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ONSET AND TERMINATION OF ACCESSORY FACIAL MOVEMENTS DURING STUTTERING

PEGGY JANSSEN AND FLOOR KRAAIMAAT[1]

Academic Hospital, Utrecht

Summary.—In this study the onset and offset times of seven types of accessory facial movements during oral and silent prolongations were described in three severe stutterers. For each observed facial movement the onset and offset times were determined by means of slow motion analysis of video-recorded speech samples. For two of the three subjects significant differences in the onset and offset times at the various facial movements were found; however, no consistent patterns in the separate facial movements could be observed. On the contrary, the onset of most facial movements appeared to be located at the very start and their offset at the end of the stuttering event, indicating that most facial movements accompany the entire stuttering moment. The implications of these findings with respect to the function of accessory facial movements in stuttering are discussed.

Stuttering is often accompanied by nonspeech phenomena. In Wingate's definition of stuttering, for example, a distinction is made between speech characteristics and nonverbal accessory features (Wingate, 1976). The speech characteristics are the essential features of stuttering and include audible/silent elemental repetitions and prolongations. As nonverbal accessory features Wingate distinguishes between speech related movements, such as pursing the lips and protruding the tongue, and ancillary body movements, such as eye blink and jerking the head.

It is not clear what is the nature of the nonverbal accessory features. They are commonly viewed as learned avoidance and escape behaviors to cope with an anticipated or actual speech block. An alternative view is that they are the visible part of an increase in physical tension of the speech-related or neighbouring muscles (Lanyon, 1978) that may have resulted from deficits in fine motor control of speech muscle systems.

In our opinion the function of nonverbal behaviors varies. The speech-related movements, for example, may be primarily a manifestation of excessive muscle tension. Ancillary body movements may have primarily an avoidance or escape function. In an earlier study (Kraaimaat & Janssen, 1985) an attempt was made to delineate the function of various accessory facial movements by exploring their association with stuttered, normally disfluent and fluent speech. It was inferred that, if a nonverbal facial movement is indicative of increased muscle tension, it would be exclusively associated with a stuttering

[1]Department of Clinical Psychology, Psychiatric Clinic, Academic Hospital Utrecht, nic. Beetsstaat 24, 3511 HG Utrecht, The Netherlands.

event. If, however, the facial movement has a coping function it would be observed during normally disfluent and fluent speech as well. It was found that 75% of the facial movements observed in this study occurred during stuttering. However, only two of these behaviors, jaw and mouth movements, were exclusively linked with stuttering, i.e., they were not observed during normally disfluent and fluent speech. This finding makes it plausible that the function of jaw and mouth movements may be explained in terms of physical tension instead of learned escape or avoidance reactions. The other facial movements may be indicative of learned reactions.

If, as has been proposed, jaw and mouth movements reflect excessive muscle tension involved in aberrant speech production, it may be reasoned that these behaviors are fundamentally associated with the entire stuttering event. That is to say, they will be observed to start at the very beginning of the stutter and disappear when fluency is achieved. In contrast, such an association should not be found for facial movements that are indicative of learned reactions. The present study was undertaken to investigate the temporal association of a selected number of facial movements with a stuttering event. More specifically the question was posed whether there are differences in the onset and offset times between jaw and mouth movements and other facial movements occurring during stuttering.

METHOD

Subjects

Three male stutterers with observable facial movements were selected as subjects. All three were diagnosed as severe stutterers. Their ages were 27, 21, and 22 yr., respectively. None were in therapy when the data were collected.

Procedure

Video-recordings were made of the head and shoulder of each subject while he read aloud a continuous passage for 10 min. in the presence of a researcher. The video-recorded speech samples were replayed as many times as the researchers deemed necessary to identify for each subject the first 20 stuttered words on which accessory facial movements occurred. Stuttering was defined as any silent or oral prolongation.

For each subject the durations of the 20 selected prolongations were determined in milliseconds by means of an electronic timer displaying a time code in minutes, seconds, and tenths of a second. This time code was inserted on the video-recordings for later use in coding. Subject 1 showed a mean duration of 1096 msec. ($SD = 290$), Subject 2 3500 msec. ($SD = 1502$), and Subject 3 5554 msec. ($SD = 3728$).

For each subject the 20 selected prolongations were then analyzed for onset and termination of a selected number of facial movements. For the purpose of the present study, a facial movement was defined as any observable movement of the orofacial structure that was not an integral part of the ongoing process of speech. The following categories were employed:

1. Jaw movements including tightening of the muscles and sideways movements of the mandible.
2. Mouth movements including pressing lips together, pursing lips, and sideways lip movements.
3. Eyelid movements including complete or partial closure of the eyes and enlarged eye openings.
4. Forehead movements defined as wrinkling the forehead or tightening the muscles of the forehead.
5. Eyebrow movements defined as excessively raising the eyebrows.
6. Head movements including movements back, down, or to either side.
7. Eyeblinks defined as any fast closure of an eye or eyes.

For each of the observed facial movements the onset and offset was determined during analysis of slow-motion displays. At the onset of facial movement the researcher stopped the video-recording and the time on the electronic timer was read. The same procedure was carried out for the offset of that behavior. During some prolongations eye blinks occurred more than once. For this category onset was defined as the start of the first eye blink and offset as the end of the last eye blink.

To equate for differences in the durations of the selected prolongations, the values for onset and offset of the facial movements in absolute milliseconds were expressed as percentages of the total duration of each prolongation.

Reliability

Reliability was assessed by reanalyzing a randomly selected sample of 15 prolongations, five from each subject. Sanders' formula (1961), used to calculate intrajudge reliability in identifying the facial movements, gave an index of .87 ($n = 59$). The reliability of the total durations of the prolongations was assessed by computing the standard errors according to the formula $SE = 1/2n \sqrt{\Sigma(X_1 - X_2)^2}$. A standard error of 171 msec. was obtained.

The same formula was used to calculate intrajudge reliability of the proportionate onset and termination times of the facial movements during each prolongation. The following standard errors expressed as percentage scores were calculated across both the onset and termination scores: 19.57 for jaw movements ($n = 24$), 21.24 for mouth movements ($n = 8$), 5.92 for eyelid movements ($n = 18$), 7.44 for forehead movements ($n = 20$), 12.82 for eyebrow movements ($n = 10$), 12.48 for head movements ($n = 26$) and 5.24 for eye blinks ($n = 12$).

Results

For each subject the means and standard deviations of the proportionate onset and offset times of each facial movement were calculated. These data

TABLE 1

MEANS AND STANDARD DEVIATIONS OF PROPORTIONATE ONSET AND OFFSET TIMES FOR EACH TYPE OF FACIAL MOVEMENT DISPLAYED BY THREE SUBJECTS

Movement	Subject 1			Subject 2			Subject 3		
	No.	Onset	Offset	No.	Onset	Offset	No.	Onset	Offset
Jaw									
M	17	23.56	69.73	13	16 88	91.53	15	19.20	60.97
SD		26.44	23.88		20 04	7.27		22.96	30.22
Mouth									
M	6	10.49	46.88	14	8.82	78.65	5	0	87.81
SD		10.54	20.37		23.55	19.05		0	17.43
Eyelid									
M	1	10.59	41.18	19	19.34	88.27	20	0	100.00
SD					20.59	8.98		0	0.00
Forehead									
M	1	11.54	50.00	14	29.30	90.61	19	6.89	99.65
SD					19.82	6.87		15.28	1.05
Eyebrow									
M	11	40 85	68.16	5	16.17	62.30	9	43.46	68.83
SD		22 80	27.06		13.83	37.96		28.89	24.93
Head									
M	14	35.68	79.41	19	10.54	97.49	18	25.03	96.51
SD		23.62	25.96		10.92	2.88		25.64	9.62
Eyeblinks									
M	7	35.18	52.36	19	50.67	74.71	2	26.86	70.19
SD		28.54	26.40		23.79	15.74		12.19	39.04

are presented in Table 1. Note that the *N* for the observations on which the means and standard deviations in this table are based differ for each subject.

Six separate analyses of variance (single-factor, unequal sample-sizes) were carried out to test the differences between facial movements in onset and offset times (Winer, 1971). For Subject 1, eyelid movements and forehead movements were omitted from analysis because they were observed only once. A summary of the results of the analyses for onset and offset is presented in Table 2.

It should be evident that significant differences between the onset times of the various facial movements were only found for Subjects 2 and 3. To investigate whether there were systematic differences between jaw and mouth movements and the other movements in these subjects, the onset times were subjected to Newman-Keuls tests. In Subject 2, the onset of the eye blinks differed significantly ($p < .01$) from those of the jaw, mouth, eyelid, eyebrow, and head movements. In Subject 3, eyebrow movements differed significantly ($p < .01$) from mouth, eyelid, and forehead movements.

Also with respect to the offset times, significant differences between facial movements were only found for Subjects 2 and 3. The data of both subjects were also subjected to Newman-Kuels tests. For Subject 2, eyebrow movements differed significantly ($p < .01$) from jaw, eyelid, forehead, and head movements; eyeblinks differed from head movements, and mouth movements

TABLE 2

SUMMARY OF ANALYSIS OF VARIANCE FOR ONSET AND OFFSET OF FACIAL MOVEMENTS FOR EACH SUBJECT

	Subject 1		Subject 2		Subject 3	
	Onset	Offset	Onset	Offset	Onset	Offset
MS between	1230.63	1556.86	3640.33	1545.52	2753.59	3610.64
df between	4	4	6	6	6	6
MS within	581.63	629.35	394.47	185.35	365.22	273.71
df within	50	50	96	96	81	81
F	2.12	2.47	9.23†	8.34†	7.54†	13.24†

†$p < .01$.

differed from head movements. For Subject 3, jaw movements differed significantly ($p < .01$) from head, forehead, and eyelid movements; eyebrow movements differed from forehead movements, and eyeblinks differed from forehead movements.

DISCUSSION

As we have noted two of the subjects participating in this study showed significant differences in the onset and offset times for various facial movements. For one subject, however, the differences were not statistically meaningful. This subject had the least severe prolongations as expressed by duration of the selected disfluencies. Possibly, then, the severity of the prolongations influenced the obtained results. In comparison with relatively mild prolongations, severe prolongations, i.e., those of longer duration, may contain not only more facial movements but also different onset and offset times. To test this, the 60 prolongations were taken together and divided into a high and a low severity group on the basis of their median duration. Chi squared showed no significant difference between the two groups in terms of the frequency of the observed nonverbal behaviors ($\chi_6^2 = 9.57$, $.10 < p < .20$). In addition a two-way analysis of variance gave no significant difference between mild and severe prolongations with respect to the onset times of the facial movements. With respect to the offset times a significant difference was found ($F_{1,234} = 13.93$, $p < .001$), indicating that among more severe prolongations the facial movements tend to terminate closer to the end of the disfluency. The nonsignificant interaction indicated that this difference was independent of the type of facial movement involved. So, the influence of severity on the offset time seems not to be restricted to specific categories of facial movements.

The main purpose of our study was to investigate whether there is a separation in onset and offset times between jaw and mouth movements at the one hand and the other facial movements at the other hand. The results of the two subjects who showed significant over-all effects in onset and offset times do not favor such a contention. In fact, no consistent patterns could be observed. Of the six facial movements only eye blinks seemed to show consistently different onset and offset times in these subjects. Compared with the other facial movements jaw and mouth movements did not occur earlier, nor did they end later in the stuttering event.

Looking more closely at the relative onset and offset times of the separate facial movement, it is of interest to note that the onset of a facial movement is generally speaking located at the start and its offset at the end of the stuttering event. This finding is obvious for nearly all the facial movements studied in this study, with the exception of eye blinks. Over the three subjects together 72% of the facial movements, eye blinks not taken into account, onset during the first quarter of the stuttering event, and 75% terminated in the last quarter. This may indicate that the physical tension hypothesis does not exclusively explain jaw and mouth movements but that a tension function can also be ascribed to the other facial behaviors. According to Lanyon (1978), an increase in physical tension of the speech-related muscles interferes directly with the mechanical production of speech. The fact that from the very beginning also nonspeech-related muscles are associated with the stuttering event may indicate that besides an increase in tension an overflow of tension is also involved. The alternative explanation of a learned escape or avoidance function of facial movements during stuttering is less plausible in the light of our findings. If the facial movements followed an escape of avoidance function, they should have been rather dispersed over the stuttering event.

One of the main intervention techniques to deal with abnormal facial or head movements during stuttering consists of response-contingent stimulation. In our view such an approach has only limited value, because the underlying tension is not attacked and any increase or overflow in tension may lead to the occurrence of other or the same facial movement. A more straightforward approach might be to focus on the underlying physical struggle by means of procedures that teach the stutterer physical relaxation of the speech-related muscles such as EMG feedback or easy-onset techniques.

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