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Gaze and Instrumental and Affective Communication in Doctor-Patient Consultations:

A Wearable Eye-Tracking Study in an Outpatient Clinic

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Abstract

This wearable eye-tracking study investigated the social and clinical context in which patients' and a clinician's gaze and verbal behaviours occurred during medical consultations at an outpatient neurology clinic. We analysed gaze behaviour and instrumental and affective communication of patients and a neurologist in selected consultations (*n* = 12), representing different consultation compositions (i.e., the social context: one-on-one, one-on-two, one-on-many) and consultation activities (i.e., the clinical context: discussing scan results, performing a neurological examination). In-depth analyses of mutual and joint gaze in relation to verbal utterances were explored in a smaller subset (*n* = 3), providing detailed descriptions of patient-neurologist gaze and verbal communication while considering the social and

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clinical context of these consultations. Results showed that both patients and the neurologist predominantly gazed at each other's faces but also looked at other locations and objects. Individual, mutual, and joint gaze patterns at faces, the screen, and companions varied across social and clinical contexts. Instrumental and affective communication were intertwined and co-occurred with patients' and the neurologist's mutual and joint gaze states. These findings underscore that doctor-patient communication is shaped by what is said and how attention is jointly managed within the broader social and clinical context of doctor-patient communication.

Keywords

Doctor-patient communication, eye tracking, instrumental communication, affective communication, mutual gaze.

Doctor-patient communication, referring to verbal and non-verbal interactions between clinicians and patients, is essential for adequate information exchange, interpersonal relationship building, and shared decision-making in outpatient consultations (Ong et al., 1995). As such, communication serves several important functions ranging from gathering and providing information to fostering the relationship and responding adequately to emotions (Epstein & Street, 2007). These functions may contribute directly to health outcomes, such as functional ability and emotional well-being, or indirectly through, for example, enhanced understanding and building trust (De Haes & Bensing, 2009; Street et al., 2009). It is for this reason that doctor-patient communication is often referred to as "the main ingredient in medical care." (Ong et al., 1995, p. 903)

Existing frameworks have emphasised both verbal and non-verbal aspects of doctor-patient communication (De Haes & Bensing, 2009; Ong et al., 1995). Regarding verbal communication, clinicians may provide information so that patients understand their diagnosis and treatment options (instrumental communication), and they may empathise with patients' situation so that they feel understood (affective communication) (Bensing & Dronkers, 1992; Lee et al., 2025). Likewise, patients may verbally express themselves by, for example, asking questions about treatment (instrumental communication) and voicing concerns about side-effects (affective communication). In turn, non-verbal communication, such as gaze behaviour (e.g., eye contact), also plays a crucial role in clinical encounters when it comes to instrumental and affective communication. First, eye contact presents an effective way to foster information exchange. For example, patient-directed gaze has been associated with general practitioners' instrumental communicative behaviour, such as asking questions and giving information (Bensing et al., 1995), and patients' retention of clinical messages (MacDonald, 2009). Second, in terms of affective communication, consistent eye contact has been associated with stronger patient trust in oncologists (Hillen et al., 2015), and relationship building between nurses and older patients (Caris-Verhallen et al., 1999). These examples show that both verbal and non-verbal behaviours independently contribute to achieving the instrumental and affective goals of doctor-patient communication.

What has largely been missing from prior research, however, is the contextualisation of clinician and patient gaze and verbal behaviours during consultations, which is essential to explain the heterogeneity in findings (e.g., Jongerius et al., 2021, 2022a, 2022b). Gaze and verbal communication depend on what happens during the consultation (e.g., discussing test

results, a physical examination) and who else is present (e.g., family members, medical interns) (e.g., Andrades et al., 2013; Ting et al., 2021). We therefore provide a contextualised account of how patients and a clinician direct their gaze beyond faces, and how gaze patterns are associated with who is present (reflecting the social context) and what activities take place (reflecting the clinical context) during the consultation. As prior research on gaze in clinical encounters has mainly considered clinicians' gaze (see Bensing et al., 1995; Jongerius et al., 2021, 2022a, 2022b), we study gaze behaviour of the patient and clinician simultaneously. Using wearable eye tracking, we move beyond lab-based studies that may not fully represent what goes on in actual clinical consultations. We study the gaze behaviours of patients and a clinician in conjunction with their instrumental and affective communication, while considering the social and clinical context of doctor-patient consultations.

Gaze in Doctor-Patient Communication

Gaze behaviour during face-to-face communication is widely recognised as a fundamental component of nonverbal interpersonal communication (for recent reviews, see Hadley et al., 2022; Hessels, 2020). Gaze is used to signal and perceive cognitive and emotional states, coordinate turn-taking in conversations, and establish interpersonal trust, affiliation, and liking (Hessels, 2020; Kendon, 1990; Kleinke, 1986). In doctor-patient communication, gaze behaviour, and (mutual) face gaze and eye contact in particular, have been associated with both instrumental (e.g., information exchange) and affective (e.g., building rapport, establishing trust) communication behaviours (e.g., Helou et al., 2022; Hillen et al., 2015; MacDonald, 2009), as well as with short-term (e.g., patient understanding, trust) and longer-term (e.g., patient well-being, patient physical health) outcomes (e.g., De Haes & Bensing, 2009; Haskard et al., 2009; Jongerius et al., 2021, 2022b).

However, the effects of face gaze and eye contact on communication processes and outcomes are not uniform, as they seem to depend on differences in context (see Mast, 2007) and measurement (see Jongerius et al., 2020 for a review). While terms such as eye contact, mutual gaze, and face gaze are often used interchangeably, different operationalisations have been employed by researchers (see Hooge et al., 2025; Jongerius et al., 2020, 2021). In this study, we are interested in where and how much patient and clinician gaze is directed at each other's face and body, the computer screen, companions, or the surrounding environment (i.e., areas of interest, AOIs) in doctor-patient consultations. Furthermore, we are interested in *mutual gaze* states, which refer to instances where two persons simultaneously look at each other's faces, and *joint gaze* states, when they are simultaneously looking at the same object or location (e.g., computer screen, companions).

Functions of Gaze

While the role of gaze in human interaction is highly context-dependent, gaze is commonly understood to fulfil both information-gathering and information-signalling functions (Hessels, 2020; Kleinke, 1986; Risko et al., 2016). From an information-gathering perspective, people continuously look around to acquire information about the environment (Hayhoe, 2017). For example, a clinician may direct their gaze at the patient's face during conversation, look at their computer screen to acquire information from the patient's electronic health record (e.g., medical history, test results), or observe a patients' body during a physical examination. In turn, gaze also facilitates the communication of affective states. Looking at someone's face and

eyes allows one to detect what that person is emotionally and mentally experiencing (e.g., MacDonald, 2009; Hessels, 2020).

From an information-signalling perspective, gaze behaviour in face-to-face communication may signal interest and attention towards another person, thereby facilitating the coordination of interaction, such as turn-taking (Kendon, 1990), and the establishing engagement and understanding (e.g., Richardson & Dale, 2005; Richardson et al., 2009). In contrast, gaze aversion can disrupt and hinder communication. For instance, when a clinician's gaze is diverted away from their patient and focused on the computer screen, patients might stop speaking or struggle to find the right words when they feel the clinician is not listening (Byrne & Heath, 1980; Ruusuvuori, 2001).

Given important informative and social functions of gaze, it plays a crucial role in clinical encounters where clinicians and patients simultaneously exchange and process often complex and emotionally laden information (e.g., Chaitchik et al., 1992). The literature, however, does not paint a uniform picture regarding the effects of gaze behaviour on the flow and experience of medical consultations. Some studies have highlighted the importance of maintaining eye contact in conversation (e.g., Bensing et al., 1995; Brooks et al., 1986; Wheeler et al., 1979). For instance, sustained eye contact was shown to be positively correlated with the perception of more patient-centredness (Gorawara-Bhat & Cook, 2011), more perceived empathy, more trust, and higher patient satisfaction (Hillen et al., 2015). Conversely, Jongerius et al. (2022b) found that while the frequency of face gaze was related to higher patient satisfaction, sustained face gaze was associated with lower patient trust. They posited that sustained face gaze by the clinician could make some patients feel observed or uncomfortable, especially in emotionally charged conversations, potentially reducing trust. These mixed findings indicate that the appropriateness of gaze behaviour is, again, context-dependent, varying with what is being communicated.

Another possible reason for these mixed findings is that there are considerable differences in the literature in how measures of gaze behaviour are defined and operationalised. Eye contact and face gaze have been measured in diverse ways (for reviews, see Hessels, 2020; Jongerius et al., 2020), and studies have relied on indirect methods such as video vignettes, observer-based coding, or self-reports to do so (e.g., Gorawara-Bhat & Cook, 2011; Hillen et al., 2015; Ting et al., 2021). To address these limitations, researchers have more recently introduced wearable eye tracking for more objective and continuous measurements of gaze behaviour in doctor-patient consultations. Jongerius and colleagues (2021, 2022a, 2022b) showed clinicians' gaze was related to temporal and functional aspects of consultations. They found that gaze at patients' faces early in the consultation predicted patient-directed face gaze later, and that different measures of face gaze (i.e., frequency, duration, and dwell time) showed distinct relationships with relational outcomes, such as patients' trust and satisfaction. Furthermore, when clinicians shifted their gaze away from patients to consult or enter information in the computer, this did not necessarily interrupt communication, although patients varied in their responses to clinicians' gaze shifts.

Finally, much prior research has treated gaze as a unidirectional phenomenon (Risko et al., 2016), by focusing on either the clinician or the patient, instead of examining gaze as a bidirectional process (Street & Buller, 1987). Moreover, gaze in medical encounters is not always limited to the doctor-patient dyad but can be shaped by contextual factors, such as the presence of companions (e.g., partners, family members), who often join patients to medical visits (Schilling et al., 2002). Companions may actively participate in the consultation by

asking questions, expressing concerns, and supporting decision-making, which alters the conversational dynamic (Andrades et al., 2013; Ting et al., 2021). In addition, the presence of companions introduces new targets of visual attention for the clinician and opportunities for mutual and joint gaze, making gaze behaviour part of a multiparty, multimodal interactional system. Hence, taking this context into account will contribute to a more complete understanding of gaze and verbal behaviour in doctor-patient communication.

Gaze and Verbal Behaviours in Doctor-Patient Communication

To better understand the meaning and functions of gaze behaviour in doctor-patient communication, it is necessary to examine gaze in conjunction with what is verbally expressed (e.g., Mast, 2007). What is verbally said affects whether eye contact or gaze is considered appropriate or not. For example, when a patient is sharing details about their sexual dysfunction, direct eye gaze from the clinician might be perceived as inappropriately intimate. On the other hand, it might be experienced as offensive when the clinician looks away when a patient asks about treatment options. Gaze can affect verbal behaviour, as research has shown that gaze of the clinician affects what patients revealed in consultations (Bensing et al., 1995; Byrne & Heath, 1980). For example, Bensing et al. (1995) analysed 337 videotaped consultations involving 15 general practitioners to investigate whether the practitioner's gaze directed toward the patient was associated with both the practitioner's and patient's instrumental and affective verbal behaviour. Their findings showed that longer periods of patient-directed gaze were associated with higher levels of instrumental behaviour focused on psychological topics, compared to other topics. Higher levels of gaze were also positively associated with patients disclosing more information about their psychological health problems during the consultation. Bensing and colleagues (1995) concluded that clinicians' non-verbal behaviour reinforces verbal communication during consultations, and that patient-directed gaze plays a pivotal role in eliciting medical information.

The interplay between gaze and verbal communication is likely complex and influenced by the consultation context, including who is present, and what clinical activities take place. The current study used a two-step approach to contextualise patients' and a clinician's gaze behaviours during outpatient consultations. First, we analysed individual gaze and verbal (instrumental and affective) communication of patients and a clinician while considering the social and clinical context in which communication takes place. The social context—i.e., who is present—is considered by looking at consultation composition (e.g., one or more companions present) and the clinical context—i.e., what clinical activities take place—was studied by looking at consultation activities (e.g., physical examination). Second, we combined these data to explore paired gaze patterns (mutual and joint gaze) and how they are related to verbal communication during the consultation. This approach allowed us to answer the following research questions (RQs):

> *RQ1:* Where do patients and the clinician direct their gaze as a function of different consultation compositions (i.e., none, one or more companions present) and consultation activities (e.g., discussing test results, physical examination)?
>
> *RQ2:* How do patient, clinician, and companion(s) communicate during their consultation in terms of (a) instrumental and (b) affective communication?

Methods

Study Design

We conducted an observational study in a hospital context to study patients' and a clinician's gaze behaviours and verbal communication during the outpatient consultation. Gaze behaviour of patients and the clinician was recorded with a wearable eye-tracker (Pupil Lab Neon). A digital voice recorder (Olympus, model VN-541PC) recorded the verbal utterances. We followed recommendations for reporting eye tracking for communication research (King et al., 2019) and the coding of verbal communication behaviour (Hillen et al., 2025). The study was approved by the first author's research institute as well as by a medical ethics review committee and the local advisory board of the hospital where we conducted the study (see Ethical Approval Statement). Study materials, including the codebooks, questionnaire items, aggregated datasets, analysis script, and additional analyses can be found as online supplementary materials on the Open Science Framework (OSF)[1].

Participants

Participants included one neurologist working at the Elisabeth TweeSteden hospital (ETZ) in Tilburg, The Netherlands, and 33 patients. The ETZ is a large teaching hospital. The outpatient clinic of the neurology department provides care to patients with a neurological disease, such as Parkinson's disease, radicular syndromes (i.e., sciatica), headache, and functional neurological disorder (FND). All patients attending a routine outpatient clinic visit aged 18 years or older were eligible for inclusion. We excluded patients with dementia or other cognitive impairments, and patients with insufficient command of the Dutch language, following standard procedures in doing observational research in the Dutch clinical context (e.g., Jongerius et al., 2022b).

Ninety patients were eligible, of which 47 agreed to participate (52%), and 44 patients ultimately participated[2] (49%). Complete and accurate eye-tracking data were obtained from 33 patients[3] (75%). The consultations of the 33 patients and neurologist reflected one of four consultation compositions (see Figure 1): one-on-one (i.e., one neurologist, one patient, n = 13), one-on-two (i.e., one neurologist, one patient, one companion, n = 14), one-on-many (i.e., one neurologist, one patient, multiple companions, n = 3), and other consultations (i.e., attended by a medical intern, n = 3), which reflected the consultation's social context. To equally include the different composition types, we analysed 12 consultations—three of each composition type—representing the total sample in terms of patients' age, gender, and education level (see Table 1).

Procedure

Between December 2024 and January 2025, patients were invited via their electronic health record to participate in the study, receiving written information about the study objectives and procedure. Within 2 to 10 days after receiving this email, a researcher called all patients to confirm participation or withdrawal. Patients were informed that they and their neurologist would wear eye-tracking glasses during the visit, that the visit was audiotaped with a voice recorder, and that they would complete a paper-and-pencil questionnaire.

On the day of the consultation, two researchers welcomed the participants, explained the study procedure, and asked for written informed consent. All other people attending the

consultation, including the neurologist, other clinical personnel, and patients' companions, also gave informed consent, as the recordings would likely capture their presence as well. Before the start of the consultation, the patient and neurologist were fitted with eye-tracking glasses and followed a calibration-validation procedure, which involved fixating nine dots on an A3-sized poster from a 60cm distance (see Niehorster et al., 2024).

When the neurologist called the patient into the consultation room, the researchers switched on the eye-tracking glasses and voice recorder after everyone was seated. To indicate the start, the researchers used a clapperboard while the neurologist and patient looked at it simultaneously. After this, the researchers left the room. The neurologist and patient carried out the consultation. A knock on the door by the neurologist signalled the end of the consultation for the researchers, who used the clapperboard again to mark the end, and ended the recordings. Patients followed the researchers to complete a brief paper-and-pencil questionnaire and were thanked for participating.

Figure 1. Visual Representations of the Various Consultation Compositions (i.e., the Social Context) and Consultation Activities (i.e., the Clinical Context).

Note. (a) one-on-one consultation. (b) one-on-two consultation. (c) consultation with a medical intern present. (d) consultation discussing scan results. (e) consultation with physical examination.

Table 1. Descriptive Statistics of the Total Sample (*N* = 33) Compared to the Selection Sample (*n* = 12) Across the Four Consultation Compositions.

	Total sample		One-on-one		One-on-two		One-on-many		Other	
	All	*Sel.*[1]	*All*	*Sel.*	*All*	*Sel.*	*All*	*Sel.*	*All*	*Sel.*
N/n	33	12	13	3	14	3	3	3	3	3
Age										
Mean	59.0	61.1	55.9	51.0	58.6	59.7	75.7	75.7	58.0	58.0
(*SD*)	(17.6)	(18.8)	(19.0)	(25.2)	(17.9)	(24.8)	(9.0)	(9.0)	(11.1)	(11.1)
Range	22–85	22–85	22–84	22–68	27–82	33–82	67–85	67–85	46–68	46–68
Gender										
Male	15	5	5	1	7	1	2	2	1	1
Female	18	7	8	2	7	2	1	1	2	2
Education										
Lower	13	6	3	1	7	2	3	3	0	0
Middle	7	1	5	1	2	0	0	0	0	0
Higher	13	5	5	1	5	1	0	0	3	3

Note. [1]Selection. Row numbers represent frequencies, unless indicated otherwise. Consultation type 'Other' included one consultation with one neurologist, one medical intern, and one patient, one consultation with one neurologist, one medical intern, one patient, and one companion, and one consultation with one neurologist, one medical intern, one patient, and multiple companions. Lower education level = no formal education/a few years of primary education, primary education, lower vocational education, or prevocational secondary education. Middle education level = secondary vocational education, senior general secondary education, or pre-university secondary education. Higher education level = higher vocational education, university bachelor's degree, or university master's degree.

Eye-Tracking Measures

Equipment and Data Processing. We used two Pupil Labs Neon eye trackers (Pupil Labs, Baumann & Dierkes, 2023), each connected to a OnePlus 10 phone running Android (version 13) and the Pupil Labs Companion application (version 2.9.26-prod), recording binocular gaze at 200Hz with a resolution of 192 × 192 pixels as well as sound through a built-in stereo microphone. They include a front-facing scene camera that records video at 30Hz with a view field of 132° × 81° and resolution of 1600 × 1200 pixels. We manually set exposure of the scene camera at 330 to minimise potential motion blur. The neurologist put the phone in his front pocket, and the patients received a neck pouch to store the phone. We used a set of adjustable lenses for patients with prescription glasses.

Gaze recordings were uploaded to Pupil Labs Cloud environment, a web-based environment for data storage and analysis. Data quality of the eye-tracking signal (i.e., accuracy and precision) was assessed by visually inspecting each eye-tracking recording and by means of a validation procedure using glassesValidator (see Niehorster et al., 2024). We conducted four separate calibration-validation procedures with the neurologist at different moments, which yielded a mean accuracy of 2.9◦ (*SD* = 0.9) and mean precision of 0.2 (*SD* = 0.0). For the 12 selected consultations, patients' calibration-validation assessment yielded an average accuracy of 2.6◦ (*SD* = 2.1) and an average precision of 0.3 (*SD* = 0.1). We concluded that data quality was sufficient for our subsequent AOI analyses.

Mapping Fixations to Areas-of-Interest (AOIs). We exported the scene-camera videos and gaze recordings with the raw gaze position/coordinates from the Pupil Cloud environment, which included two recordings for each doctor-patient dyad. These recordings were imported into GazeCode (Benjamins et al., 2018) running on MATLAB 2023b, an open-source software package for manual annotation of wearable eye-tracking data. We used the default fixation-classification algorithm of GazeCode (Benjamins et al., 2018). Areas of interest (AOIs) were defined in GazeCode to correspond participants' gaze behaviour to specific objects and locations in the room, including faces, bodies, the neurologist's computer screen, the table, and the room (e.g., walls, other objects). For consultations with companions present, AOIs were added for companions' faces and bodies. An overview of all AOIs and their descriptions can be found in the Supplementary Material (see Supplementary Material A, Tables A1-A2).

We manually coded fixations following four steps, which we repeated for each consultation composition: training, blind double coding, consensus meeting, and independent coding. For training sessions, three coders (NB, DD, TV) concurrently discussed the fixations of one consultation to develop the codebook (see Supplementary Material A). Next, two coders (NB, TV) engaged in double-blind coding for one or two consultations per consultation type, with 21% being double coded. All categories demonstrated good intercoder reliability, with an overall percentage agreement between 94 and 97% across AOIs (for detailed intercoder reliability statistics, see Supplementary Material A, Table A3). Consensus meetings were held to resolve discrepancies and further refine the codebook. As a final step, the remaining video consultations were divided and independently coded by two coders (NB, TV).

Gaze Measures. We exported the patients' and neurologist's gaze data from GazeCode for each consultation. We computed *fixation counts* and *average total fixation duration* (ms) per AOI (i.e., face, body, screen, table, face companion, body companion, room). By summing up all fixation durations per AOI and dividing by the total fixation duration of the recording, we computed a *relative total dwell time* (%). This provides a relative measure of how much time gaze was directed at one of the AOIs as a percentage of the total time of the consultation, which is a good descriptor of overall gaze patterns (see Jongerius et al., 2021). We used this measure for all AOIs analyses throughout the results, but we also added overall descriptives and visualisations of fixation counts and average fixation durations per AOI (see Supplementary Material B).

Instrumental and Affective Communication Measures

Coding Procedure. Verbal utterances of everyone present were audio-recorded, transcribed verbatim, and content coded. Following the Roter Interaction Analysis System (RIAS, Roter & Larson, 2002), we assessed who pronounced the utterance (i.e., neurologist, patient, companion, medical intern), whether the utterance was a question (i.e., no question, an open question, a closed question), and whether the utterance contained instrumental and/or affective communication. We predefined a coding scheme based on earlier research on instrumental (task-related) and affective (socio-emotional) communication (e.g., Bensing & Dronkers, 1992; Hall et al., 1987; Roter et al., 1987; Tenfelde et al., 2023). If the utterance contained instrumental and/or affective communication, it was further categorised into instrumental (diagnosis, treatment, psychological feelings, daily life, lifestyle, and practical procedures) and affective (expression of concern, negative talk, social talk, and verbal attentiveness) subcategories. Utterances could be both instrumental and affective, but could not be coded

more than once within an instrumental or affective category. The codebook can be found in Supplementary Material C.

We content-coded the transcripts of the 12 selected consultations. Two coders (NB, DD) were trained using one transcript, after which four transcripts (one per category) were double coded to resolve discrepancies and reach acceptable consensus (> 74%)[4]. The remaining transcripts were coded independently by one coder (DD).

Verbal Communication Measures. For all instrumental and affective (sub)categories, we counted *total numbers of utterances* as well as *relative numbers of utterances* (%) by dividing a subset of utterances (e.g., the total number of open questions) by the total number of utterances (e.g., the total number of open and closed questions). In addition, total and relative numbers were calculated for utterances expressed by the patient, neurologist, and companion(s) for each variable, which we reported in the results (and visualised in Supplementary Material D).

Self-Reported Measures. Patients reported their age (in years), gender (male, female, other, prefer not to say), and highest completed education level. Education levels were categorised into lower (i.e., 1 through 4), middle (i.e., 5 through 6), and higher (i.e., 7 through 9) levels of education (see Statistics Netherlands, 2026, and Table 1 for educational levels per subcategory). Patients also answered questions about how they perceived the communication during the consultation, including information exchange, relationship building, shared decision making (adapted from Ong et al., 1995; Ong et al., 2000), and feeling heard (Roos et al., 2023). Patients and the neurologist completed items on their general satisfaction with the consultation (PSQ; adapted by Zandbelt et al., 2004), their inhibition (Schouten et al., 2007), and private and public self-awareness during the conversation (Fenigstein et al., 1975). As we focussed on the observational data for this study, we provided the questionnaires in Supplementary Material E and the self-reported data on OSF (see self-reported datasets).

Data Analysis

Eye-tracking and verbal communication data were analysed in two ways. First, we performed descriptive analyses on the manually coded data of the selected consultations ($n = 12$) to examine patients' and neurologist's gaze considering different consultation compositions (reflecting the social context) and consultation activities (reflecting the clinical context) and to understand how patient, neurologist, and companion(s) communicate in terms of instrumental and affective behaviour. Given the sample size, patterns were described rather than making statistical comparisons. We used R (version 4.4.1, R Core Team, 2024) for analyses and MATLAB 2023b for visualisations.

Second, for illustrative purposes, we analysed the paired data of the patient's and neurologist's gaze and verbal utterances of a subselection ($n = 3$) to examine mutual and joint gaze states and in relation with verbal communication. We used ELAN (version 7.0, The Language Archive, 2025) to manually annotate synchronised consultation recordings with visual gaze overlays and audio-recordings. We created variables for mutual and joint gaze based on overlaps between patient's and neurologist's gaze annotations. We annotated the first 5 minutes of each consultation (see Supplementary Material F for a description of the annotation procedure). Raw annotation data—including timestamps, durations, and annotation codes—were exported from ELAN and imported into R, using package *ggplot2* (Wickham, 2016), for visualisation.

Results

The 12 selected consultations lasted between 08:32 and 37:48 minutes (M = 24:06, SD = 08:03), comprising 63,845 gaze fixations and 6,254 utterances. The medical intern received less than 1% of the fixations across consultations and did not express any utterances. As such, we decided to merge the "other" consultation composition category into the existing categories for further analyses, resulting in four one-on-one, four one-on-two, and four one-on-many consultation compositions.

Gaze Behaviours (RQ1)

Areas of Interest (AOIs) Across Consultation Compositions and Consultation Activities. We first report descriptive analyses of gaze behaviour from both patients and the neurologist, measured as relative total dwell times (%) per AOI. Across all consultation compositions, representing the social context, patients' and the neurologist's gaze was predominantly directed toward faces. Patients spent 37% of the total consultation time gazing at the neurologist's face on average, while the neurologist averaged 47% of visits gazing at the patient's face. When companions were present in the consultation, 5% of the patient's gaze and 10% of the neurologist's gaze was directed at them. Another notable AOI was the computer screen, with both the patient and neurologist spending a fair proportion of their gaze at the computer screen (10% by patients and 18% by the neurologist).

When assessing how and when gaze was directed at different AOIs as a function of different consultation compositions, several patterns emerged. For patients, gaze at the neurologist's face varied slightly across the compositions. On average, it was highest in one-on-two (40%) and one-on-one consultations (37%), and lowest in one-on-many consultations (32%). Patients' gaze at the neurologist's body decreased as the number of companions increased: patients spent on average 26% their time gazing at the doctor's body during one-on-one consultations, but only 15% when one companion was present and only 6% when two companions were present. In one-on-two consultations, patients' gaze at the companion covered on average 3% of the consultation time and in one-on-many consultations this was 6%. Patients' gazes at the neurologist's computer screen were highest in one-on-many (18%) and one-on-one consultations (11%), and lowest in one-on-two consultations (3%).

For the neurologist, gaze at the patient's face decreased as the number of companions increased. In one-on-one consultations, more than half of the total gaze duration of the neurologist was directed at patients' faces (57%), while this was 44% in one-on-two consultations and further reduced to 39% in one-on-many consultations. Nonetheless, gaze towards patients' bodies remained a bit more stable across consultation compositions (5 to 6%), as was gaze towards the computer screen (17 to 20%). In one-on-two consultations, the neurologist gaze at companions covered on average 8% of the consultation time and in one-on-many consultations this was 12%. Relative total dwell times of patients' and the neurologist's gaze for all AOIs across consultation compositions are visualised in Figure 2.

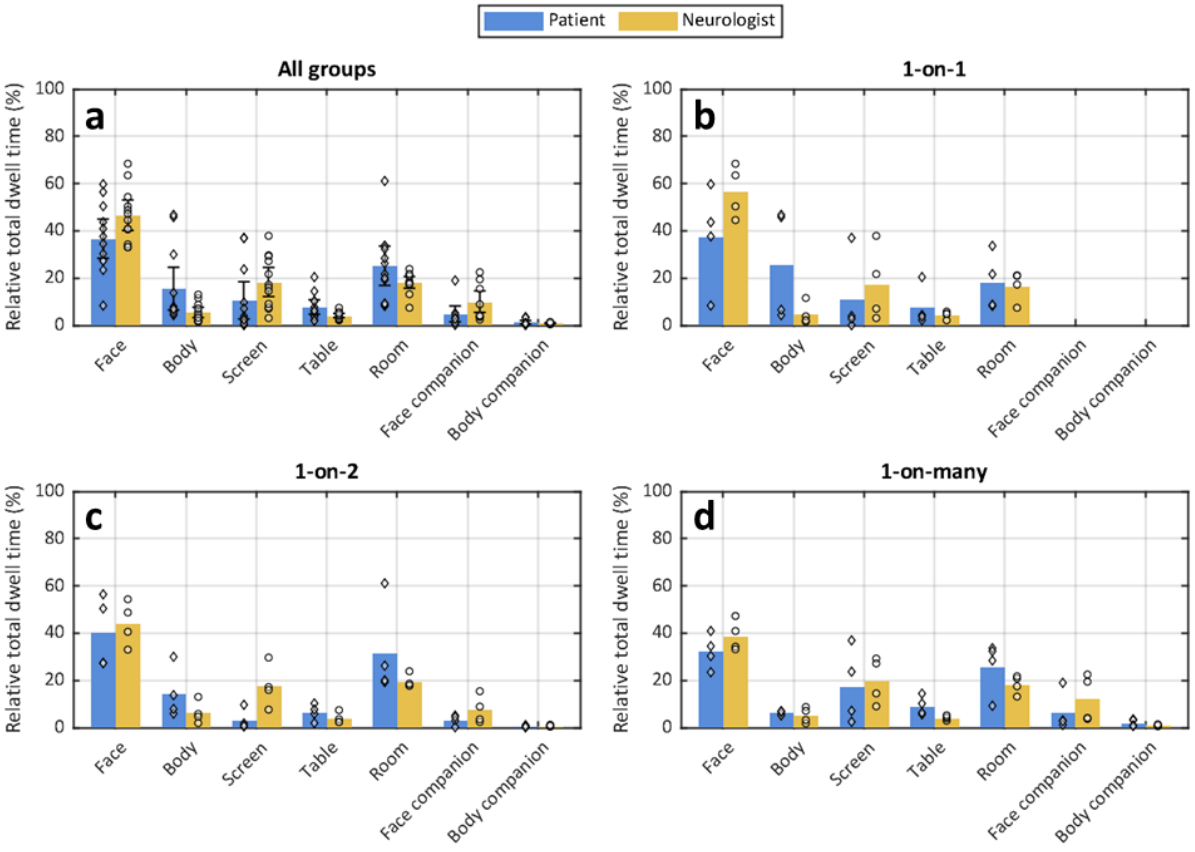

Figure 2. Patients' and Neurologist's Gaze for the AOIs Across Consultation Composition (i.e., Social Context).

Note. (a) relative total dwell time (%) per AOI category, averaged across all consultations (n = 12). Blue bars depict patients' averaged relative total dwell time per AOI and white diamonds patients' individual data points. Orange bars depict the neurologist's averaged relative total dwell time per AOI and white circles the neurologist's individual data points. 95% CIs are depicted only for the All groups panel. (b) one-on-one composition (n = 4). As only the patient and neurologist were present in this composition, no data were available for the face companion and body companion AOIs. (c) one-on-two composition (n = 4). (d) one-on-many composition (n = 4).

To further contextualise and better understand gaze variation beyond consultation compositions (reflecting the social context), we looked at two consultation activities (reflecting the clinical context) that distinguished the 12 consultations: discussing scan results and performing a neurological examination. Regarding discussing scan results, which occurred in 2 out of 12 consultations, notable differences were observed in both patients' and the neurologist's gaze towards the computer screen. While this was on average 7% for patients and 15% for the neurologist during consultations in which no scan results were discussed, this was 30% for patients and 33% for the neurologist during consultations in which scan results were discussed. Interestingly, face gaze did not suffer much from enhanced screen gaze (37% for patients' gaze towards the neurologist regardless of discussing scan results and 48% vs. 42% for the neurologist's gaze towards the patient).

In 4 out of 12 consultations, a neurological examination was performed. While this did not change patients' gaze much, it did so for the neurologist regarding face gaze and body gaze. In consultations without a neurological examination, the neurologist spent 50% of the time gazing at the patient's face and 3% at the patient's body, while in consultations with a neurological

examination, patient-directed face gaze decreased to 40% and body gaze increased to 9%. Furthermore, the neurologist spent relatively more gaze directed at the screen (24% vs. 16%) and less gaze directed at companions (3% vs. 14%) during consultations in which a neurological examination was being performed. Descriptives for these additional analyses can be found in Supplementary Material G.

Mutual and Joint Gaze. We provide three examples of how data of patients' and clinician's gaze can be combined to visualise mutual gaze states (i.e., when patient and neurologist are simultaneously looking at each other's face) and joint gaze states (i.e., when patient and clinician are simultaneously looking at the screen or at a companion). From our individual gaze data analyses per AOIs, we found that consultation composition (who else is present, i.e., the social context) as well as consultation activity (what happens during the consultation, i.e., the clinical context) influenced gaze behaviour. Hence, we explored and visualised mutual and joint gaze states for a one-on-one consultation where the patient and neurologist discussed scan results, a one-on-two consultation during which the neurologist performed a neurological examination, and a one-on-many consultation in which the patient and neurologist engaged in conversations with multiple companions present.

The scarfplots in Figure 3 present three examples of mutual face gaze. These examples show that patients' and neurologist's episodes of mutual gaze, as well as individual face gaze, occurred less when discussing scan results, as compared to the one-on-two consultation with a neurological examination and the one-on-many consultation. Similarly, mutual gaze as well as individual face gaze clearly decreased as soon as the neurological examination started.

Figure 3. Mutual Gaze and Patient's and Neurologist's Face Gaze Across Three Different Consultation Compositions (i.e., the Social Context) and Consultation Activities (i.e., the Clinical Context).

Note. Scarf plots depicting episodes of mutual gaze across three different consultation compositions (i.e., reflecting the social context), representing different consultation activities (i.e., reflecting the clinical context). Time (0:00 to 5:00 minutes) is depicted on the x-axes. (a) depicts instances of mutual gaze in a single one-on-one consultation where scan results were discussed (starting at 00:13). (b) represents mutual gaze data from a one-on-two consultation during which a neurological examination took place (starting at 03:58). (c) depicts mutual gaze data from a one-on-many consultation.

The scarfplots in Figure 4 depict three examples of joint gaze. During the one-on-one consultation in which scan results were discussed, both the patient's and neurologist's gaze were predominantly directed at the neurologist's screen, which we interpret as a clear example of joint attention for the information presented within that AOI. During the consultation example where two companions were present, the patient's and neurologist's individual gaze were at times directed at one of these two companions. Notably, their gaze at the companions oftentimes occurred simultaneously, resulting in joint gaze and shared attention to other people present during the consultation.

Figure 4. Joint Gaze and Patient's and Neurologist's Gaze Towards the Screen and Companions Across Three Different Consultation Compositions (i.e., the Social Context) and Consultation Activities (i.e., the Clinical Context).

Note. Scarf plots depicting episodes of joint gaze across two different consultation compositions (i.e., reflecting the social context), representing different consultation activities (i.e., reflecting the clinical context). Time (0:00 to 5:00 minutes) is depicted on the x-axes. (a) depicts instances of joint screen gaze in a single one-on-one consultation where scan results were discussed (starting at 00:13). (b) represents joint gaze data for (shared) gaze towards Companion 1 from a one-on-many consultation. (c) depicts joint gaze data for (shared) gaze towards Companion 2 from a one-on-many consultation.

Verbal Communication Behaviours (RQ2)

Instrumental Communication. A total of 3,866 instrumental utterances were expressed across the 12 selected consultations. Patients expressed 1,476 (38%), the neurologist 1,831 (47%), and companions 559 (14%) of these instrumental utterances. Instrumental utterances expressed by the patient could be categorised into diagnosis (54%), treatment (19%), daily life (12%), psychosocial feelings (9%), practical information/follow-up procedures (4%), and lifestyle (2%). The neurologist also mostly communicated about diagnosis (51%) and treatment (27%), and to a lesser extent about practical information and follow-up procedures (9%), daily life (6%), psychosocial feelings (4%), and lifestyle (2%). Companions also contributed to the discussion regarding the patient's diagnosis (45%) and treatment (19%). To a similar extent as patients, companions discussed the patient's daily life (19%), and to a lesser extent psychosocial feelings (8%), practical information and follow-up procedures (7%), and lifestyle (3%). Table 2 provides an overview of all instrumental subcategories, their descriptives across all consultations on average, as well as example quotes.

Table 2. Descriptive Statistics and Example Quotes of Instrumental Communication Subcategories by Patients, the Neurologist, and Companions.

Subcategory	Participant	Mean (*SD*)	Example Quotes
Diagnosis	Patient	53.8 (17.8)	"And I'm still having problems with walking. I can really only walk short distances."
	Neurologist	50.8 (18.9)	"Uh, where should we start, maybe… I tend to lean toward, at least for me, I think it's often helpful to first know what symptoms are present at the moment?"
	Companion	45.0 (19.4)	"But here she's really in a lot of pain. I've never heard her complain about anything, but she does about that elbow."
Treatment	Patient	18.8 (14.1)	"I'm not going to the physiotherapist anymore."
	Neurologist	27.4 (15.8)	"So, um, yeah, so I mainly want to give you, but really, do with this whatever you want, but I would strongly advise you to have a physiotherapist involved. Do keep moving. And if that exercise bike, if you enjoy that, then do the exercise bike. (…)"
	Companion	19.0 (7.7)	"Is that under general anesthesia or local anesthesia?"
Psychosocial	Patient	8.6 (7.4)	"Yeah, but I, I haven't done anything for a year now, you know, I, I'm just fed up with it. But this controls my life so much that I'd rather be gone today than tomorrow."
	Neurologist	4.4 (4.1)	"Because that pit you were in, are you kind of climbing out of it again now, so to speak?"
	Companion	7.6 (4.6)	"It's [a] very sensitive [topic]."

Table 2 Descriptive Statistics and Example Quotes of Instrumental Communication Subcategories by Patients, the Neurologist, and Companions (continued).

Subcategory	Participant	Mean (*SD*)	Example Quotes
Daily life	Patient	12.4 (11.5)	"After 6 weeks, 7 weeks, we started playing Bridge again."
	Neurologist	6.4 (8.6)	"So, you're saying, I fall asleep late in the afternoon. And, and so is that on the couch? Or where, uh…"
	Companion	19.0 (19.4)	"Um, the first month I think I helped out with the household…"
Lifestyle	Patient	2.1 (3.3)	"No, I don't swim anymore. (...) …but swimming, no, I nearly drowned once in a swimming pool."
	Neurologist	2.3 (3.9)	"Hey, and uh, do you ever have a little drink, alcohol?"
	Companion	2.8 (3.5)	"I think [the patient smokes] at least thirty [cigarettes a day] or so."
Practical	Patient	4.1 (3.0)	"How long can it take before that man [surgeon] calls me in [for an appointment]?"
	Neurologist	8.7 (3.9)	"Hey, but if we reason like that, then we shouldn't make a new appointment, because then I'll just be asking again how things are going."
	Companion	6.6 (9.1)	"Well, it's very nice that you're getting in touch with the gynecologists [to try and move the appointment forward]".

Note. Means and standard deviations (*SD*s) are based on the proportion scores of instrumental communication subcategories, relative to the number of instrumental utterances produced by each conversation partner within a consultation.

Affective Communication. Combined, the patients, neurologist, and companions expressed a total of 3,685 affective utterances across consultations, of which 1,317 (36%) were uttered by patients, 1,830 (50%) by the neurologist, and 538 (15%) by companions. Affective utterances of patients were most often categorised as verbal attentiveness (55%), followed by expression of concern (20%), social talk (16%), and negative talk (8%). In comparison to patients, the neurologist expressed more affective utterances, but the pattern within this broad category was the same. Similarly, verbal attentiveness was the most common way of expressing affect (59%), followed by the neurologist's expression of concern (24%), social talk (16%), and negative talk (2%). Likewise, companions' contribution to affective communication followed a similar pattern: most utterances consisted of verbal attentiveness (48%), followed by social talk (24%), expressing concerns (16%), and negative talk (12%). Descriptive statistics and example quotes of affective communication can be found in Table 3.

Table 3. Descriptive Statistics and Example Quotes of Affective Communication Subcategories by Patients, the Neurologist, and Companions.

Subcategory	Participant	Mean (*SD*)	Example Quotes
Expression of concern	Patient	20.0 (18.7)	"Yeah, it's also more like, yeah, suppose that there is something going on, yeah, that you might then be able to catch it a bit earlier… or that you can slow it down earlier."
	Neurologist	23.8 (9.5)	"So there is quite a bit going on with that back, but we don't see a massive herniated disc that's compressing everything, right?"
	Companion	15.5 (12.5)	"So how could it suddenly happen so quickly, so quickly like that?"
Negative talk	Patient	8.4 (11.8)	"Yes, they had forgotten about me, so then I had to wait again for the new doctor before I could start rehabilitating."
	Neurologist	2.2 (1.3)	"So that posture you're taking on now as well, not very helpful."
	Companion	12.5 (16.7)	"Yeah, but back then you had the wrong one [physiotherapist]"
Social talk	Patient	16.4 (13.7)	"I am a chemical chemical pedal bin."
	Neurologist	15.5 (9.8)	"You were already doing very well, but try even harder now. Haha."
	Companion	23.7 (7.0)	"Really, I'm super proud of my mother, truly, from way back…
Verbal attentiveness	Patient	55.2 (21.1)	[Repeating the neurologist:] "No, no, there's no point (...) there's no point."
	Neurologist	58.5 (10.2)	"I'm just going to ask briefly: how is all of this landing with you right now? Because sometimes I get the feeling, when we talk like this, that you're somewhere else in your thoughts. I don't know if that's correct?"
	Companion	48.3 (20.8)	"Oh? Yes. That's kind of what he looks like now, I see, I know what you're trying to say. That's what [patient's name] looks like now, but…"

Note. Means and standard deviations (*SD*s) are based on the proportion scores of affective communication subcategories, relative to the number of affective utterances produced by each conversation partner within a consultation.

Relationships Between Gaze and Instrumental and Affective Communication. We again used the same three examples to show how we can present paired data on gaze behaviours in conjunction with verbal communication behaviours. The scarfplots in Figure 5 illustrate different patterns of instrumental and affective communication during mutual gaze. For example, in the one-on-one consultation, it seemed that the few instances of mutual gaze that existed happened at the same time the neurologist (to a greater extent) and patient (to a lesser

extent) expressed themselves affectively. For the one-on-two and one-on-many consultation examples, mutual gaze occurred more frequently, mainly during instrumental and affective communication between patient and neurologist and to a lesser extent when companions verbally expressed themselves.

Figure 6 shows how joint gaze and verbal communication happen in conjunction. In the one-on-one consultation, joint screen gaze was accompanied by a lot of instrumental communication by the neurologist. Regarding the one-on-many consultation, joint gaze towards companions and verbal communication aligned very closely. When a companion was speaking, both the patient's and neurologist's gaze shifted in the direction of this person.

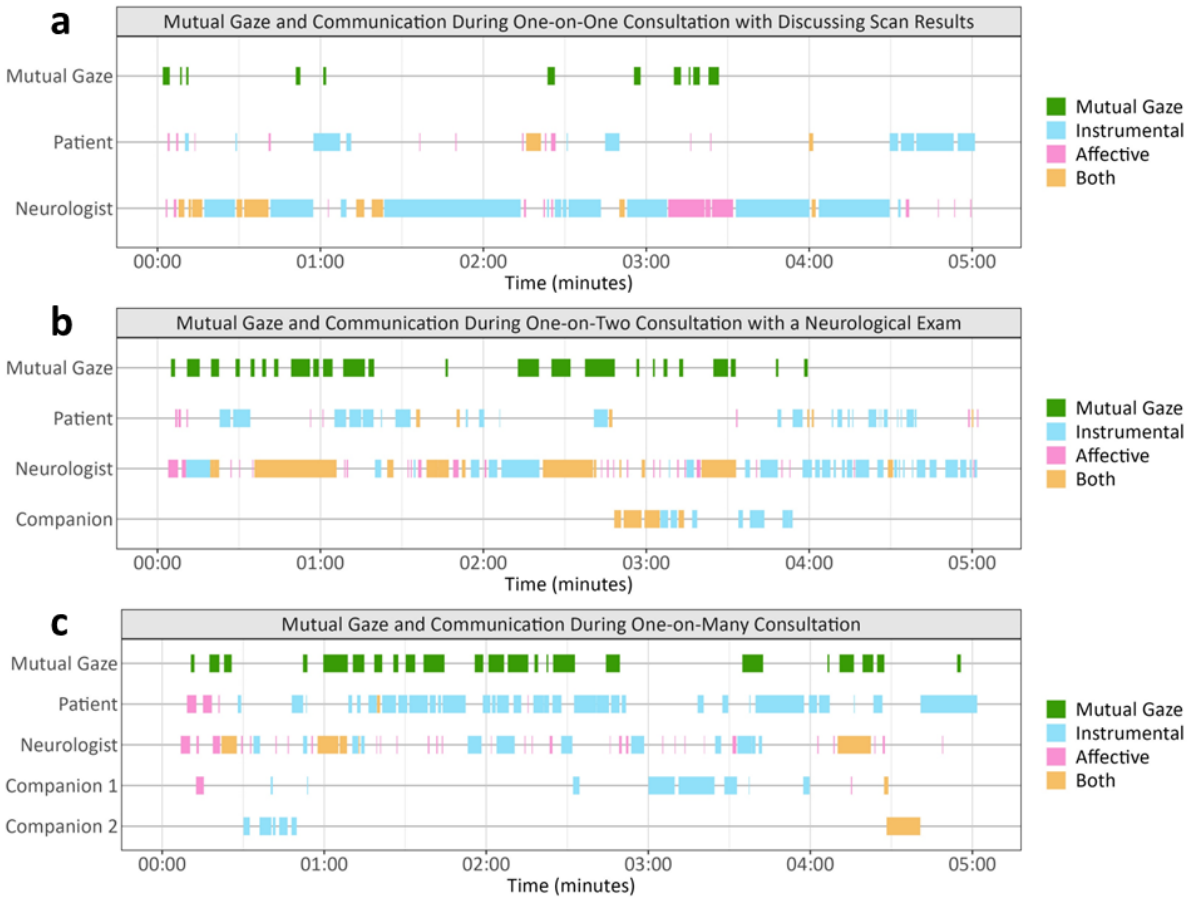

Figure 5. Mutual Gaze and Patient's, Neurologist's, and Companion's Verbal Communication Across Three Different Consultation Compositions (i.e., the Social Context) and Consultation Activities (i.e., the Clinical Context).

Note. Scarf plots depicting episodes of mutual gaze in conjunction with instrumental and affective verbal communication across three different consultation compositions (i.e., reflecting the social context), representing different consultation activities (i.e., reflecting the clinical context). Time (0:00 to 5:00 minutes) is depicted on the x-axes. (a) depicts instances of mutual gaze and verbal communication in a single one-on-one consultation where scan results were discussed (starting at 00:13). (b) represents mutual gaze and verbal communication data from a one-on-two consultation during which a neurological examination took place (starting at 03:58). (c) depicts mutual gaze and verbal communication data from a one-on-many consultation.

Figure 6. Joint Gaze and Patient's, Neurologist's, and Companion's Verbal Communication Across Three Different Consultation Compositions (i.e., the Social Context) and Consultation Activities (i.e., the Clinical Context).

Note. Scarf plots depicting episodes of joint gaze in conjunction with instrumental and affective verbal communication across two different consultation compositions (i.e., reflecting the social context), representing different consultation activities (i.e., reflecting the clinical context). Time (0:00 to 5:00 minutes) is depicted on the x-axes. (a) depicts instances of joint screen gaze and verbal communication in a single one-on-one consultation where scan results were discussed (starting at 00:13). (b) represents joint gaze data for shared gaze towards Companion 1 and verbal communication from a one-on-many consultation. (c) depicts joint gaze data for shared gaze towards Companion 2 and verbal communication from a one-on-many consultation.

Discussion

We conducted an observational study using wearable eye-tracking devices to investigate gaze in conjunction with instrumental and affective communication during naturally occurring doctor-patient consultations. By integrating gaze and verbal behaviour from both patients and a neurologist, this study provides examples of information-acquisition and information-signalling behaviours during doctor-patient communication. We specifically examined the role of the social and clinical context in which gaze occurs to provide a more detailed and contextualised account of gaze at different areas of interest (e.g., faces, bodies, screens, and companions). To do so, we considered different consultation compositions (i.e., presence of one or more companions) and consultation activities (i.e., discussing scan results or performing a neurological examination), and linked gaze patterns to verbal communication. We extended

previous research by studying gaze behaviour of the patient and clinician simultaneously and exploring where gaze is directed beyond faces.

Main Findings and Theoretical Implications

We found that both patients' and the neurologist's gaze was directed at each other's face, the body, the computer screen, companions, and other areas in the room. In line with the literature (e.g., Hessels, 2020 for a review), gaze from both patients (37%) and the neurologist (47%) was predominantly directed at each other's faces. Face-directed gaze appeared remarkably robust across different consultation compositions, despite increased gaze at other AOIs, such as the neurologist's screen and companions. As more people were present or when the screen became an important part of the conversation, these gaze directions more often became a (joint) focus of attention. Nonetheless, in consultations with one or more companions present, patients and the neurologist still maintained mutual gaze.

This aligns with findings by Ting et al. (2021), who found from observing video-recorded surgical consultations that surgeons increased mutual gaze at patients when companions were present (see also Laidsaar-Powell et al., 2013 for a review on triadic communication). Our findings also suggest that differences in consultation composition and activities associate with differences in visual attention across multiple relevant AOIs, implying that the absence of mutual or joint gaze is not inherently problematic or something to be avoided; rather, its function and meaning are shaped by contextual factors within the consultation.

Regarding verbal communication, consultations consisted of a similar number of instrumental and affective utterances. Interestingly, the neurologist made the most instrumental and affective utterances compared to patients and companions. This pattern is broadly consistent with previous research indicating that clinicians play a central role in both task-oriented and relational aspects of medical communication (e.g., Bright & Reeves, 2022, DiMatteo, 1998). In parallel, we found that instrumental and affective utterances were closely intertwined in practice, rather than occurring as clearly separable modes of communication. This interpretation is supported by the observation that instrumental utterances were frequently delivered in an affective manner, and that affective utterances often served instrumental communication functions. This blending was particularly visible in verbal attentiveness being the most common affective utterance for both patients and clinicians. Verbal attentiveness appeared to function as a conversational tool to regulate communication, monitor understanding, and to ensure that patient, clinician, and companions remained aligned (see also the concept of "communicative grounding" in Larsson, 2018). Such utterances can be considered a form of meta-communication that supports grounding processes crucial for establishing both factual understanding (Larsson, 2018) and social rapport in conversation (Tickle-Degnen & Rosenthal, 1990), thereby paving the way for better health outcomes (Street et al., 2009).

Regarding the interplay between gaze and verbal communication, our results showed that verbal and non-verbal behaviours independently contribute to the instrumental and affective goals of doctor-patient communication. Examining them in isolation overlooks how they operate in tandem. In a small subsample (n = 3), we explored temporal associations between gaze and verbal communication to analyse how mutual and joint gaze co-occur with different communicative functions across consultation contexts. We illustrated how mutual gaze states co-occurred with instrumental and affective communication during consultations with multiple

companions, and during physical examinations. Conversely, less mutual gaze but more joint screen gaze was observed during instrumental utterances by the neurologist when discussing scan results.

Limitations and Methodological and Practical Considerations

We also acknowledge several study limitations. We examined both verbal and non-verbal behaviours, but we did not consider the broader communicative context. Specifically, our study did not focus on auditory cues (e.g., intonation, rhythm, emphasis) and potential intercultural differences in gaze and verbal exchanges (Knapp et al., 2014). Regarding auditory cues, prosody influences how a message is interpreted (e.g., Roseano et al., 2016; Vromans et al., 2024). For example, patients may interpret certain information as less certain when a clinician uses a rising intonation at the end of his sentence, and vice versa (Vromans et al., 2024). Moreover, we only included one neurologist, which may have influenced the observed communication patterns. As the neurologist was perceived as highly empathic, shown in consistently high patient-reported experience scores (see self-reported patient dataset on OSF), this may have been reflected in the overall gaze and verbal communication behaviours of the neurologist. Future research could focus on analysing doctor-patient communication within the broader non-verbal context beyond gaze and extending it to more culturally diverse and representative clinical contexts.

More importantly, while wearable eye tracking offers an objective method to measure gaze behaviour in doctor-patient communication, there are several methodological challenges and practical considerations to this technology (Hessels et al., 2020), especially when applied in real-world clinical contexts. First, operationalisations and measures of gaze to faces, bodies, screens, and other objects are not straightforward, especially when examined in real clinical contexts with dynamic areas of interest, and multiple interactors present. For example, as discussed by Jongerius et al. (2021, 2022a), different measures of gaze may be linked to different functional purposes and responses within doctor-patient communication, but relating these to patient outcomes and experiences remains challenging.

Despite the advantages of wearable eye tracking to collect eye-tracking data outside of conventional lab-based environments, technical and methodological challenges remain, for example regarding data processing and data analysis (see Hessels et al., 2020; Valtakari et al., 2021). We opted for manual annotation of individual eye-tracking data (i.e., mapping fixations to AOIs) and paired multimodal data (i.e., gaze and verbal utterances), which allows for flexibility in defining and constructing AOIs but is very time-intensive. Methods for automatic mapping and synchronisation of wearable eye-tracking data to dynamic AOIs (e.g., face and object-recognition) are becoming more widely available but technically challenging (Niehorster et al., 2025), especially when multiple eye-tracking devices are involved (see Valtakari et al., 2021). Automatic methods typically require additional modifications to the consultation room to optimise conditions for such methods, which in our case was not possible due to practical reasons (e.g., hospital room availability).

Wearable eye-tracking technology can still be perceived as invasive and may even alter people's (gaze) behaviour (Canigueral et al., 2018). In doctor-patient consultations, personal and sensitive topics are being discussed, and the presence of researchers and recording devices is not subtle. Patients may be less willing to participate, disclose information, or otherwise may not express themselves freely when they know they are being recorded (e.g., see Laughlin &

Wong-McCarthy, 1975). Similarly, from the clinician's perspective, this may also affect how they behave towards patients. Furthermore, the neurologist mentioned that adding eye tracking slightly altered the start of the consultation, as the neurological consultation typically starts outside the consultation room which was not possible due to the technical study setup.

Conclusion

This study demonstrates that gaze behaviour is not merely a background feature of clinical encounters, but a central component of how instrumental and affective communication are coordinated in real time. By simultaneously capturing patients' and clinician's gaze with wearable eye tracking, while considering the impact of different consultation compositions (reflecting the social context) and consultation activities (reflecting the clinical context), and exploring gaze in conjunction with verbal communication, we show how visual attention shifts across faces, screens, and other interaction partners as the consultation unfolds. While gaze is robustly directed towards faces, gaze becomes more distributed as consultation compositions grow more complex, for example when companions are present or when digital information is jointly consulted. These findings underscore that effective doctor-patient communication is shaped not only by what is said, but also by how attention is jointly managed during the consultation. Methodologically, our approach highlights the added value of integrating gaze with analyses of instrumental and affective communication to capture the dynamics of real-world consultations. Clinically, the results suggest that seemingly subtle shifts in gaze, such as attention to the computer screen or third (or more) parties, may have meaningful implications for information exchange and relational processes, yielding directions for future research and communication training in naturalistic healthcare settings.

Notes

1. For all online supplementary materials, see OSF.
2. One participant withdrew because the eye-tracking glasses hampered their sight; two participants withdrew because they did not feel well enough to participate.
3. We had missing recordings in five instances and poor-quality recordings in six instances.
4. For the final coded transcript, which contained 354 utterances, percentage agreement for coded elements were: question asking (99%), question open or closed (97%), instrumental utterance (92%), instrumental subcategory (75%), affective utterances (85%), affective subcategory (79%).

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Conflict of Interest

We have no conflicts of interest to disclose.

Ethical Approval

The study was approved by the Research Ethics and Data Management Committee of the Tilburg School of Humanities and Digital Sciences (reference number: REDC2024.50), the Medical Ethics Review Committee (METC) Brabant (reference number: NW2024-76), and the local advisory board of the ETZ (reference number: L2110.2024). METC Brabant declared that the study did not fall within the scope of the Medical Research Involving Human Subjects Act (WMO).

Data Availability Statement

This manuscript features online supplementary material including codebooks, questionnaire items, datasets, analysis script, and additional analyses. These can be found on the Open Science Framework (OSF).

References

Andrades, M., Kausar, S., & Ambreen, A. (2013). Role and influence of the patient′s companion in family medicine consultations: “The patient’s perspective.” *Journal of Family Medicine and Primary Care*, *2*(3), 283–287. https://doi.org/10.4103/2249-4863.120767

Baumann, C., & Dierkes, K. (2023). *Neon accuracy test report*. Pupil Labs. https://doi.org/10.5281/zenodo.10420388

Benjamins, J. S., Hessels, R. S., & Hooge, I. T. C. (2018). Gazecode: Open-source software for manual mapping of mobile eye-tracking data. *Proceedings of the 2018 ACM symposium on eye tracking research & applications, 54*, 1–4. https://doi.org/10.1145/3204493.3204568

Bensing, J. M., & Dronkers, J. (1992). Instrumental and affective aspects of physician behavior. *Medical Care, 30*(4), 283–298. https://doi.org/10.1097/00005650-199204000-00001

Bensing, J. M., Kerssens, J. J., & Van der Pasch, M. (1995). Patient-directed gaze as a tool for discovering and handling psychosocial problems in general practice. *Journal of Nonverbal Behavior, 19*(4), 223–242. https://doi.org/10.1007/BF02173082

Bright, F. A. S., & Reeves, B. (2022). Creating therapeutic relationships through communication: A qualitative metasynthesis from the perspectives of people with communication impairment after stroke. *Disability and Rehabilitation*, *44*(12), 2670–2682. https://doi.org/10.1080/09638288.2020.1849419

Brooks, C. I., Church, M. A., & Fraser, L. (1986). Effects of duration of eye contact on judgments of personality characteristics. *The Journal of Social Psychology*, *126*(1), 71–78. https://doi.org/10.1080/00224545.1986.9713572

Byrne, P. S., & Heath, C. C. (1980). Practitioners' use of non-verbal behaviour in real consultations. *Journal of the Royal College of General Practitioners, 30*(215), 327–331. https://pmc.ncbi.nlm.nih.gov/articles/PMC2159600/

Cañigueral, R., Hamilton, A., & Ward, J. A. (2018). Don't look at me, I'm wearing an eyetracker! In *Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers* (pp. 994–998). https://doi.org/10.1145/3267305.3274123

Caris‐Verhallen, W. M., Kerkstra, A., & Bensing, J. M. (1999). Non-verbal behaviour in nurse–elderly patient communication. *Journal of Advanced Nursing, 29*(4), 808–818. https://doi.org/10.1046/j.1365-2648.1999.00965.x

Chaitchik, S., Kreitler, S., Shaked, S., Schwartz, I., & Rosin, R. (1992). Doctor-patient communication in a cancer ward. *Journal of Cancer Education: The Official Journal of the American Association for Cancer Education*, *7*(1), 41–54. https://doi.org/10.1080/08858199209528141

DiMatteo, M. R. (1998). The role of the physician in the emerging health care environment. *Western Journal of Medicine*, *168*(5), 328–333.

Dale, R., & Richardson, D. C. (2006). Grounding dialogue: Eye movements reveal the coordination of attention during conversation and the effects of common ground. In *Proceedings of the Annual Meeting of the Cognitive Science Society*. (pp. 691–696). https://escholarship.org/uc/item/5m48273p

De Haes, H., & Bensing, J. (2009). Endpoints in medical communication research, proposing a framework of functions and outcomes. *Patient Education and Counseling, 74*(3), 287–294. https://doi.org/10.1016/j.pec.2008.12.006

Epstein, R. M., & Street Jr, R. L. (2007). *Patient-centered communication in cancer care: Promoting healing and reducing suffering*. National Cancer Institute. https://doi.org/10.1037/e481972008-001

Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology*, *43*(4), 522–527. https://doi.org/10.1037/h0076760

Gorawara-Bhat, R., & Cook, M. A. (2011). Eye contact in patient-centered communication. *Patient Education and Counseling*, *82*(3), 442–447. https://doi.org/10.1016/j.pec.2010.12.002

Hadley, L. V., Naylor, G., & Hamilton, A. F. D. C. (2022). A review of theories and methods in the science of face-to-face social interaction. *Nature Reviews Psychology, 1*(1), 42–54. https://doi.org/10.1038/s44159-021-00008-w

Hall, J. A., Roter, D. L., & Katz, N. R. (1987). Task versus socioemotional behaviors in physicians. *Medical Care, 25*(5), 399–412. https://doi.org/10.1097/00005650-198705000-00004

Haskard, K. B., DiMatteo, M. R., & Heritage, J. (2009). Affective and instrumental communication in primary care interactions: Predicting the satisfaction of nursing staff and patients. *Health Communication, 24*(1), 21–32. https://doi.org/10.1080/10410230802606968

Hayhoe, M. M. (2017). Vision and action. *Annual Review of Vision Science*, 3(1), 389–413. https://doi.org/10.1146/annurev-vision-102016-061437

Helou, S., El Helou, E., & El Helou, J. (2022). Physician communication skills in telemedicine: The role of eye contact. S*tudies in Health Technology and Informatics*, *290*, 849–853. https://doi.org/10.3233/SHTI220199

Hessels, R. S. (2020). How does gaze to faces support face-to-face interaction? A review and perspective. *Psychonomic Bulletin & Review, 27*(5), 856–881. https://doi.org/10.3758/s13423-020-01715-w

Hessels, R. S., Niehorster, D. C., Holleman, G. A., Benjamins, J. S., & Hooge, I. T. C. (2020). Wearable technology for "real-world research": Realistic or not? *Perception*, *49*(6), 611–615. https://doi.org/10.1177/0301006620928324

Hillen, M. A., de Haes, H. C. J. M., Van Tienhoven, G., Bijker, N., Van Laarhoven, H. W. M., Vermeulen, D. M., & Smets, E. M. A. (2015). All eyes on the patient: The influence of oncologists' nonverbal communication on breast cancer patients' trust. *Breast Cancer Research and Treatment, 153*, 161–171. https://doi.org/10.1007/s10549-015-3486-0

Hillen, M. A., Hoeben, E. M., Kok, R., McHale, C., Sexton, M. M., van der Asdonk, S., van de Bongardt, D., Bowman, B., Brown, R., Branje, S., Chorney, J., Donker, M. H., Ejbye-Ernst, P., Geeraerts, S., Van der Giessen, D., Humphris, G., Larsen, H., Philpot, R., Portell, M., … Noordman, J. (2025). Guidelines for reporting research using systematic coding of observed human behaviour (SCOBe). *Quality & Quantity*, *59*(1), 587–603. https://doi.org/10.1007/s11135-024-01969-9

Hooge, I. T. C., Nuthmann, A., Nyström, M., Niehorster, D. C., Holleman, G. A., Andersson, R., & Hessels, R. S. (2025). The fundamentals of eye tracking part 2: From research question to operationalization. *Behavior Research Methods, 57*(2), 73. https://doi.org/10.3758/s13428-024-02590-2

Jongerius, C., Hessels, R. S., Romijn, J. A., Smets, E. M. A., & Hillen, M. A. (2020). The measurement of eye contact in human interactions: A scoping review. *Journal of Nonverbal Behavior, 44*(3), 363–389. https://doi.org/10.1007/s10919-020-00333-3

Jongerius, C., Hillen, M. A., Romijn, J. A., Smets, E. M. A., & Koole, T. (2022a). Physician gaze shifts in patient-physician interactions: Functions, accounts and responses. *Patient Education and Counseling, 105*(7), 2116–2129. https://doi.org/10.1016/j.pec.2022.02.018

Jongerius, C., Twisk, J. W., Romijn, J. A., Callemein, T., Goedeme, T., Smets, E. M. A., & Hillen, M. A. (2022b). The influence of face gaze by physicians on patient trust: An observational study. *Journal of General Internal Medicine, 37*(6), 1408–1414. https://doi.org/10.1007/s11606-021-06906-2

Jongerius, C., Van den Boorn, H. G., Callemein, T., Boeske, N. T., Romijn, J. A., Smets, E. M. A., & Hillen, M. A. (2021). Eye-tracking analyses of physician face gaze patterns in consultations. *Scientific Reports, 11*(1), 19823. https://doi.org/10.1038/s41598-021-99068-4

King, A. J., Bol, N., Cummins, R. G., & John, K. K. (2019). Improving visual behavior research in communication science: An overview, review, and reporting recommendations for using eye-tracking methods. *Communication Methods and Measures, 13*(3), 149–177. https://doi.org/10.1080/19312458.2018.1558194

Kendon, A. (1990). *Conducting interaction: Patterns of behavior in focused encounters*. Cambridge University Press.

Kleinke, C. L. (1986). Gaze and eye contact: A research review. *Psychological Bulletin, 100*(1), 78–100. https://doi.org/10.1037/0033-2909.100.1.78

Knapp, M. L., Hall, J. A., Horgan, T. G., Knapp, Mark, L., Hall, J. A., & Horgan, T. G. (2014). *Nonverbal communication in human interaction* (Eighth edition). Wadsworth Cengage Learning.

Laidsaar-Powell, R. C., Butow, P. N., Bu, S., Charles, C., Gafni, A., Lam, W. W. T., Jansen, J., McCaffery, K. J., Shepherd, H. L., Tattersall, M. H. N., & Juraskova, I. (2013). Physician–patient–companion communication and decision-making: A systematic review of triadic medical consultations. *Patient Education and Counseling*, *91*(1), 3–13. https://doi.org/10.1016/j.pec.2012.11.007

Larsson, S. (2018). Grounding as a side-effect of grounding. *Topics in Cognitive Science*, *10*(2), 389–408. https://doi.org/10.1111/tops.12317

Laughlin, P. R., & Wong-McCarthy, W. J. (1975). Social inhibition as a function of observation and recording of performance. *Journal of Experimental Social Psychology*, *11*(6), 560–571. https://doi.org/10.1016/0022-1031(75)90007-4

Lee, M., Oh, B., & You, M. (2025). Consultation time and communication patterns in outpatient care: An observational study in South Korea. *BMC Health Services Research*, *25*, 1159. https://doi.org/10.1186/s12913-025-13431-z

MacDonald, K. (2009). Patient-clinician eye contact: Social neuroscience and art of clinical engagement. *Postgraduate Medicine, 121*(4), 136–144. https://doi.org/10.3810/pgm.2009.07.2039

Mast, M. S. (2007). On the importance of nonverbal communication in the physician–patient interaction. *Patient Education and Counseling, 67*(3), 315–318. https://doi.org/10.1016/j.pec.2007.03.005

Niehorster, D. C., Hessels, R. S., Benjamins, J. S., Nyström, M., & Hooge, I. T. C. (2024). GlassesValidator: A data quality tool for eye tracking glasses. *Behavior Research Methods, 56*(3), 1476–1484. https://doi.org/10.3758/s13428-023-02105-5

Niehorster, D. C., Nyström, M., Hessels, R. S., Andersson, R., Benjamins, J. S., Hansen, D. W., & Hooge, I. T. (2025). The fundamentals of eye tracking part 4: Tools for conducting an eye tracking study. *Behavior Research Methods, 57*(1), 46. https://doi.org/10.3758/s13428-024-02529-7

Ong, L. M., De Haes, J. C., Hoos, A. M., & Lammes, F. B. (1995). Doctor-patient communication: A review of the literature. *Social Science & Medicine, 40*(7), 903–918. https://doi.org/10.1016/0277-9536(94)00155-m

Ong, L. M. L., Visser, M. R. M., Lammes, F. B., & de Haes, J. C. J. M. (2000). Doctor–Patient communication and cancer patients' quality of life and satisfaction. *Patient Education and Counseling, 41*(2), 145–156. https://doi.org/10.1016/S0738-3991(99)00108-1

R Core Team. (2024). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Richardson, D. C., & Dale, R. (2005). Looking to understand: The coupling between speakers' and listeners' eye movements and its relationship to discourse comprehension. *Cognitive Science, 29*(6), 1045–1060. https://doi.org/10.1207/s15516709cog0000_29

Richardson, D. C., Dale, R., & Tomlinson, J. M. (2009). Conversation, gaze coordination, and beliefs about visual context. *Cognitive Science, 33*(8), 1468–1482. https://doi.org/10.1111/j.1551-6709.2009.01057.x

Risko, E. F., Richardson, D. C., & Kingstone, A. (2016). Breaking the fourth wall of cognitive science: Real-world social attention and the dual function of gaze. *Current Directions in Psychological Science*, *25*(1), 70–74. https://doi.org/10.1177/0963721415617806

Rhodes, P., Small, N., Rowley, E., Langdon, M., Ariss, S., & Wright, J. (2008). Electronic medical records in diabetes consultations: Participants' gaze as an interactional resource. *Qualitative Health Research, 18*(9), 1247–1263. https://doi.org/10.1177/1049732308321743

Roos, C. A., Postmes, T., & Koudenburg, N. (2023). Feeling heard: Operationalizing a key concept for social relations. *Plos One*, *18*(11), e0292865. https://doi.org/10.1371/journal.pone.0292865

Roseano, P., González, M., Borràs-Comes, J., & Prieto, P. (2016). Communicating epistemic stance: How speech and gesture patterns reflect epistemicity and evidentiality. *Discourse Processes*, *53*(3), 135–174. https://doi.org/10.1080/0163853X.2014.969137

Roter, D. L., Hall, J. A., & Katz, N. R. (1987). Relations between physicians' behaviors and analogue patients' satisfaction, recall, and impressions. *Medical Care, 25*(5), 437–451. https://doi.org/10.1097/00005650-198705000-00007

Roter, D., & Larson, S. (2002). The Roter interaction analysis system (RIAS): Utility and flexibility for analysis of medical interactions. *Patient Education and Counseling, 46*(4), 243–251. https://doi.org/10.1016/S0738-3991(02)00012-5

Ruusuvuori, J. (2001). Looking means listening: Coordinating displays of engagement in doctor–patient interaction. *Social Science & Medicine*, *52*(7), 1093–1108. https://doi.org/10.1016/S0277-9536(00)00227-6

Schilling, L. M., Scatena, L., Steiner, J. F., Albertson, G. A., Lin, C. T., Cyran, L., Ware, L. & Anderson, R. J. (2002). The third person in the room: Frequency, role, and influence of companions during primary care medical encounters. *Journal of Family Practice 51*(8), 685–692. https://pubmed.ncbi.nlm.nih.gov/12184964/

Schouten, A. P., Valkenburg, P. M., & Peter, J. (2007). Precursors and underlying processes of adolescents' online self-disclosure: Developing and testing an "internet-attribute-perception" model. *Media Psychology*, *10*(2), 292–315. https://doi.org/10.1080/15213260701375686

Statistics Netherlands. (2026). *Education level*. https://www.cbs.nl/en-gb/news/2023/48/satisfaction-high-in-caribbean-nl-in-spite-of-low-material-well-being/education-level

Street Jr, R. L., & Buller, D. B. (1987). Nonverbal response patterns in physician-patient interactions: A functional analysis. *Journal of Nonverbal Behavior, 11*(4), 234–253. https://doi.org/10.1007/BF00987255

Street Jr, R. L., Makoul, G., Arora, N. K., & Epstein, R. M. (2009). How does communication heal? Pathways linking clinician–patient communication to health outcomes. *Patient Education and Counseling, 74*(3), 295–301. https://doi.org/10.1016/j.pec.2008.11.015

Tenfelde, K., Antheunis, M. L., Habibovic, M., Widdershoven, J., & Bol, N. (2024). Instrumental, affective, and patient-centered communication between cardiologists and patients with low socioeconomic status: An observational study. *Health Communication, 39*(2), 297–309. https://doi.org/10.1080/10410236.2023.2164955

The Language Archive. (2025). *ELAN* (Version 7.0) [Computer software]. https://archive.mpi.nl/tla/elan

Tickle-Degnen, L., & Rosenthal, R. (1990). The nature of rapport and its nonverbal correlates. *Psychological Inquiry*, *1*(4), 285–293. https://doi.org/10.1207/s15327965pli0104_1

Ting, Y. Y., Reid, J. L., Treloar, E., Lee, W. S. B., Tee, J. Y., Cong, W. J. P., Peng, D., Edwards, S., Ey, J., Edwardes, N., Granchi, N., & Maddern, G. J. (2021). The doctor will see you now: Eye gaze, conversation and patient engagement in the surgical outpatient clinic. An Australian observational cross-sectional study. *ANZ Journal of Surgery*, *91*(11), 2376–2381. https://doi.org/10.1111/ans.17163

Valtakari, N. V., Hooge, I. T., Viktorsson, C., Nyström, P., Falck-Ytter, T., & Hessels, R. S. (2021). Eye tracking in human interaction: Possibilities and limitations. *Behavior Research Methods, 53*(4), 1592–1608. https://doi.org/10.3758/s13428-020-01517-x

Vromans, R. D., Van de Ven, C. C., Willems, S. J., Krahmer, E. J., & Swerts, M. G. (2024). It is, uh, very likely? The impact of prosodic uncertainty cues on the perception and interpretation of spoken verbal probability phrases. *Risk Analysis, 44*(10), 2496–2515. https://doi.org/10.1111/risa.14319

Wheeler, R. W., Baron, J. C., Michell, S., & Ginsburg, H. J. (1979). Eye contact and the perception of intelligence. *Bulletin of the Psychonomic Society*, *13*(2), 101–102. https://doi.org/10.3758/BF03335025

Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis*. Springer.

Zandbelt, L. C., Smets, E. M. A., Oort, F. J., Godfried, M. H., & Haes, H. C. J. M. (2004). Satisfaction with the outpatient encounter: A comparison of patients' and physicians' views. *Journal of General Internal Medicine*, *19*(11), 1088–1095. https://doi.org/10.1111/j.1525-1497.2004.30420.x

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