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Words and meanings in cancer communication: Denotational and connotational misalignments

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Shared understanding of words used in cancer care is crucial to the quality of patients' engagement with their treatment. A cancer diagnosis introduces the patient to many unfamiliar words and meanings. This study identifies words that are prone to impede communication by (i) evaluating lay participants' ($n = 292$) *definitional* understanding of terms commonly used in cancer care and (ii) comparing the *connotations* of terms held by lay participants with those held by healthcare practitioners ($n = 82$). A critical impediment to definitional understanding was found when words are used in a different, sometimes contradictory, way from their meaning in general language use. Participants who misunderstood terms were no less confident in the accuracy of their understanding than those who understood well. Connotational meaning was assessed using semantic differential and word association techniques. A lack of congruence between lay and health practitioner connotations was found for most target terms; a substantial number of 'fear'- or 'sad'-related associations from lay participants contrasted with a near absence of such connotations from healthcare practitioners. Findings reveal routes to improved health communication.

Background

'A substantial proportion of the lay population do not understand terms doctors use to describe cancer diagnosis and prognosis and cancer screening and treatment procedures' (563–564). This is the disturbing conclusion of Chapman et al.'s (2003) study examining the familiarity with cancer-related terms of 105 randomly selected members of the public. More recent research inspired by that study suggests that despite the surge of online information and increasing attention to patient engagement and education in the intervening period, there has been little improvement in lay people's understanding of key medical terms. Pieterse et al. (2013: 1190) replicated Chapman et al.'s study in a Dutch context and concluded that 'lay people's understanding of commonly-used terms in cancer consultations is suboptimal'. More recently, Gotlieb et al. (2022: 7), in a partial replication of Chapman et al., found that while understanding of some specific terms was comparatively higher in their (US) sample, 'Medical jargon remains a common source of confusion for patients'. Pitt and Hendrickson (2020: 1864) reviewing studies in so-called

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'medical jargon' conclude that 'If we wish to provide safe, effective, patient-centred care, we must improve our ability to communicate with patients in ways that they find meaningful'. This echoes broader approaches to health education whose key tenet is the link between health literacy and health outcomes (e.g. Nutbeam 1996, 2000). The study we report here extends this body of enquiry, scrutinising lay understanding of key terms used in cancer care not only from a denotational (definitional) but also from a connotational perspective. This enables us to identify features that increase the risk of misunderstandings and to suggest ways in which to minimise such risk.

A cancer diagnosis can confront the patient and those around them with unfamiliar words and concepts. This is problematic, given assertions that shared understanding of terms is key to decision-making, treatment, and patient autonomy (Chapman et al. 2003; Foster and Fenlon 2011). However, to date, the growing field of health communication research has focused more on corpus and discourse approaches to language analysis, and studies exploring the use of terminology, phrases, and general vocabulary in healthcare settings are relatively scarce. The exceptions to this have largely emerged from the medical, rather than linguistics, research field, and include both studies focusing on terminology (see above), and studies that take a more holistic approach to health communication but which identify terminology as a component. An example of the latter is Fagerlin et al.'s 'communication of risk' framework, which consists of recommended strategies to maximize the clarity with which practitioners can communicate to cancer patients the risks and benefits of medical decisions. The first of their 10 recommendations calls for the 'reduction or elimination of clinical and statistical jargon' (2011: 1437).

As is implied by the term *jargon*, studies around the words used in health communication, such as those mentioned above, have tended to focus on definitional knowledge. In a linguistics context, it is recognized that word knowledge entails more than knowledge of denotational meaning and includes, for example, a word's connotations, associations, and semantic value (Richards 1976; Nation 2001). The study we report here seeks new insights by applying analytic methods from linguistics in order to examine connotational, as well as denotational meanings of terms commonly used in cancer care. This enables investigation of the ideas and feelings attached to specific terms, and scrutiny of the ways in which these might differ between lay people and healthcare practitioners. Identification of such differences can initiate pathways to optimizing communicative effectiveness in cancer consultations and care. The denotational aspect of this study enables comparison with findings from previous research relating to definitional knowledge of terms and facilitates scrutiny of the relationship between denotational and connotational meaning in this context.

The study reported here used a novel methodology to address this communicative challenge, investigating whether selected words that are used in cancer care mean the same to potential patients as they do to healthcare practitioners. The study's premise is that when meanings held by one group do not map onto those of the other, communication will be impeded. There are two ways in which this mis-mapping might happen: (i) when the two parties do not share denotational understanding of a term and (ii) when the term triggers different, or incongruent, connotations for each party.

Our investigation of denotational meaning, partially replicating Chapman et al. (2003), presented participants with eight scenarios, each containing a term used in cancer consultations. Participants were asked to describe what each term meant, state how confident they were of the accuracy of their understanding, and rate how worried the scenario would make them feel (Chapman et al. connect the "worry" score with their assessment of denotational understanding by considering how "appropriate" the worry score is for each term. We note, though, that as an affective measure it has relevance to connotational meaning too, as emerges from our findings). Our investigation of connotational understandings of terms used in cancer care used two linguistic elicitation tools: semantic differential scales and word associations. This is the first time these tools have been applied in a health terminology context and, to our knowledge, the first time that connotational responses to medical terminology have been examined in this way.

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Following Chapman et al. (2003) and others, 292 lay members of the general public were considered proxies for patients at the initial stages of cancer diagnosis. Data were collected using questionnaires and were analysed to address the following questions:

1. How well do members of the public understand terms commonly used in cancer consultations, and how confident are they in their understanding?
2. What ideas/feelings (connotations) do these terms evoke for them?

   A subsection of the questionnaire was also administered to healthcare practitioners to address the question:
3. Are there any differences in the ideas/feelings (connotations) these terms evoke for lay people and for healthcare practitioners?

Data collection instrument and data coding

Lay participants completed a three-part questionnaire. Healthcare practitioners completed parts two and three of the same questionnaire. Both groups also completed a biodata form. See below for detailed information about participants, and Supplementary Appendix S1 for a copy of the questionnaire.

The selection of terms for investigation was informed by Chapman et al. (2003) and Pieterse et al. (2013). It was further mediated and augmented by two authors of this paper using their extensive and ongoing professional experience in oncology care. This follows the principle of 'indigenous criteria,' which harnesses input from 'domain experts' in order to bring real-world validity and authenticity to studies focusing on specific environments. Their insights, or 'tacit' knowledge, are considered 'indigenous' to the communication context in which they operate (Jacoby and McNamara 1999). 'Indigenous criteria' can make a valuable contribution to applied linguists' capacity to connect with the contexts they study and have typically been used in healthcare-related studies (Elder and McNamara 2016; Pill 2016). Here, input from domain experts on the selection of target terms was sought in order to maximize the relevance and applicability of findings. As noted below, practical constraints limited the number of terms that could be investigated. However, it is anticipated that if the novel methodology used here yields insightful findings, it can then be replicated for other key terms.

In order to minimize instances where participants did not complete the full questionnaire, and to respect their time contribution, we designed the questionnaire so that it could be completed within 15 minutes. This restricted the number of items we could test in each section. Allocation of items to each questionnaire section was informed by the research cited above and by the experience of expert oncologists. Section 1 targeted items that had previously been noted as causing comprehension challenges due to partial or misunderstanding of their denotational meaning. Sections 2 and 3, which targeted connotational meaning, focused on terms for treatments. Section 3 additionally includes two terms typically associated with more positive diagnoses (*benign*) or disease stages (*remission*).

The data collection team's field notes recorded factors affecting the quantity and quality of data collected. The former included location and weather and informed the subsequent data collection strategy (e.g. the team used very rainy days for data inputting and did not return to locations where take-up had been poor). The latter is related to the performance of the questionnaire. The field notes were reviewed by the team after the first day of data collection. In two cases, participants had asked for further instructions regarding Section 2 (semantic differential scales—see below) and completed the section appropriately following an explanation from the team. In two other cases, participants had not noticed questions on the second side of the double-sided questionnaire. The team agreed on a form of words to use if participants needed/requested further instruction for Section 2 and decided that reminding participants that the questionnaire was double-sided was preferable to printing it as a single-sided document. No further difficulties were identified, and data collection proceeded.

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Questionnaire section 1: scenarios

In the first section of the questionnaire, lay participants were presented with eight scenarios containing terms used in cancer consultations and were asked to describe what they thought each term meant. Each scenario began '*Imagine you are a patient. After a series of tests your doctor says/proposes*….' and ended with a phrase using the target word, for example '*…you have a benign tumour*'. This approach was a partial replication of Chapman et al. (2003). The terms selected for investigation were *benign*; *(tumour is) progressing; remission*; *metastasized*; *positive*; *radical surgery*; *margins*; *controlled*. After describing what they thought each term meant, participants were asked two further questions: '*How would this statement make you feel?*' (5-point scale from 1 = *not worried* to 5 = *very worried*) and '*How confident are you in the accuracy of your understanding?*' (5-point scale from 1 = *not confident* to 5 = *very confident*).

Participants' responses were coded on a four-point scale for analysis: Category 1 indicated a higher understanding, 2 a lower/partial understanding, 3 a misunderstanding, and 4 was used when participants stated that they did not know the meaning of the given term. Coding of responses into these four categories was informed by the NHS website (www.nhs.uk) and the US National Cancer Institute Dictionary of Cancer Terms (https://www.cancer.gov/publications/dictionaries/cancer-terms). Two researchers coded the data independently. Once the coding had been completed by both raters, the scoring was compared, revealing that 91.5 per cent of responses had been assigned to the same code by both raters. Coding for the remaining 8.5 per cent of the responses was agreed after a short discussion and close reference to the information sources above. Detailed information about coding choices for section 1 can be found in Supplementary Data File S1. This coding differed from Chapman et al.'s three categories: 'high understanding', 'don't know/partial understanding', and 'low understanding' (2003). Our decision to use a 'misunderstanding' category was in order to distinguish poor or incomplete understanding from wrong understanding of a term, the latter being potentially more dangerous, particularly if the participant reported a high level of confidence in their answer. Responses to the question '*How confident are you in the accuracy of your understanding?*' were conflated into a three-point scale for analysis, with 1 = less confident (where participants had chosen 1 or 2 on the questionnaire), 2 = neutral (3 on the questionnaire), and 3 = more confident (4 or 5 on the questionnaire). The five-point scale was retained for responses to the question '*How would this statement make you feel? (not worried>>>very worried)*' on the basis that any medical scenario can be worrying but some more acutely than others.

Questionnaire section 2: semantic differentials

The second section of the questionnaire, completed by all participants (lay and practitioner), targeted four terms used in cancer consultations relating to treatments. Such consultations typically entail the patient and consultant making shared decisions around treatment plans, and it is fitting to consider the extent to which they share connotational understanding of the terms. The selected terms were *chemotherapy*, *radiotherapy*, *palliative*, and *surgery*. After each term, six 7-point scales were presented: active–passive; strong–weak; bad–good; useful–useless; sophisticated–basic; happy–sad. Participants were instructed to rate the term according to the six scales. These scales, known as semantic differentials, are used by psychologists and linguists to assess the subjective perceptions and associations prompted by words and concepts. That is, they access the connotative, in contrast to the denotative, meanings of words (Osgood 1952). Osgood and colleagues identify three independent and dominant factors in semantic differential analysis: evaluation, potency, and activity (Osgood et al. 1969). These are represented in our task by the scales *bad–good*, *strong–weak*, and *active–passive*, respectively. Noting the cautions in previous studies regarding the use of appropriate scales (Valois and Godin 1991; Stoklasa et al. 2019), the selection of relevant adjectives for the remaining three scales was informed by oncology expert advice, and items with heavy denotational load were avoided. Scales relating to functionality, sophistication, and emotional affect were agreed on as most relevant to our study aims, and the three adjective pairs selected to represent these were *useful–useless*, *sophisticated–basic*, and *happy–sad*.

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Data from section 2 yielded a set of six ratings for each of the four terms from each participant. The seven-point scale was retained for analysis. In order to address our third research question, which compares lay data with data collected from healthcare practitioners, any participants from the general public group who had ticked '*I have had experience with cancer through my education or work*' in the biodata questions (further information below) were excluded from analysis.

Questionnaire section 3: word associations

The third section of the questionnaire comprised a word association task. Participants were presented with six cue words and were asked '*For each of the following words, write down the first words you think of when you read it (please try to write up to 3)*'. The cue words were remission, surgery, radiotherapy, palliative, chemotherapy, and *benign*. They were selected to include target items from the semantic differential analysis, enabling additional connotational analysis of those items. Two further items (*remission* and *benign*) were included on advice from 'domain experts', based on their experience of oncology consultations. In the consultation context, these six terms convey diagnoses and treatment options and carry a heavy semantic load for the patient. Word association analysis allows us to assess the extent to which the health practitioners' and lay participants' connotational understanding aligns.

Word association data are used by linguists and psychologists to identify which words and concepts might be activated when people hear or read a particular prompt, or cue word. They can therefore provide information about connotations and associations beyond (though typically including) a word's denotational and collocational load (Szalay and Deese 1978). Individual differences reported in connotation and association studies (e.g. Szalay and Deese 1978; Fitzpatrick 2007; Clarke and Costall 2008) indicate that experience and usage influence connotational associations; in this study, we compare associations of lay people with those of healthcare practitioners.

The word associations provided by participants were compiled into norms lists. (Norms lists are a convention used in word association research where responses are collected from a group of participants; the words given as responses to each cue are ranked from the most frequently given to the least frequently given response. The frequency distribution of responses varies from cue to cue and according to group size, but typically the distribution has a few dominant (very frequently given) responses, at least twice as many moderately frequent responses, and a long tail of unique responses (Postman and Keppel 1970)). A separate norms list was compiled for each group, to enable comparison (Supplementary Data File 2). As before, any participants from the general public group who had selected '*I have had experience with cancer through my education or work*' were excluded from analysis.

Participants

Two groups of participants were recruited for this study.

General public (lay participants)

The first group was 292 members of the general public. The assumption here was that their awareness of and familiarity with cancer-related terminology would be analogous to that of a cancer patient when first diagnosed. We aimed to collect data from a representative cross-section of the general public. Chapman et al. had addressed this challenge by choosing Brighton beach as their data collection site, as it 'would provide a good cross section of the population and because people on the beach would have more time to complete the questionnaire than they would in other contexts' (2003: 559). Our data collection took place in and around a city in South Wales, and to get as representative a population sample as possible, it centred on a bus station, a park, a department store, and the main shopping streets. As outlined above, the data collection tool was a three-part questionnaire. Participants could choose to complete it themselves or to have the researcher ask them the questions and note their responses; previous research indicates that there would be

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Table 1. Gender of participants: number and (rounded percentage).

Gender		
Female	**Male**	**Prefer not to say/blank**
144 (49%)	141 (48%)	7 (2%)

Table 2. Age of participants.

Age ($n = 289$)[a]				
Youngest	**Oldest**	**Median**	**Mean**	**Standard deviation**
18	86	28	36.38	16.314

[a]Three participants did not specify their age.

Table 3. Education level of participants: number and (rounded percentage).

Education ($n = 282$)[a]	
No tertiary education	**Tertiary or higher**
150 (51%)	132 (45%)

[a]10 (3%) participants did not respond.

no difference in responses between these conditions (Gotlieb et al. 2022), and in either case, the researcher was on hand for further instruction, explanation, or support. In several cases, not all parts of the questionnaire were completed (e.g. because the participant's bus arrived), and where appropriate, analysis of data below is based on the number of participants who had responded to an individual question, rather than the N of 292. Participant biodata enables us to assess how representative the sample population was in terms of gender, age, education level, or first language(s) (Tables 1–4); Table 5 compares the group's data with demographic data from the 2021 census for England and Wales (Office for National Statistics).

The comparison indicates that our population sample is representative of the England and Wales population in terms of gender, is moderately well matched in terms of first language, but is younger, and likely has a higher level of education (though see table notes) than the census average.

One further question asked about participants' experience with cancer, as follows:

My experience of/with cancer is: (please tick any that apply)

- I have a relative/friend who has had cancer, but I was not directly involved in supporting or caring for them
- *I have supported and cared for a relative/friend who has had cancer*
- *I have been treated for cancer, or have had a cancer scare resulting in hospital treatment*
- *I have had experience with cancer through my education or work (please state your job, or educational course)*

This question served two purposes: (i) It acknowledged that any population sample is likely to include people who are currently living with cancer; Macmillan Cancer Support (2025) estimates

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Table 4. Participants' first languages: number and (rounded percentage).

	First language ($n = 287$)[a]	
English	**Welsh**	**Other languages (English L2)**
279 (96%)	1 (<0.5%)	8 (3%)

[a]5 (2%) participants did not respond.

Table 5. Profiles of lay participants and 2021 census data.

	2021 census	Lay participants in this study
Female	51%	49%
Male	49%	48%
Median age	40.7	28
Tertiary-level education	34%	45%[a]
First language English/Welsh	91%[b]	96%

[a]This figure includes those currently in tertiary education, as well as those who have completed it.
[b]The census does not give separate figures for English and Welsh.

Table 6. Healthcare practitioners' roles.

Job title ($n = 82$)	
Doctor (includes consultant, registrar, GP, surgeon, radiologist, pathologist, etc.)	43
Nurse (includes clinical nurse practitioners, etc.)	21
Other practitioner (includes physiotherapist, speech and language therapist, radiographer, etc.)	10
Administration/management	5
Did not specify	3

that almost 3.5 million people in the UK have at some point had a cancer diagnosis. In this study, it was considered authentic to include these people in the lay participant sample, but future research might explore whether this experience affects people's construal of cancer-related terms. (ii) It enabled us to exclude any healthcare practitioners from the lay group, to preserve the integrity of lay and practitioner response comparisons. Thirty participants ticked '*I have had experience with cancer through my education or work*'.

Healthcare practitioners

The second participant group, included in order to address our third research question (comparing lay and practitioner responses), comprised eighty-two healthcare practitioners, recruited through authors' professional networks. The inclusion criterion here was that the participants must work with cancer in their professional role. They were invited to state their role or job title; a summary of this information is in Table 6. Participants were sent a link to a two-part questionnaire identical to the second and third sections of the questionnaire administered to the lay participants. They were not asked to complete the first section of the questionnaire; we worked on the

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basis that as health professionals, their definitions would concur with each other and with the external references used for coding the lay responses (This assumption is being further investigated in a separate study).

Ethical considerations

Data collection, processing, and storage methods received institutional ethics approval. Informed consent was obtained from all participants before data collection proceeded, and all data were collected anonymously. Lay participants were told before beginning the questionnaire that the research related to cancer and had the opportunity to withdraw from the study. Participants confirmed that they were 18 or over before data collection commenced. Researchers carried ID, and protocols relating to researcher safety were followed. Researchers were instructed not to attempt to answer any cancer-related questions from lay participants but rather to refer them to https://www.macmillan.org.uk/.

Data analysis and results

Below, we present the results of our analysis, first in relation to denotational word meaning and then in relation to connotational meaning.

How well do members of the public understand terms commonly used in cancer consultations, and how confident are they in their understanding?

As noted above, responses to the eight scenario questions eliciting denotational meaning were coded at four levels. The term that the highest proportion of participants demonstrated high understanding of was *positive* (67%). For every other term except *controlled* (51%), fewer than half the participants demonstrated high understanding. The term with the greatest number of participants with lower/partial understanding was *progressing* (70%). Over one quarter of respondents misunderstood the terms *benign* and *margins*. The term that the greatest number of participants did not know the meaning of was *metastasized* (56%).

In order to investigate the relationship between participant understanding of each term and their confidence in the accuracy of their understanding, an average (mode) confidence rating, on a scale of 1–3, was calculated for each cell of Table 7 (i.e. for each level of understanding, for each term). The average level of confidence in the accuracy of understanding was 3 (= confident) in all cases except the following, where the average was 1 (= not confident):

Table 7. Lay participants' understanding of the eight terms in questionnaire section 1.

	High understanding	Lower/partial understanding	Misunderstanding	'don't know'
Benign ($n = 276$)	39%	27%	27%	7%
tumour is progressing ($n = 285$)	20%	70%	7%	3%
In remission ($n = 278$)	33%	44%	20%	3%
Metastasized ($n = 263$)	29%	7%	9%	56%
Positive ($n = 271$)	67%	14%	12%	7%
Radical surgery ($n = 275$)	7%	62%	24%	7%
Margins ($n = 266$)	16%	10%	35%	38%
Controlled ($n = 274$)	51%	41%	5%	3%

Percentages are based on the number of participants answering each question (n). Blanks are excluded from calculations.

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- Misunderstanding of *benign*
- Lower/partial understanding of *metastasized*
- Misunderstanding of *metastasized*
- Misunderstanding of *margins*

Table 7 shows participants' understanding of the terms in detail.

Participants were on average, most worried by the terms *progressing*, *metastasized*, *positive*, *radical surgery*, and *controlled*, and least worried by the terms *benign* and *in remission*.

The findings relating to misunderstandings bear further scrutiny. The high confidence ratings suggest that asking patients *if* they understand a term is likely to result in an overestimation of their actual understanding (see also Chapman et al. 2003). It is notable that in our study, for five of the terms (*progressing*, *in remission*, *positive*, *radical surgery*, *controlled*), participants who misunderstood were on average no less confident in the accuracy of their understanding than those who had high understanding. It is striking that those who had misunderstood *tumour is progressing* (7%) and *positive* (12%) had construed those terms to mean the opposite of what was intended, that is, they had mistakenly believed that the doctor was telling them that their condition was improving. A Mann–Whitney *U* test analysis of cases where participants had misunderstood terms revealed no significant difference between the average number of terms misunderstood by males ($M = 1.298$) and females ($M = 1.271$), $U = 10{,}155$ ($P = .998$). Previously, we noted a discrepancy between the age and educational experience of our participant group and that of the national population. With this in mind, we compared the average number of terms misunderstood across educational experience and across age bands. A Mann–Whitney *U* test found no significant difference between participants with ($M = 1.265$) and without ($M = 1.333$) tertiary education, $U = 10{,}234$ ($P = .612$). An independent one-way ANOVA showed no significant effect of age on the number of terms misunderstood ($F\ (2,\ 284) = 0.867$, $P = .421$), when ages were categorized into three bands (18–37, 38–57, 58+).

The following are examples of typical misunderstandings in participant responses for each of the eight terms.

benign

- 'a cancerous growth'
- 'not sure, I think 'benign' means terminally, in which case is not curable'
- 'very bad news'

[tumour is] progressing

- 'I would probably think the tumour is getting better as "progress" is usually a positive term'
- 'unsure. Could mean getting worse or better'
- 'it's reducing'

remission

- 'coming back'
- 'I am cured'
- 'they've removed the cancer'

metastasized

- 'the tumour has increased in size'
- 'that I'm at the last stage of my life, and an operation will results useless [*sic*]'
- 'it is in one place?'

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positive

- 'I'm positive you don't have cancer'
- 'situation has improved'
- 'it's good news'

radical surgery

- 'ground breaking surgery and bad and long'
- 'rapid surgery'
- 'this is a new type of surgery possibly relatively untested'

margins

- 'margin for error'
- 'keep costs low/unsure'
- 'they will attempt to operate but will not take too many risks'

controlled

- 'they are they extra careful [*sic*]? Low-risk? Extensive supervision/care?'
- 'that the cancer can be minimized during treatment'
- 'would be killed quicker from cancer'

What ideas/feelings (connotations) do terms used in cancer care evoke for lay people and for healthcare practitioners?

Data from sections 2 and 3 of the questionnaire were analysed separately for the two groups of participants, to enable between-group comparisons. As noted above, the 30 lay participants who had reported that '*I have had experience with cancer through my education or work*' were excluded from the comparative analyses, resulting in group sizes of $n = 262$ (lay participants) and $n = 82$ (healthcare practitioner participants).

In the semantic differential task, participants rated the words *chemotherapy, palliative, radiotherapy,* and *surgery* on six evaluative scales. Nine lay participants did not provide any data for section 2 of the questionnaire and were excluded from this analysis, resulting in $n = 253$ (lay) and $n = 82$ (healthcare practitioner) participants. Figure 1 maps the evaluations for each target word for each group, by percentage of participants. For clarity, 'neutral' responses are not included in these radar charts but are included in the more detailed table in Supplementary Appendix S2.

To determine whether the differences in the semantic differential ratings of the words between the two groups were significant, another series of Mann–Whitney *U* tests was conducted. These revealed significant differences between the ratings of healthcare practitioners (HPs) and lay people as follows:

chemotherapy was rated as

more active by HPs than by lay people ($U = 8{,}319.5$, $P = .013$, $r = 0.168$)
less sad by HPs than by lay people ($U = 5{,}474.5$, $P < .001$, $r = 0.451$)

palliative was rated as

more active by HPs than by lay people ($U = 4{,}798.5$, $P < .001$, $r = 0.364$)
more strong by HPs than by lay people ($U = 4{,}424.5$, $P < .001$, $r = 0.420$)
more useful by HPs than by lay people ($U = 3{,}604.5$, $P < .001$, $r = 0.524$)

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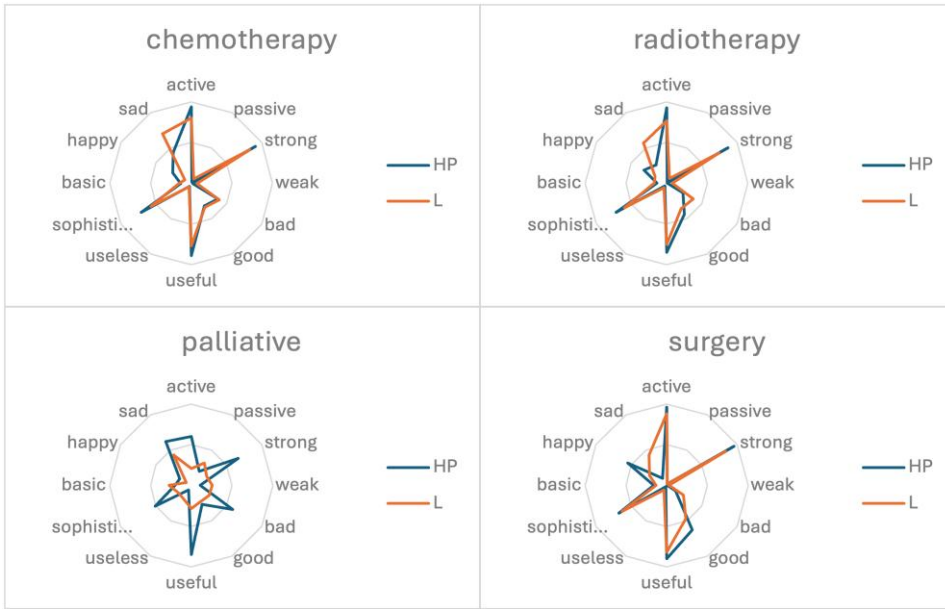

Figure 1. Healthcare practitioner (HP) and lay (L) evaluations of the terms chemotherapy, radiotherapy, palliative, and surgery (%). See Supplementary Appendix for a more detailed data report. (Outer circle = 100%; percentages are calculated out of the whole participant group of 253 or 82, respectively).

more sophisticated by HPs than by lay people ($U = 5{,}173.5$, $P < .001$, $r = 0.306$)

radiotherapy was rated as

more good by HPs than by lay people ($U = 11{,}455.5$, $P = .029$, $r = 0.159$)
more sophisticated by HPs than by lay people ($U = 8{,}215$, $P = .038$, $r = 0.151$)
less sad by HPs than by lay people ($U = 5{,}647$, $P < .001$, $r = 0.431$)

surgery was rated as

less sad by HPs than by lay people ($U = 5{,}523$, $P < .001$, $r = 0.446$)

The second tool used to investigate connotations of target words was the word association task. Participants gave three associative responses to each of six terms: *remission*, *surgery*, *radiotherapy*, *palliative*, *chemotherapy*, and *benign*. Eight lay participants did not provide any data for this section and were therefore excluded from this analysis, resulting in $n = 254$ (lay) and $n = 82$ (healthcare practitioner) participants. Not all participants provided a full set of three responses to each of the six cues; the total number of responses provided by each group to each target word can be seen in Table 8.

The norms lists for each target word for each group can be seen in Supplementary Data File 2. Those lists exclude responses given by only one participant (for a full set of all responses given, see https://mental-lexicon.swansea.ac.uk). The norms lists are calculated from all responses in the data, whether they were the first, second, or third response given; eliciting multiple responses creates a more detailed picture of the semantic space occupied by these target words, and of where this aligns and diverges for the two groups. However, because the first response in a multiple-response word association task is the most spontaneous and often considered the

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Table 8. Total number of word association responses provided by the lay and healthcare practitioner (HP) group.

	LAY ($n = 254$)	HP ($n = 82$)
Remission	547	219
Surgery	577	229
Radiotherapy	506	232
Palliative	366	223
Chemotherapy	589	235
Benign	476	223
Total	3,061	1,361

most informative (Playfoot et al. 2018), we have separated those out for additional consideration. To provide an initial overview of response data, the most frequently given (dominant) first responses and general responses from each group are shown in Table 9.

With the caveat that Table 9 shows only the most frequent responses, it does indicate differences in the groups' associations with the target words. There are two ways in which we might assess (in)congruence of responses. The first is to count the number of responses shared (or not shared) by the groups. It can be seen from Table 9 that the majority of dominant first responses from lay participants (19 of 32) are not dominant for the healthcare practitioner group. The fact that this is also the case when we consider all responses (18 of 32) indicates that the different connotations for these groups go beyond the immediate, spontaneous response. Some target words demonstrate less congruence than others according to this measure: the two groups only share one response to *palliative*, and only two to *radiotherapy* and *chemotherapy*. The target word demonstrating the most congruence according to this measure is *benign* (four shared first responses).

The second way in which one might investigate congruence in these data is to scrutinize the semantic fields of the responses given. Although most of the responses to *remission* differ between the groups, they are almost all in the semantic fields of positivity and improvement. Responses to the other target words represent a broader range of semantic fields. Practitioners primarily associate the target word *surgery* with the notion of *cure,* whereas for lay participants, it elicits the incongruent notion of *fear*. It is notable too that the terms *side effects* and *symptom* are prevalent in practitioner responses to *radiotherapy*, *palliative,* and *chemotherapy* but do not appear at all in the top responses of lay people. Lay participants' data, on the other hand, seem to include more responses relating to emotions or specific physical impacts.

Examining the dominant responses in this way offers an indication of group similarities and differences. However, because the cut-off of rank five in the table above is arbitrary, and because norms lists do not group items in the same word family, the entire set of responses should be considered in order to make more robust observations about group-wise data patterns. Our next step therefore was to identify and count responses in the set that related to positive emotion, negative emotion, and fear. The decision to use these categories was informed by the overview of dominant responses above, and by the aim, in this section, to focus on connotation (e.g. *benign* > *happy*) rather than definition (e.g. *benign* > *good*). Zupan et al.'s rating of emotion words (2023) was used to identify words in these categories in a principled way. Through participants' assessment of valence, their study generated word lists associated with *happy* (128 words), *sad* (88), and *fear* (67). Responses in our data that were included in those lists were coded accordingly. Responses in the same word family as an entry on those lists were also coded accordingly, so that, for example, *scary* (a response not in their list) was coded in the same way as *scared* (in their list). Responses were then scrutinised for items that were not included in the Zupan et al. lists, but which were related to 'happy', 'sad,' or 'fear'. These items were considered by two raters and were included if the raters agreed that the item fit centrally into

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Table 9. Most frequently given responses from lay and healthcare practitioner (HP) groups (ranked 1–5, in order; equally ranked words share cells). Words not appearing in the other group's top 5 responses are in bold.

	First response		All responses	
	LAY	**HP**	**LAY**	**HP**
Remission	Good	**Clear**	Good	Positive
	Recovery	Good	**Happy**	Good
	Cancer	**Positive**	**Recovery**	Relief
	Relief	Relief	Positive	**Clear**
	Happy	**Time**	**Better;** relief	**Hope**
Surgery	Operation	**Cure**	Operation	Pain
	Scary	**Curative**	Pain	**Cure;** recovery
	Invasive	Operation	**Hospital**	**Curative**
	Pain; **scared**	Pain	**Scary**	Operation
		Treatment	**Invasive;** recovery	
Radiotherapy	Treatment	Treatment	Treatment	Treatment
	Cancer	Cancer **targeted**	Cancer	**Side_effects**
	Radiation		**Radiation**	**Palliative**
	Painful	**Burn; pain; radical; side_effects**	**Hair_loss; scary**	**Targeted**
	X-rays			**Burn;** cancer; **pain**
Palliative	**Care**	**Incurable**	Care	**Symptoms**
	Sad	**Symptom_control symptoms**	**Sad**	Care; **incurable**
	Caring		**Death**	
	Dying	Dying	**Caring**	**Support; symptom_control**
	death; end	**support**	**dying**	
Chemotherapy	**Cancer**	Treatment	**hair_loss**	**side_effects**
	Hair_loss	**Side_effects**	**Cancer**	Treatment
	Treatment	Sickness	Treatment	Sickness
	Sick; Sickness	**Toxicity; nausea**	Sickness	**Toxicity**
			Sick	**Nausea**
Benign	Good	Relief	**Tumour**	Relief
	Tumour	Good	Good	Good
	Relief	Noncancerous; **not_cancer**	Relief	**not_cancer**
	Happy		Happy	Happy**; harmless; positive**
	Noncancerous; safe	**Harmless;** safe	**Safe**	

one of the three target categories (a working principle here was that a definition of the response item would include an item on the relevant Zupan et al. list). Examples of such responses are *heartbreak* for category 'sad'; *elation* for 'happy'; *dread* for 'fear'.

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Table 10. Lay and healthcare practitioner (HP) emotion-related responses.

	LAY per cent all responses	HP per cent all responses	LAY per cent first responses	HP per cent first responses
'happy' category	10.1	10	11.4	8.7
'sad' category	5.3	1.8	4.4	2.2
'fear' category	7.6	2.0	7.4	1
total per cent happy/ sad/fear words	23	13.7	23.2	12

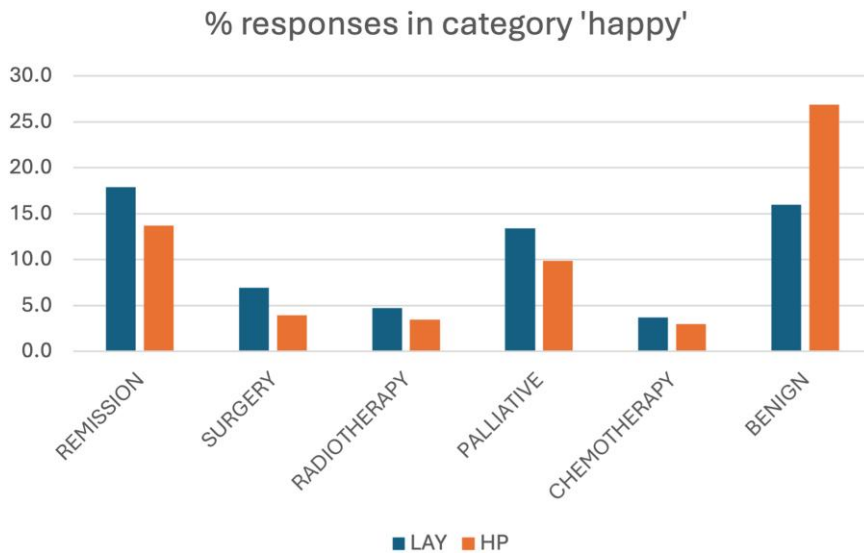

Figure 2. Lay and healthcare practitioner (HP) responses in the category 'happy'.

As shown in Table 10, the lay participants' data included proportionally more emotion-related responses than the practitioner data, both in terms of the overall response set and when considering first responses only. The relatively high proportion of 'happy' words is perhaps surprising at first glance, but scrutiny of the norms lists and of Zupan et al.'s word list reveals that many of these words were in the families *relief* and *hope*. The most prevalent items in the 'sad' category were in the word families *sickness, sad,* and *upset*. Most responses in the 'fear' category were in the families *worry*, *scared*, *fear*, and *anxious*.

The distribution of the emotion-related responses across the six target words can be seen in Figures 2–4, and here some more specific group differences are indicated. In the category 'happy', the distribution of practitioner responses broadly mirrors that of lay responses across all target words except *benign*. 27 per cent of practitioner responses to *benign* relate to 'happy'; in the context of oncology work, this is perhaps unsurprising. It is striking that for four of our target words, the practitioner group produced no responses in the 'sad' category at all, and for *palliative* and *chemotherapy*, they produced far fewer 'sad' responses than did the lay participants. Figure 4 shows that while fewer than 4 per cent of healthcare practitioners' responses to any target word were related to 'fear', lay participants produced more than this for all items except *remission*. Notably, nearly 15 per cent of lay responses to *surgery* related to 'fear'; as we saw in Table 9, predominant practitioner responses were *cure* and *curative*.

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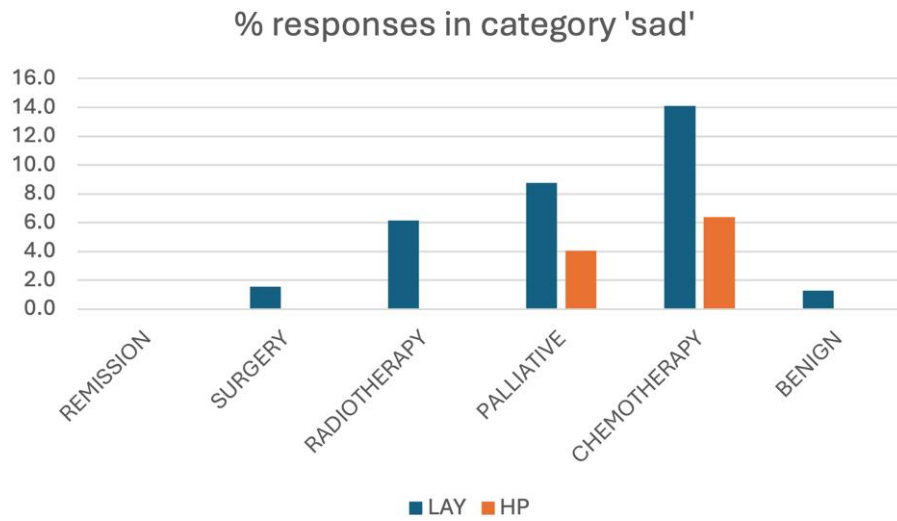

Figure 3. Lay and healthcare practitioner (HP) responses in the category 'sad'.

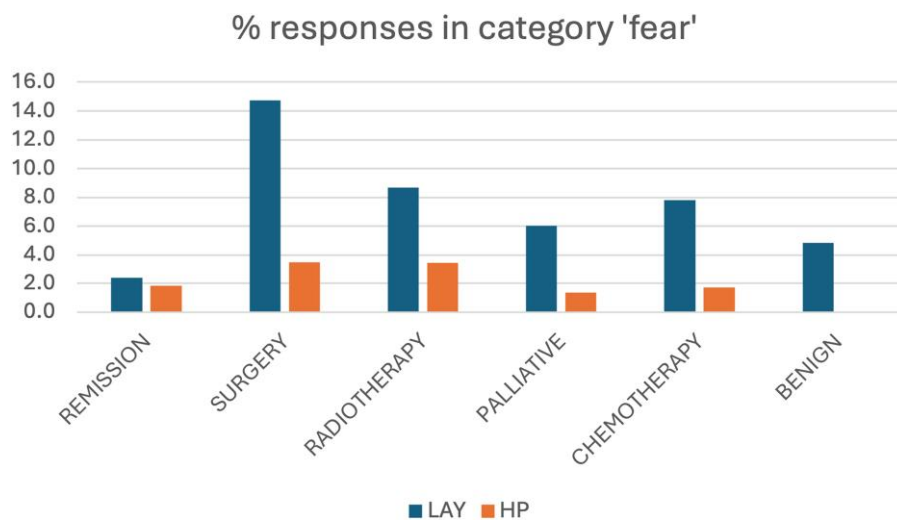

Figure 4. Lay and healthcare practitioner (HP) responses in the category 'fear'.

Discussion

We set out in this study to assess public understanding of a selection of cancer-related terms and examine the connotations attached to those terms by lay people and healthcare practitioners. Below, we consider the study's findings, first in connection with each target word, then in terms of general data patterns, and potential extrapolation to other terms and contexts. Finally, we assess the effectiveness of the novel methods employed here to investigate understandings of medical terminology.

Word-by-word analysis

As noted at the start of this paper, understanding the way in which potential patients might construe words used in cancer consultations can provide pathways to more effective communication.

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Table 11. Questionnaire sections examining each target item.

	Section 1: scenarios (denotation)	Section 2: semantic differentials (connotation)	Section 3: word associations (connotation)
Benign	X		X
Chemotherapy		X	X
Controlled	X		
Margins	X		
Metastasized	X		
Palliative		X	X
Positive	X		
Progressing	X		
Radical surgery	X		
Radiotherapy		X	X
Remission	X		X
Surgery		X	X

Through a word-by-word analysis, it is possible to identify which terms are the most problematic and in which ways.

The constraints of questionnaire length meant that target items did not appear across all three sections of the questionnaire but were allocated to sections in a principled way (see Table 11 and explanation above). Four items (*chemotherapy, radiotherapy, palliative, surgery*) were examined in the two connotation tasks. Six items (*controlled, margins, metastasized, positive, progressing, radical surgery*) were examined only in the denotation task. Two items (*benign, remission*) were examined in the denotation task and in the connotational word association task. The observations below therefore draw on data from different sections of the questionnaire and interpret the most salient findings in relation to each word in turn.

Benign *was misunderstood by 27 per cent of lay participants as meaning cancerous and/or necessitating urgent treatment. However, the confidence rating associated with this was low, indicating that many were aware that they may not fully understand the word. This is reflected in the most frequently given associative response from lay participants,* tumour; tumour *appeared only once in the healthcare practitioners' norms list. Similarly, there are no responses related to 'fear' or 'sad' in the practitioner responses whereas these do appear in the lay responses (6 per cent).*

Chemotherapy was rated as more 'sad' than 'happy' by significantly more lay participants than healthcare practitioners. The dominant associative response from practitioners to chemotherapy was *side effects*, and specific side effects (in order of frequency: *sickness, nausea, hair loss, fatigue*) were also common responses from that group. In the lay participants' data, 15 per cent of responses relate to hair loss and 8 per cent to fear, compared to 5 per cent and 2 per cent, respectively, in the practitioners' responses.

Controlled was understood well or partially by nearly all participants. Misunderstandings differed, with interpretations of 'keep the cancer controlled' including indication of an imminent death, assurance that the cancer would not get worse, and an intention to closely monitor the condition.

Margins were misunderstood by 35 per cent of participants. However, the confidence rating associated with this was low, indicating that many were aware that they may not (fully) understand the word. 38 per cent reported that they didn't know the meaning.

Metastasized was well understood by only 29 per cent of participants. Of the others, 16 per cent reported low confidence in their understanding (including the 9 per cent who misunderstood), and 56 per cent reported not knowing the meaning.

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Palliative elicited the biggest difference in semantic differential ratings between lay and healthcare practitioner participants, with practitioners rating it as more active, more strong, more useful, and more sophisticated than lay people did. There are similarities in the most frequent associations of the two groups, but palliative generated a much smaller number of lay responses than did the other terms, indicating a lack of knowledge of the term. The practitioners produced more responses in the word families of *comfort, kindness, support, care, dignity* (15 per cent of responses) than did the lay participants (5 per cent), echoing the differences in the semantic differential ratings of the two groups. 6 per cent of lay participants' responses related to 'fear', and 9 per cent to 'sad', compared to 1 per cent and 4 per cent, respectively, of the healthcare practitioner responses.

Positive, in the phrase '*test results have come back positive*', was well understood by most lay participants. However, 12 per cent misunderstood the word as communicating good rather than bad news, the polar opposite of the speaker's intention, and were generally confident in this interpretation.

Progressing, in the phrase 'the tumour is progressing', was misunderstood by 7 per cent of participants, who were nevertheless confident in their interpretations, which included that the tumour was getting better, or reducing.

Radical surgery was well understood by only 7 per cent of lay participants. 24 per cent misunderstood, assuming that it referred to surgery that was fast or ground-breaking.

Radiotherapy was seen by healthcare practitioners as more good, more sophisticated, and less sad than it was by lay participants. 'Fear' associations were more evident in the lay responses (8 per cent) than in those of the practitioners (3 per cent); the latter group produced no responses relating to 'sad'.

Remission was misunderstood by 20 per cent of lay participants, with most of these interpreting it as meaning the cancer is cured. The confidence rating for these inaccurate interpretations was generally high. The most common associative responses from both lay and practitioner groups were related to 'happy'.

Surgery was rated as less sad by significantly more healthcare practitioners than lay people. *Surgery* attracted the highest proportion of 'fear' related emotions from lay participants (15 per cent of responses) than did any other word and in contrast to practitioners' 3 per cent.

Observations about denotation and connotation in health communication

In their 2003 paper, Chapman et al. conclude that

> 'members of the general public have varying levels of understanding of terms used to describe cancer diagnosis, prognosis, screening and treatment … doctors should not assume that terms readily understood by their colleagues will be understood by their patients' (565).

Our findings indicate that public understanding of cancer-related terms is still variable and includes some substantial misunderstandings.

Before discussing the key observations emerging from this study, we should acknowledge the need to interpret our findings and conclusions in light of the characteristics of our participant groups and of our methodological decisions. As noted in Table 5, our population sample, though broadly representative of the wider population, is younger and has a higher education level than the population average. In a number of previous studies (e.g. Thompson and Pledger 1993; Gotlieb et al. 2022), education has been one of the few demographic factors that has been associated with greater understanding of medical terminology. The fact that the participant group in this study includes a relatively high proportion of tertiary-educated people may mean that our findings overestimate the medical vocabulary knowledge of the general population. Our study also included proportionally fewer people with an L2 other than English or Welsh than in the census data. We should also note that the lay participant group included people with experience of cancer

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care (8 per cent had had cancer, 34 per cent had cared for someone with cancer), and while this is demographically representative, further research is needed in order to establish the effect of this experience on their construal of cancer-related terms. The health practitioner group included a number of different roles (Table 6); we have assumed a level of homogeneity in their connotative understanding of terms, and concurrence with health literature in their denotative understanding, but again this is open to further investigation. Finally, the selection of terms to be investigated was informed by previous research along with indigenous criteria, and not all terms were investigated in all sections of the questionnaire but rather were assigned to the most salient, according to those sources. This enabled us to keep the questionnaire to a manageable length, maximizing sample size. With this study now serving as proof of concept for the novel methodological approach, analyses can stretch to other terms and, where appropriate, across all three measures of understanding.

Returning to the findings emerging from this study, in relation to understanding of denotational meaning, we can conclude from the confidence ratings alongside the comprehension questions in section 1 of the questionnaire, that confidence in understanding is not an indication of actual understanding. As can be seen in Table 7, for five of the eight items, participants were generally confident of their interpretation of the target term, despite it being wrong. A clear message for practitioners here is that asking *if* a patient understands is unlikely to be helpful; in most cases here, the participants thought they *did* understand.

Scrutiny of individual target words, and information from the Cambridge Dictionary about meanings, reveals three potential causes of misunderstanding or imprecise/partial understanding. First, words such as *metastasized* and *remission* are marked as specific to a medical context. This explains the low confidence rating in our study; participants know that they don't know these words. However, *remission* is (less frequently) used in other contexts, and the medical meaning could be extrapolated from knowledge of these. Second, words such as *benign*, *controlled*, and *margins* are not primarily applied to medical contexts. The dictionary's second entry for *benign* specifies an oncology context ('a benign tumour'), and some understanding of the word could be extrapolated from the first definition entry. Examples or definitions from medical contexts are not given for *controlled* or *margins*, but some understanding could be extrapolated from knowing the primary definition of *controlled*, and the third definition of *margins*.

The remaining words from the denotation task are *positive*, [the tumour is] *progressing*, and *radical surgery*. Importantly, even participants who misunderstood these words were confident that they had understood them correctly. Like *controlled* and *margins*, these are polysemous words, whose specific meaning when used in technical (medical) contexts is different from their use in general English. Because their technical meaning is not always apparent, they are often classed as 'cryptotechnical' words (Fraser 2009). Fraser and others (e.g. Coxhead 2017; Jakobsen 2018) have documented the challenges that cryptotechnical words present in the context of teaching languages for Specific Purposes (English and Danish in these cases), but their role in a (first language) health literacy/communication context is yet to be systematically addressed. While all can be classed as cryptotechnical words, *positive*, *progressing,* and *radical* [surgery] differ from *controlled* and *margins* in a critical way: their meaning in a medical context cannot be extrapolated from knowledge of their meaning in general language use. The first dictionary definition for *positive* is 'full of hope and confidence, or giving cause for hope and confidence'. Although the first definition for *progressing* gives a medical context example: 'improve or develop in skills, knowledge—e.g. The doctor said that she was making good progress (= getting better after a medical operation or illness)', knowledge of this meaning is entirely unhelpful to our target context: 'the tumour is *progressing*.' Attempts at extrapolating the meaning of *radical* (surgery) from knowledge of the first two dictionary definitions would also be unsuccessful. The third dictionary definition given is precisely for '*radical surgery*': 'aimed at removing all diseased tissue', but this is labelled as specialized medical terminology.

While the order in which dictionary definitions are presented is typically based on global estimates of each definition's frequency (or sometimes its prototypicality—coreness of meaning),

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these estimations do not account for individuals' experience of language. We might predict, for example, that a health professional will encounter *radical* more frequently in its 'surgery' context than in other contexts. Hanks' TNE (Theory of Norms and Expectations) model considers word meaning to be inextricably linked to context; and analysing a scientific text about plankton, he concludes that 'scientists live in a terminological world of their own' (2013: 49). This 'world of their own' chimes with Fillmore's Frame Semantics, where words evoke and are evoked by *frames*. His early work, presenting *frame* as a cover term to encompass (among others) the concepts of *schema* and *scenario*, considers that 'words represent categorizations of experience, and each of these categories is underlain by a motivating situation occurring against a background of knowledge and experience' (Fillmore 1982: 112). Polysemy is therefore explained by the occurrence of a single wordform in different frames, and furthermore, when there is a 'disparity of schematization', or a conflict of frames, miscommunication can occur (1982: 127). In terms of our study, we might propose that the lay and practitioner groups encounter the target words in different frames. The items in section one are presented in a frame that is unfamiliar to lay participants; imposing on those items the frames determined by their own 'background of knowledge and experience' is not only unhelpful but can be, in the cases of *progressing* and *positive*, deleterious. It should be noted that in our study, the practitioners were from a distinct area of health study (oncology), and almost all participants' first language was English. As Dahm observes (2012, 2018), the real-world context of health communication is often more complex; she considers the 'differing underlying knowledge schema' not only of patients and practitioners but also of L1 and L2 users, and of practitioners with different medical backgrounds, all of whom draw on a 'dynamic multiplicity of meanings for the same medical terms' (2018: 100). More detailed semantic modelling is beyond the scope of this paper, with its applied focus, but further consideration of semantic tools, not least the FrameNet database https://framenet.icsi.berkeley.edu/ would be a fruitful direction for further exploration (see also models of lexical priming (e.g. Hoey 2012) and semantic prosody (e.g. Hunston 2007)).

In sum, then, we can categorize the terms examined in section 1 as

- Terms most often used in medical contexts; participants are likely to be aware of whether they understand them or not (*metastasized, remission*)
- Terms used in general language use as well as in medical contexts, but whose meaning in a medical context can be more or less extrapolated from their general meaning (*benign, controlled, margins*)
- Terms whose use in medical contexts is completely different (and in the cases of *progressing* and *positive*, conflicting with) their meaning in nonmedical use. Because participants know these words in general English contexts, they may mistakenly think they understand them in a medical context. (*positive, progressing, radical*)

The third of these is the most likely to lead to critical misunderstandings.

Comparing denotational and connotational meanings and understandings, as we have done in this study, provides insights into the nature of word knowledge, and in particular, the partial acquisition of word knowledge. Few of our participants could accurately demonstrate denotational understanding of the medical term *remission* and indeed may never need to acquire the precise meaning of that term. However, the connotational meanings as indicated in the word association responses to *remission* were overwhelmingly positive and very similar to those of the healthcare practitioners. This is evidence that connotational knowledge can precede denotational: we know to respond with gentle positivity when told that a friend's loved one is 'in remission', and with sadness and sympathy when told that they are 'undergoing chemotherapy' despite, perhaps, being unable to define what remission or chemotherapy is.

While the two participant groups shared many of the connotational meanings of most target words, there were some exceptions to this. Perhaps the most striking difference was in associative responses in Zupan et al.'s 'fear' category (2023). Emotion and stress have long been related to

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decreased capacity for processing and retaining medical information. Fallowfield and Jenkins conclude that 'Anxiety about having a life-threatening disease can make interpretation and comprehension of complex information even more difficult' (1999: 1593), and similar observations have been made elsewhere (e.g. Timmermans 1994; Furber et al. 2013, 2015; Formagini et al. 2022). The connotations of fear and sadness revealed in this study to be held by lay people in relation to cancer terminology suggest that even words associated with the treatment or cure of cancer are anxiety-inducing.

As seen in Fig. 4, this is much less the case for healthcare practitioners. We might speculate that this is because for them, the conversations around surgery, chemotherapy, etc. are ones with potentially positive outcomes. On the other hand, this observation from Fallowfield and Jenkins offers an alternative explanation: 'The context and content of communication in oncology can often generate challenging and highly charged emotions and some doctors exhibit a cold, professional detachment as a means of preserving their own emotional survival' (1999: 1594). Whatever the cause of the difference in connotational space of the target items for lay people and practitioners, communication is likely to be enhanced by recognition that terms for which practitioners might generally have positive connotations might nevertheless induce distress in their patients. *Surgery*, for example, evoked the highest number of fear-related responses in lay participants.

Conclusion

This paper reports the first study (to our knowledge) that elicits connotational as well as denotational meanings of terms used in health communication, from both lay and practitioner participants. The novel methods used for this, semantic differential analysis and word association analysis, have yielded new information about aspects of meaning that are not straightforwardly shared by lay people and healthcare practitioners and have exposed those terms where connotational incongruity is most acute. The findings from this study that relate to denotational meaning have also exposed misalignments of understanding. A comparison with Chapman et al.'s (2003) findings suggests that understanding of cancer-related terms has not improved since that study. Of the four items tested in both studies, three (*positive, benign, metastasized*) were misunderstood by more lay people in the study reported here than in the 2003 study. In our study, *progressing* was misunderstood by fewer people; nevertheless, the capacity to construe this term, and *positive*, as meaning the opposite of a healthcare practitioner's intention, is cause for concern.

This information can be harnessed to inform, for example, the design of practitioner training modules and patient information materials, with a view to improving communicative efficacy in patient communication. Strategies for practitioners might include

- emotion regulation: sequencing or pacing conversations to enable a pause after introducing emotive terms such as *palliative*, so that key information is not obscured by immediate reactions of sadness or fear;
- acknowledgement of immediate association: noting that mention of *chemotherapy* is likely to trigger anxiety about hair loss, and recognizing that while *surgery* is, from an oncologist perspective, a potential route to a wholly successful outcome, for a patient it induces fear and anxiety, and addressing or inviting verbalization of these associations;
- avoidance of ambiguity: replacing or clarifying problematic cryptotechnical terms, for example, by avoiding *positive* without explicit clarification, and replacing *progressing* with a more transparent alternative, such as *getting worse;*
- explicit explanations: scaffolding use of domain-specific terms (*remission, metastasized,* etc.) with definitions and paraphrase.

Of course, healthcare practitioners are far from ignorant of these challenges to communication; indeed, many actively seek to address them. For those, the linguistic findings presented in this paper can serve as evidence to direct their efforts. The novel methods used here have yielded not only

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evidence of, but precise information about, some causes of the 'communication gap' (Pham et al. 2014) between patients and practitioners. The methodology presented in this paper is straightforwardly transferable to other areas of oncology and other medical domains. Extending the application of these methods will generate deep insights into the nature of incongruent lexical understandings and signpost practical routes to a comprehensive enhancement of health communication.

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Supplementary data

Supplementary data is available at *Applied Linguistics* online.

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