

Repeated head movements, their function and relation to speech

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Abstract

This paper presents a study of multimodal communication in spontaneous “getting to know each other conversations”. The study focuses on repeated head movements (head-nods and head-shakes) and the speech co-occurring with them. The main function of such repeated head movements is found to be communicative feedback. This is also the most frequent function of the speech co-occurring with the head movements. However, there is mostly no 1-1 relation between repetition in head movement and vocal words. Repeated head movements are more often accompanied by single than repeated words. Both repeated head movements and repeated vocal words can also occur without accompaniment in the other modality. In such cases, the most frequent function for the head movements is still communicative feedback. However, the most frequent function of repeated words without accompaniment in the other modality is own communication management. Frequent functions of repeated head movements, besides feedback, are emphasis, self-reflection, citation, self-reinforcement and own communication management. Other findings in the study are that affirmative repeated head nods mostly start with an upward movement and involve two repetitions.

1. Introduction

Research based on naturalistic multimodal face-to-face communication is important both for a deeper understanding of human-human communication and human communication with virtual agents. This is the underlying motivation of the NOMCO project – a cooperative project between Sweden, Denmark and Finland. In the project we are investigating human-human communication and creating an annotated corpus that will be available for other researchers over the Internet. The project is focused on studies of feedback, turn management, own communication management (OCM) and information structure. In this paper we present a study of repeated head movements (nods, jerks, shakes and tilts) and their relation to speech and attempt to answer the following questions:

- (i) Which head movements occur in repeated form?
- (ii) What is uttered (if anything) simultaneously with a repeated head movement?
- (iii) What is the function of repeated head movements and of multimodal contributions involving both repeated head movements and speech?

A specification of the second question concerns whether repetition in head movement accompanies repetition in speech, or vice versa. Figure 1 below shows the possible combinations that exist in multimodal contributions regarding repetition in speech and/or repetition of gesture:

			Speech	
			+	-
Repetition of head movement	+	A	B	
	-	C		

Figure 1. Possible relations between repeated head movements and repetition in speech.

Since head movements (mainly head nods and head shakes) frequently are used to express communicative

feedback (Allwood and Cerrato 2003), we will in this paper focus our interest on the relationship between head movements as communicative feedback and the vocal counterpart of repeated head movement feedback, namely repeated feedback words.

2. Method, data and procedure

The data consists of four video recordings of strangers meeting for the first time who during approximately seven minutes get to know each other. There are two participants in each recording. In two of the recordings both participants are female, in two of them one participant is female and the other one male. The interactions are in Swedish.

The four recordings have been coded for

- (i) Repeated head movements
- (ii) What is uttered (if anything) by the head mover simultaneously with the movement
- (iii) Repeated words, which do not occur with repeated head movements

The head movements have been classified according to overall movement type (nod, shake or other), number of repetitions and (initial) direction (up or down for head nods and left or right for head shakes). Head nods and head jerks are not separated as different main types (both are classified as head nods). They can, however, be differentiated on the basis of the initial direction of the repeated head nods, i.e. up (sometimes called *jerk*) and down (*nod* in a more restricted sense than in this article).

The identification of a repeated head movement is based on the definition of a single use of a head movement, as indicated below (cf. Allwood et al 2005).

- Nod: up, then down, *or* down, then up
- Shake: left, then right, *or* right then left
- Tilt: leaning head to one side

A repeated head movement occurs whenever the movement continues over and above the single head

movements described above. Since the last repeated movement in a sequence of repeated movements can have the same direction as the first movement in the sequence, it is possible that the number of movements in one direction exceeds the number of movements in the other direction. For example a head nod can be produced as up-down-up-down-up. To account for this, we have counted half units of repeated head movements. The case of an up-down-up-down-up nod has been coded as a “2+½ up-nod”.

Slow motion playback has been used to identify repeated head movements. In addition, a functional analysis has been done of the movements.

To test inter-annotator reliability a random selection of 15 coded head nods (137 in total) and five coded head shakes (total: 21) was made. Based on the sample for coded head nods there is 93% agreement on the direction of head nods ($\kappa=0.86$, according to Cohen’s kappa; Cohen 1960) and 80% agreement on number of repetitions. There is less agreement on the coding of the head shakes. Three of the five selected head shakes are agreed upon (both direction and number). Concerning the functional coding there is complete agreement on the function, or functions, in 85% of the 20 randomly selected cases. The 15% of non-complete agreement consist in cases of agreement on one function (feedback: CPU), but where one of the annotators has suggested an additional function to the one agreed upon, not suggested by the other (e.g. agreement).

3. Results

3.1 Overview

There are a total number of 162 repeated head movements in the four recordings: 137 repeated head nods, 21 repeated head shakes, three repeated tilts, and one repeated circling of the head. Most of the repeated head nods start in an upward direction (cf. the notion of jerk). The number of repetitions ranges from one up to 8+½ repetitions of the movement. Tables 1 and 2 provide information on type of head movement, initial direction, no. of repetitions and the frequency of repeated head nods and head shakes.

No. of repetitions	Right	Left	Σ
2	4	2	6
2+½	4	1	5
3	4	0	4
4	1	1	2
4+½	1	0	1
5	2	0	2
6	1	0	1
Σ	17	4	21

Table 1. Initial direction, number of repetitions and frequency of head shakes

No. of	Up	Down	Σ
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repetitions			
1+½	2	3	5
2	26	16	42
2+½	8	2	10
3	11	10	21
3+½	3	3	6
4	9	9	18
4+½	2	3	5
5	10	3	13
5+½	1	1	2
6	6	1	7
6+½	2	0	2
7	2	2	4
8	1	0	1
8+½	1	0	1
Σ	84	53	137

Table 2. Initial direction, number of repetitions and frequency of head nods

A majority of the repeated head movements (121, i.e. 74%) are produced simultaneously with speech. The same person produces speech and head movement making them part of a complex multimodal contribution. The movements not produced simultaneously with speech belong to two types: either they are produced in an overlap with another speaker or they are part of the head mover’s turn, who however does not speak at the time of producing the head movement.

In most cases the speech produced simultaneously with head movements has a feedback function (for the Swedish system of communicative feedback see Allwood 1988, Allwood and Ahlsén 1999). In the schema below, we show the coded repeated head movements and their co-occurrence with speech.

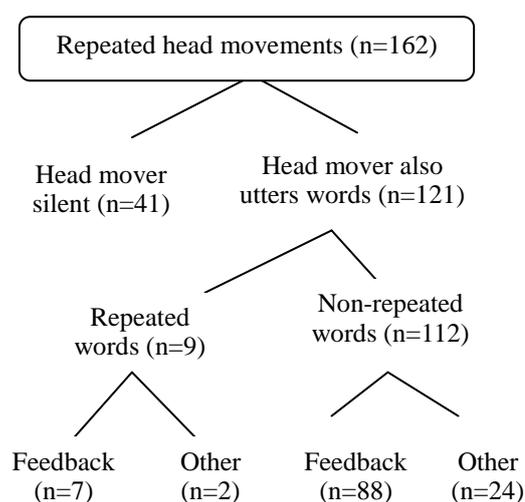


Figure 2: Repeated head movements and their co-occurrence with speech

In two instances the simultaneous speech was incomprehensible. No functional analysis was done in these two cases.

In addition to the repeated speech co-occurring with repeated head movements there is also repeated speech

that does not co-occur with repeated head movements (19 instances). These vocal verbal repetitions include repetition of feedback words and phrases (8 instances), but mainly repetitions of other words with the function of own communication management for choice (i.e. word finding) (9 instances as well as a repeated greeting *hej* ('hi hi')).

3.2 Feedback

Communicative feedback is given by (unobtrusive) vocal and bodily expressions to inform an interlocutor about ability and willingness to (i) continue the interaction (C), to (ii) perceive (P), and (iii) understand (U) what is communicated, as well as about (iv) other attitudinal and emotional reactions (A) (see Allwood 1988, Allwood and Ahlsén 1999, Allwood et al 2007).

Thirty-three (33) of the 41 of the repeated head movements produced under silence have feedback function, expressing contact/continuation, perception and understanding. In some cases the function seems also to be stronger by also expressing acceptance or agreement with what is said by the interlocutor.

When simultaneous with speech, repeated head nods and headshakes most often are simultaneous with vocal (verbal) feedback expressions, making up multimodal feedback (95 of the 162 (59%) repeated head movements are simultaneous with feedback words). However, in only seven cases, a repeated nod or shake occurs simultaneously with repeated feedback words. Table 3 shows the vocal feedback (FB) expressions co-occurring with repeated head movements.

Non-repeated FB expressions

m ('m')	31
{j}a ('yes')	9
okej ('ok')	9
ja ('yes')	7
{j}a precis ('yes exactly')	3
jo ('yes (rejection of negation)')	3
jaha ('yes, I see')	2
mhm ('mhm')	2
nä ('no')	2
{j}a / de{t} blir de{t} ('yes it will be like that')	1
{j}a / de{t} e0 ju de{t} ('yes it is you know')	1
{j}a de{t} e0 en bra början ('yes that's a good start')	1
{j}a de{t} e0 första boken ('yes it's the first book')	1
{j}a precis nej ('yes exactly no')	1
amen precis {j}a ('yes exactly yes')	1
ja okej ('yes ok')	1
ja precis {j}a ('yes exactly yes')	1
japp ('yup')	1
m // ja ('m // yes')	1
m okej ('m ok')	1
nä / de{t} e0 de{t} ('no it is')	1
nä ja{g} hö{r} de{t} knappt alls ('no I hardly hear it at all')	1
näe ('no')	1
nämen precis ('no but exactly')	1
okej / {j}a ('ok / yes')	1
okej {j}a ('ok yes')	1
okej ja ('ok yes')	1
okej jag fattar ('ok I understand')	1

okej men ('ok but')	1
<i>Repeated FB expressions</i>	
m / m ('m / m')	3
jo precis precis ('yes exactly exactly')	1
nä det stämmer det stämmer det stämmer ('no that's correct that's correct that's correct')	1
nä nä de{t} / de{t} ja{g} tänkte ('no no that / that I thought')	1
okej akej ('ok ak')	1

Table 3. Vocal feedback expressions simultaneous with repeated head movements

Comment: slash "/" is used for short pauses and brackets, "{" and "}" surrounds non-pronounced part of standard orthographical representation of a word, e.g. the words *det* ('it') and *ja* ('yes') are pronounced without final and initial consonants respectively (cf. Nivre 1999).

All repeated headshakes involved in feedback co-occur with *nä* ('no') or related variants (*näe*, *nämen*), with the exception of one headshake that co-occurs with *jaha* ('yes, ok'), where the verbal message expresses acceptance of what previous speaker has said but the head shake expresses lack of understanding of what has been accepted. Head nods occur with more positive feedback words like (*m*, *mhm*, *okej*, *{j}a* ('yes') etc.). However, three repeated head nods co-occur with *nä* ('no'). These occurrences of *nä* all follow negative claims by the interlocutor where the *nä* expresses acceptance (by agreement on negative polarity) and the head nod also expresses acceptance but without the negative agreement. All instances of bodily and multimodal feedback (including those containing *nä*) discussed here therefore express CPU and in some cases also acceptance.

Based on the data presented above, we may now consider the following two questions:

- What does repeated head movement add to the function expressed by the vocal verbal feedback?
- Does the head movement have an independent meaning from the vocal component?

Considering the first question one answer is that the head movement strengthens the function expressed by the vocal expression. The complex multimodal expression of head movement and words is more robust and perceptually salient in interaction than words or gesture alone. However, answering the second question, one might consider the possibility that the gesture not only intensifies the functions of the vocal component. For example the repeated head movement sometimes also indicates self-reflection, over and above understanding, a kind of activation perhaps assisting the head mover in understanding what is communicated.

Another observation is that all uses of repeated head movements that co-occur with the word *okej* ('ok') are instances of a repeated upward nod with two or three reduplications. The function of *okej* (alone and in combination with the upward repeated head nods) is that of expressing the notification (being made aware of) of a fact. Further investigation might deepen the

understanding of short upward head nods as a bodily means of expressing the same or a similar function to that which is expressed by vocal *okej*.

In addition to multimodal feedback there also are occurrences of repeated feedback words, not occurring with repeated head movements. In the observed sample, the following seven instances of repeated vocal feedback expressions are not accompanied by repeated head movement: *ja ja ja* ('yes yes yes'), *jo jo* ('yes yes' (rejection of negation)), *nä nä* ('no no'), *nä nä nä* ('no no no'), *precis / precis* ('exactly / exactly'; two instances), *{j}a ja{g} vet {j}a ja{g} vet* ('yes I know yes I know'), and *ja de{t} e0 klart de{t} e0 klart* ('yes that's clear that's clear').

In comparison with the Gothenburg Spoken Language Corpus (GSLC), the relative frequency of repeated feedback words in the four interactions under investigation is slightly lower. GSLC contains 1.4 million words and almost 3 600 instances of repeated feedback words, not interrupted by pauses (approximately 1:400 ratio). (The comparison relies on frequency of repeated feedback words without intervening pauses to reduce the complexity of making the comparison). The four recordings, analyzed in this paper comprise slightly more than 6 300 words, but only five instances of repeated feedback words not interrupted by pauses, i.e. *nä nä* (2), *nä nä nä*, *ja ja ja* and *jo jo* (approximately 1:1 200 ratio). Hence, repeated feedback words are approximately three times more common in GSLC. A possible explanation for the difference might be the lack of familiarity and slight awkwardness often present in a first encounter. Perhaps repetition is facilitated by familiarity.

3.3 Other functions of repeated head movements

Even though most of the repeated head movements have a feedback function (alone or in combination with speech), all do not. In total there are 32 instances of repeated head movement that do not have a feedback-function. Other functions identified are:

- *Emphasising words and phrases uttered.* Head nods and headshakes simultaneous with speech are used to emphasize parts (words) of what is said (cf. "batons" of Ekman and Friesen 1969: 68; also see Bull and Connelly 1985, McClave 2000). This is also the function of one of the repeated tilts and the repeated circling of the head identified in the empirical data. All except two of the head shakes that do not co-occur with the feedback-word *nä*, instead co-occur with negations such as *inte* ('not') and *aldrig* ('never'), i.e. are used to emphasise the negation in what is uttered (10 instances).
- *Self-affirmation.* Another function of repeated head nods apart from feedback is that of expressing self-affirmation. For example, repeated head nods are used after statements as an expression of self-reflection, acceptance and reinforcement of what the speaker him/herself has said (12 instances of repeated head nods).

- *Citation and imitation.* In one case of a repeated head nod, and one case of a repeated tilt, the function is that of marking a switch from direct to indirect discourse, i.e. the introduction of quotes (see McClave 2000). Alternatively to *introduce* quotes, the function of these head movements can be that they are used as *part of* the quote, to imitate not only what others have said, but also what they have gestured.
- *Part of own communication operations of choice* (word finding). In the two cases of reduplication of both speech and gesture that are not feedback (see schema above), the function identified is "own communication management" of choice, i.e. activation, planning and hesitation about what to say (cf. Allwood et al 2006, McClave 2000). In total, two repeated head shakes and three repeated nods are involved in own communication management.

We may also consider the question of what the function is of repetition, whether it be of head movement or of vocal words. There are at least three possible answers to this question: (i) there is a common function of repetition for both modalities, (ii) there is one common function for head movements and a different common function for vocal words or (iii) there are several functions of repetition both for vocal words and head movements.

We believe it is possible to give an analysis of the function of repetition that provides an answer of the first type by claiming that repetition always has the function of activation.

If we relate this claim to the specific functions of repeated head gestures, we have found in the data, we suggest the following analysis. Repetition always means increased activation of the expression and/or content of the gesture or vocal word that is repeated. All functions we have found associated with repeated forms also occur with the single vocal words and gestures corresponding to the repeated forms, but in less activated form

This increased activation can be used for emphasis (intensification) of the element that is repeated e.g. feedback or other types of content. A special case of emphasis is self-reinforcement, i.e. reinforcement of something one is communicating. Another special case is hyperbole and irony, where the intensification is exaggerated or unmotivated.

The increased activation, however, can also be used for improved activation of content or expression which has not been completely successfully activated (e. g. the choice function in OCM (word finding)) and, as a special case of this, self-reflection, where the same expression and content are repeatedly activated to activate further thoughts. Repetition with this function can also have the function of turn keeping or turn holding. One keeps the turn by indicating or displaying by repetition that one has more to say.

Two further special functions noted above are citation

through imitation of someone else's repetition and switching from direct to indirect discourse. However, we do not believe that these two functions are specific to repetition since repetition like any other communicative feature can be imitated and that repetition to indicate a breach or a switch in the flow of discourse could also be achieved by other noticeable communicative means. The fact that repetition can be used in this function could perhaps also (besides its salience) be seen as an extension of the OCM choice function.

In sum, we, thus, suggest that the main function of repetition is activation of expression (vocal or gestural) and content of an element of communication. This activation has two main uses:

- (i) Increased activation if the element is not sufficiently activated, e.g. word finding, self-reflection.
- (ii) Emphasis (intensity) and self-reinforcement

4. Conclusions

Repeated head movements mainly function as feedback. They may be part of multimodal feedback expressions or serve as bodily expressions of feedback without speech. There is no strong tendency for repetition in head movement to co-occur with repetition in speech or vice versa. In addition to strengthening the information provided by the feedback words, making the signaling of feedback functions more robust and perceptually salient, repeated head movements can have the functions of emphasising the words and phrases uttered, self-affirmation and self reflection as well as assisting in choice related own communication management. In general, repetition always means increased activation of the expression and/or content of the gesture or vocal word that is repeated.

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