directed upon it [. . .] a change of attention can transform something that is taken for granted into something problematical. (p. 74)

The condensed terms and limited elaborations of reasons for erroneous diagnoses are thus matters of choice, guided by the participants’ pragmatic interests at this point. The fact that the medical scientists choose to restrict their ‘reflective glance’ and that no attempts are made to transform these cases into ‘something problematical’ show that the scientists take understanding to be shared and elaborations to be pragmatically uneconomic. One could view potential elaborations, such as those accompanying the initial set of cases, as having now been embedded (see Hopper, 1981a) in brief references to a ‘pleural change’ or ‘a kindred spirit’, just as ‘individual utterances, essays or speeches, [. . .] may be embedded at any time into a new normal form, and processed as single units’ (Hopper, 1981a: 203). If asked to do so, the radiologists could provide the embedded expansions. This does not mean, however, that the meaning of the talk in these later stages of the session is found in a silent rehearsal of a protracted explanation. The scientists have merely established a basis upon which it is possible to talk in this way, with brief expressions usefully *indexical* (Garfinkel, 1967) to richly textured radiological considerations.

Two further contrasts can be made between Excerpt 5 and the preceding sequences regarding language and the recruitment of multimodal resources. As cases are treated against a background of shared understanding, few instances of perceptual and interpretive vocabulary are present. Throughout the treatment of these three false positives, virtually no gestural or otherwise embodied resources are used. A relative topical backgrounding of perception and interpretation, as well as a relaxation of the body, can thus be discerned. Although articulations of as yet non-self-evident reasons for error in

previous excerpts relied upon the use of gestures and other resources such as laser pointers to specify precisely the particular shapes, locations and virtual movements intended, the shared indexical ground presently relied upon makes such layering of modalities excessive and pragmatically redundant. Economy of expression seems to go hand in hand with an economic use of multimodal resources.

Conclusion

The analysis of the session reveals a set of practices in which ‘consensual seeing and knowing’ (Lynch, 1988) are worked up and displayed as such in talk. Two orders of work are set in motion as an error is encountered. First, details of the body that have either been missed or miscategorized are identified and re-described (see Rystedt et al., 2011). Second, reasons behind the error are articulated, involving identifying artifacts produced by the tomosynthetic technique and the ways in which normal interpretive procedures may fail in this new context. In both orders of work, coordination, calibration and consensus are treated as important. As this consensual perception is gradually established, an increased sense of recognition, recurrence, typicality and taken-for-grantedness is discernible in the treatment of the cases. Explorative talk characterized by expansions and elaborations, displays of understanding in the form of reformulations, understanding checks, articulated implications and so on, leave room for reifications of interpretative difficulties into characteristics of the imaging technique, brief typifications and closure-relevant contributions. Topically, perception and interpretation recede into the background, and embodied engagement becomes decreasingly salient. On a more general level, this movement from extended accounts to the presumed accountability of indexical expressions illustrates the interlocking relation between two levels of accountability: ‘the taken-for-granted level of reasoning through which a running index of action and interaction is created and sustained [and] the level of overt explanation in which social actors give accounts of what they are doing in terms of reasons, motives or causes’ (Heritage, 1988: 128). Although accounts in the face of deviation from established rules normally serve to sustain the taken-for-granted, they are also central means through which new avenues of taken-for-granted reasoning are established.

Reflecting the overarching purpose of the learning session, the participants’ treatment of each new case involves producing abstracted formulations of the identified and re-described anatomical structures (e.g. that a false positive was ‘an interlobar fissure’), the reasons behind the error (e.g. the limited depth resolution of TS) and possible ways of avoiding error. Based on these articulations, the academic article is then constructed. Although the article states that the participants ‘gave their reasons for erroneous analyses’, it is clear that the ‘reasons’ were the outcomes of extensive interactional, embodied and discursive work in which manipulations of the visualizations were used as means for reconstructing reasonable accounts of error. Reasons were furthermore not produced merely as accounts of individual error, but as proffered reckonings of a generalized ‘one’, often ratified, expanded and co-constructed by several participants. In that sense, the medical scientists engage in intersubjectively coordinated *rationalization*, that is, ‘selecting, arranging, and unifying the historical context of an action after its occurrence so as to present a publicly acceptable or coherent account of it’ (Garfinkel, 1967: 267).

The point is not that reasons are ‘mere’ after-the-fact constructions; instead, the publicly ratified sensibility and recognizability of an account are precisely what is at issue in the session.

The abstracted formulations in the published text rely upon the repetitive, case-by-case, marking-by-marking, interactional working up of generality from particularity. Each case starts from individual diagnoses, with errors often prompting an individualized account of why ‘I’ interpreted the image in a certain way. These accounts are followed by proffered generalizations through articulated perceptions and actions of a generalized ‘one’. If and when these proffers are ratified, a potential ground is established for producing characterizations of the intersection of body, technology, image and de-individualized interpretative work. It becomes possible to say, for instance, that ‘it’s the pleural changes that disturb the image’ or more tentatively that ‘it’s very knotty when it’s so close’. Additional evidential basis of generality is found in the displayed markings of the group. Particular configurations of ratings make relevant, for instance, an account of why the raters were ‘so certain’ (Excerpt 2, line 211) or an articulation of why another nodule in the same patient was missed by everyone (Excerpts 1.1–1.2).

The formulations of ways of avoiding pitfalls have a similar genealogy, starting from identified ‘reasons for erroneous analyses’ and then articulating what ‘one’ or ‘we’ could do, what this generalized viewer then potentially ‘understands’, and so on. These suggestions, similar to articulated reasons for error, use manipulations of the tomosynthetic visualization to, for instance, enact the ‘relating’ of the position of the suspected nodule and the rib. Once consensually recognized and ratified, generalized formulations of the suggested instruction can be produced. The production of these instructions can also be understood in the following way. When the ‘reasons for erroneous analyses’ are consensually articulated, such reasonableness establishes erroneous analyses as nevertheless *instructed* actions, for instance, when normal criteria for determining location are shown to produce a false positive (Excerpt 3.2). If an error is made despite such accountability, then the instructed character of the action seems to be at fault. The formulation of novel instructions for action is consequently made relevant, projecting a re-instructed diagnostic practice in which error is possibly avoided.

Examining what it means to interpret tomosynthetic images under the guidance of, for instance, an inscription such as Figure 1 is beyond the scope of the present article. Here, our concern has been with the genealogy of instructions: the ways in which they are produced through reflexively treating traces of interpretive work as material for discerning recurrent patterns of error and as clues to ways in which error may be avoided. The analyzed case shows that to uphold a reliable embodiment of living tissue through visualization – the first-order day-to-day interpretation of images as renderings of bodies – disciplinary attention must be shifted to a second order in which ‘understanding’ and ‘seeing’, rather than simply bodily entities such as ‘nodule’ or ‘pleura’, become salient as objects of knowledge. The new technology prompts practitioners to perform ‘a change of attention’ that transforms the taken-for-granted into ‘something problematical’ (see Schütz, 1967). The reasoned processing of the problematical is, in turn, directed toward re-establishing a new, shared, re-instructed perception. The shared quality of this perception is crucial. Members’ production of professionally ‘objective expressions’ (Garfinkel and Sacks, 1970) concerning the visual rendering of bodies, from the indexical, locally

achieved accountability of individual error, builds on the ratified generalizations of error accounts repeatedly worked up over the course of the learning session. In the interest of a ‘translocal orchestration’ (Lachmund, 1999) of this new perception, textual inscriptions are produced, findings, instructions and guidelines are formulated, and academic articles are eventually published.

Acknowledgments

We would like to thank Keith Murphy, Åsa Mäkitalo, Oskar Lindwall and two anonymous reviewers for intellectual input and comments on previous versions of this article.

Funding

This work was carried out within the University of Gothenburg Learning and Media Technology Studio. Financial support was provided by the Swedish Research Council (2010-5105, 2011-488), the Swedish Radiation Safety Authority (2010-4363, 2012-2021, 2013-2982), the Swedish Federal Government under the LUA/ALF agreement (ALFGBG-136281) and the Health & Medical Care Committee of the Region Västra Götaland (VGFOUREG-12046, VGFOUREG-27551, VGFOUREG-81341).

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