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"Spontaneous" late recovery from stuttering: Dimensions of reported techniques and causal attributions

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ABSTRACT

Purpose: (1) To survey the employed techniques and the reasons/occasions which adults who had recovered from stuttering after age 11 without previous treatment reported as causal to overcome stuttering, (2) to investigate whether the techniques and causal attributions can be reduced to coherent (inherently consistent) dimensions, and (3) whether these dimensions reflect common therapy components.
Methods: 124 recovered persons from 8 countries responded by SurveyMonkey or paper-and-pencil to rating scale questions about 49 possible techniques and 15 causal attributions.
Results: A Principal Component Analysis of 110 questionnaires identified 6 components (dimensions) for self-assisted techniques (Speech Restructuring; Relaxed/Monitored Speech; Elocution; Stage Performance; Sought Speech Demands; Reassurance; 63.7% variance explained), and 3 components of perceived causal attributions of recovery (Life Change, Attitude Change, Social Support; 58.0% variance explained).
Discussion: Two components for self-assisted techniques (Speech Restructuring; Elocution) reflect treatment methods. Another component (Relaxed/Monitored Speech) consists mainly of items that reflect a common, non-professional understanding of effective management of stuttering. The components of the various perceived reasons for recovery reflect differing implicit theories of

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causes for recovery from stuttering. These theories are considered susceptible to various biases. This identification of components of reported techniques and of causal attributions is novel compared to previous studies who just list techniques and attributions.
Conclusion: The identified dimensions of self-assisted techniques and causal attributions to reduce stuttering as extracted from self-reports of a large, international sample of recovered formerly stuttering adults may guide the application of behavioral stuttering therapies.

1. Introduction

Stuttering is the most frequent speech fluency disorder. Its mean prevalence (the proportion of affected persons in a population at a given time) in children and adolescents (2–18 years of age) has been reported as 1% (range 0.3%–2.12%; Bloodstein & Bernstein Ratner, 2008) and as 1.3%–1.4% in school-aged children (Craig & Tran, 2005; Craig, Hancock, Tran, Craig, & Peters, 2002). Stuttering is carried over to adulthood for about 0.2% of females and 0.8% of males (Bloodstein & Bernstein Ratner, 2008; Craig & Tran, 2005). Its incidence, however (the proportion of occurrence of new cases in a population within a specified period), has been reported for preschool age between 5% (Månsson, 2000) and 11% (Reilly et al., 2013). The discrepancy between prevalence and incidence in childhood is caused by a high rate of recovery—a marked reduction (partial recovery) or disappearance (complete recovery) of stuttering symptoms—that occurs without recognizable causes in 70%–80% of children until puberty. This recovery appears to occur spontaneously and not related to explicit or recent therapeutic intervention. Seemingly spontaneous recovery, whether before or after puberty, has also been labeled "non-assisted" (Ingham, 1984) or "unassisted" (Ingham, Finn, & Bothe, 2005), or "self-recovery" (Shearer & Williams, 1965), although it cannot be ruled out that it has been, in some cases, facilitated by former treatment or self-management. Yet, this kind of recovery is opposed to a partial or complete disappearance of stuttering symptoms due to stuttering therapy.

Although most recoveries without recognizable causes are observed until puberty, some may occur in adolescent or adult persons who stutter (PWS) (Finn, 2004; Martyn & Sheehan, 1968). This kind of recovery is the topic of our study and is called "spontaneous" late recovery henceforth. To qualify as complete recovery, several, not always consistent, criteria have been suggested by different authors. A common—and admittedly arguable—criterion is that the percentage of stutter-like disfluencies is less than 3% (Bloodstein & Bernstein Ratner, 2008; Chang et al., 2018; Yairi & Ambrose, 1999). In addition, the speech should be indistinguishable from that of persons who have never stuttered (Finn, 1997). Not only overt symptoms of stuttering, such as repetitions, prolongations, and blocks should be absent, but also covert symptoms, like speech avoidance or negative emotions which typically accompany the speech of PWS (Iverach et al., 2009). Furthermore, the fluent speech should not to be restricted to a limited range of speaking situations. For recovery to be considered permanent, the fluent speech should be evident for at least 12 months (Yairi & Ambrose, 1999).

There is some debate, however, about whether a partial disappearance of stuttering symptoms also deserves the term recovery. How much symptom reduction of stuttering in which speaking situations and in what aspects of speech or their emotional concomitants is the minimal requirement to justify the label (Finn, Howard, & Kubala, 2005)? We take a liberal position and consider the recovery label appropriate if a person reports a marked reduction in disfluencies and emotional concomitants, and considers herself or himself as recovered, without recent help of explicit treatment. This view rests on the assumption that varying degrees of recovery are functionally equivalent with respect to participation and functioning in the social environment, which means that the degrees of recovery are not categorically different according to the International Classification of Functioning, Disability, and Health (ICF; World Health Organization, 2001). It is in agreement with realistic treatment goals and expectations for outcome of stuttering therapies (Finn, 1996). In this view, an unequivocally complete recovery is an extreme form of recovery, but not necessarily qualitatively different from a partial recovery.

1.1. Validity of self-reports on recovery

Self-reported recovery by people who stuttered raises the question of the validity of such self-reports (Ingham, 1983). (1) How can it be confirmed that stuttering occurred in the past and that recovery was not primarily related to treatment? (2) Is the speech of persons who consider themselves recovered similar to or even indistinguishable from that one of persons who never stuttered? (3) Does the recovery still hold in emotionally stressful and communicatively demanding speaking conditions? Past research has provided the following answers to these questions. (1) Finn (1996) has developed a validation procedure based on an independent verification and self-report. First, past stuttering of recovered persons could be confirmed reliably by reference persons. Their questionnaire-based evaluation of the former speaking manner of the persons they knew when they still had stuttered was consistent with the self-description of the recovered persons and differed from their evaluation of the speech of nonstuttering control persons. Second, an objective content analysis of the recovered subjects' self-reports confirmed their former stuttering, and the analysis of their self-descriptions indicated that recovery was independent from treatment. (2) Some speakers achieve a degree of recovery that their speech may be indistinguishable from normally fluent speakers, but many retain certain features of disfluency (Finn, 1997). Even if complete fluency is not achieved, the speakers may nevertheless consider themselves to have recovered because they no longer feel handicapped by their residual stuttering (Finn, 2004). (3) About 60% of speakers who consider themselves as "spontaneously" recovered still report a tendency to stutter (Finn, 1997; Wingate, 1976) which is most evident under stressful speaking

conditions (Finn et al., 2005).

1.2. How spontaneous is a "spontaneous" recovery?

Traditionally, a recovery without recognizable causes is, as mentioned above, often called "spontaneous". However, the assumption that the recovery occurs out of the blue or is due to maturational processes may not be warranted because persons who recovered "spontaneously" frequently report self-management strategies to get rid of disfluencies (Finn, 2004). Such strategies may not even be strictly self-invented, but may originate in suggestions from others, such as disfluent peers or speech-language pathologists (Finn, 1996; Ingham et al., 2005), or from exposure to earlier treatment procedures which are embraced and implemented years later, as reported by Anderson and Felsenfeld (2003) and Manning (1999) to occur occasionally.

1.3. What can be learned from "spontaneous" late recovery?

It has been suggested that "spontaneous" late recovery may provide insight into the mechanisms of successful stuttering therapies and could thus contribute to their further development (Finn, 1997, 2004; Frackowiak, 2000-2001 Ingham, 1983, 1990, 1993; Ingham & Cordes, 1999; Ingham et al., 2005).

In order to learn from successful mastery of late recovery, a systematic investigation of the techniques which recovered PWS report and the reasons to which the reported recovery is attributed to is desirable. Past studies about reported techniques and causal attributions for"spontaneous" late recovery (Anderson & Felsenfeld, 2003; Finn, 1996; Finn et al., 2005; Shearer & Williams, 1965; Sheehan & Martyn, 1996; Wingate, 1964) have provided some valuable information which served as a basis for the current study. As to techniques, the most often reported ones were slowed speech rate, changed speech pattern, and controlled speech breathing (Finn, 1996). Less common ones were relaxation, environmental change, change in attitude towards self, and learning to play a wind instrument. As to attributions, Finn (1996, p. 1176) reports that previous studies list "motivation, attitudinal change, modifications in speech behavior, and relaxation" as recurring themes. In addition, increased (self)confidence, relaxation, and greater understanding of the problem have been reported (Anderson & Felsenfeld, 2003; Finn et al., 2005; Shearer & Williams, 1965).

The above-cited studies share several methodological features frequently found in qualitative research approaches: (1) Sample sizes were small (e. g., six participants – Anderson & Felsenfeld, 2003) to moderate (e. g., 58 participants – Shearer & Williams, 1965) to obtain reliable reduction methods, (2) self-reported techniques and reasons were mostly anecdotal or verbal responses to open-ended or general questions, and (3) methods of data reduction were based on content analysis or an intuitive grouping of responses. With the current study it is intended to utilize an advantage of quantitative research, that is, to be able to apply a transparent and objective algorithmic method of data reduction with a sample size that is sufficiently large for a reliable solution. Such a method is arguably less susceptible to subjective bias than an intuitive data reduction, because the application of a mathematical algorithm provides numeric values for the quality of the data reduction.

Many subjects in previous studies reported more than one technique that they had employed or more than one reason to which they attributed their recovery (Anderson & Felsenfeld, 2003, p. 249). Rather than just listing the reported techniques and reasons and grouping them thematically, the objective of the present study was to explore whether the techniques and reasons cluster in statistically relevant dimensions. In the behavioral sciences, coherent clusters of problem-solving behaviors are generally called "strategies" (e. g., Kenrick & Keefe, 1992), and coherent causal attributions are generally called "implicit theories" (e. g., Thai, Coa, & Kaufman, 2018), which denote everyday lay theories. The overarching aim of the present study is thus to explore strategies and implicit theories to overcome stuttering.

1.4. Aim of the study

The international questionnaire-based study presented here aimed at answering two main research questions: (1) Which techniques for stuttering reductions and causal attributions for recovery are reported how often by the recovered persons? (2) Can these self-reported techniques and causal attributions be reduced to a few coherent dimensions, that is, to a few strategies and implicit theories to overcome stuttering?

2. Method

2.1. Participants

Participants were 124 adults or adolescents from eight countries (Australia, Belgium, Denmark, France, Germany, Israel, Netherlands, and USA), who by self-declaration reported "spontaneous" recovery from developmental stuttering after the age of 11 years. This age limit has been set in order to ascertain that the participants could remember the circumstances of their reported recovery and that the recovery did not occur spontaneously before puberty. Participants were recruited using the following sources: (1) Professional organizations of speech-language pathologists were asked to provide names of practitioners who specialize in stuttering. These speech-language pathologists were requested to ask their stuttering clients about recovered relatives. In addition, recovered persons were recruited by (2) newsletters and website calls from professional organizations, (3) website calls from the study team, (4) self-help organizations, (5) the senior author from an ongoing study on "spontaneous" late recovery (Kell, Neumann, Behrens, Wolff von Gudenberg, & Giraud, 2018; Kell et al., 2009), and (6) word-of-mouth. Upon the initiative of the German authors,

the other authors were recruited within or via the *Fluency Committee of the International Association of Logopedics and Phoniatrics*.

The invitation to the recovered persons requested that only those persons qualified for participation who "… have stuttered in childhood and have recovered after 11 years of age". Persons whose recovery was reported to have occurred less than six months after the last formal treatment of stuttering were excluded. The occurrence of stuttering before the age of 12 years was verified by a third person, if available, who had first-hand knowledge about the person's childhood stuttering (henceforth called "corroborator") and

Table 1
Percentages of participants who reported having used the technique in order to reduce disfluencies (% answering "probably true" or "definitely true"); importance of item indicated in last data column as product of loading and frequency of use; if no entry in last two data columns, item did not load on any of the main components with > .50; item descriptions occasionally slightly abbreviated.

Technique used	%	Loading	Importance
Component A: Speech Restructuring			
Stretched out the beginnings of words	22	.72	15.8
Slurred speech gliding smoothly from syllable to syllable	21	.68	14.3
Connected the end of a word with the beginning of the next one	20	.68	13.6
Changed word accent	18	.71	12.8
Spoke with a deeper voice	13	.78	10.1
Spoke rhythmically without an external pacemaker	13	.56	7.3
Spoke with a higher voice	7	.80	5.6
Controlled lip muscles such that lips did not touch each other	10	.51	5.1
Sung utterances (rap, parlando)	8	.56	4.5
Reduced perception of own voice by speaking with masking noise	6	.74	4.4
Took relaxing or other anti-stuttering medication	5	.76	3.8
Spoke with an external pacemaker (e.g. metronome)	5	.62	3.1
Component B: Relaxed/Monitored Speech			
Tried to be more relaxed at all	40	.72	28.8
Took care to make enough speech breaks	38	.74	28.1
Took more time for thinking beforehand what to say and how to say it	33	.79	26.1
Always tried to concentrate on my speaking manner	33	.76	25.1
Concentrated on even and relaxed breathing while speaking	37	.67	24.8
Reduced speech tempo	33	.65	21.5
Concentrated on what I will say, not how I will say it	29	.70	20.3
First thought, then spoke	33	.56	18.5
Took a deep breath before each utterance	22	.64	14.1
Tried to speak clearly with precise articulation	22	.63	13.9
Relaxed before certain utterances and spoke as soon as I was relaxed	20	.58	11.6
Component C: Elocution			
Read aloud or to someone	29	.63	18.3
Analyzed sounds and words with which I had problems	25	.64	16.0
Analyzed what my articulatory muscles did during stuttering	18	.68	12.2
Read poems	15	.76	11.4
Worked on my secondary symptoms (e.g. tics, arm movements, grimaces)	14	.59	8.3
Read texts aloud together with a fluent speaker	12	.66	7.9
Talked to myself in front of a mirror	10	.63	6.3
Purposely used difficult words	12	.52	6.2
Component D: Stage Performance			
Took singing lessons	10	.74	7.4
Took acting lessons	7	.74	5.2
Learned to play a wind instrument	2	.88	1.8
Component E: Sought Speech Demands			
Held public speeches	25	.89	22.3
Participated actively in discussions	34	.63	21.4
Participated purposely in difficult speech situations	20	.79	15.8
Component F: Reassurance			
Made eye contact seconds before speaking in order to ease speech onset	24	.71	17.0
Tried to keep eye contact, especially when I stuttered or expected to	26	.59	15.3
Paid heed to a stress-free life with sufficient sleep and physical activity	23	.65	15.0
Items not loading sufficiently on any main component			
Stopped when I stuttered a word and repeated it	30		
Sought out relaxed speech situations	28		
Spoke with soft voice onset	24		
Quit avoiding or replacing difficult words	23		
Increased voice volume (e.g. through deep breathing)	19		
Consciously relaxed parts of my speech apparatus	16		
Used relaxation exercises	15		
Stuttered purposely but differently than usual	11		
Participated in rhetoric courses	9		

received a 14-item questionnaire which asked for descriptive details about the participant's childhood speech. Such a verification was made available, however, for only a minority of the participants. Together, the inclusion criteria were (a) age ≥14 years, (b) recovery after 12th birthday, (c) reported recovery complete or substantial with no longer feeling as being somebody who stutters, and (d) a period of six months or more between the last treatment and the reported recovery. The inclusion criterion of "complete recovery or substantial improvements" was considered fulfilled if the participant responded on a 5-scale questionnaire item about the current tendency to stutter (see 2.2 Questionnaires) with "never" or "seldom" or "sometimes". Persons were excluded who (a) were suspected of past or present cluttering or other speech and language disorders, or for neurological or psychiatric diseases, (b) responded with "frequently" or "very often" to the question about the current tendency to stutter, or (c) had recovered prior to their 12th birthday.

Of the total 124 participants, 14 were excluded because they either did not fulfill the inclusion criteria or were unable to provide information about the techniques which they had employed in their attempts to achieve fluency, and about the reasons they believed may have contributed to their reported recovery. The remaining 110 participants (73 males, 36 females, 1 undeclared) had a mean age of 44 years (range 14–75 years) and a reported median age at stuttering onset of 4.8 years. Their native languages were German (44 participants), French (20), Hebrew (13), English (17), Dutch (10), Danish (2), Persian (1), Italian (1), and not indicated (2). Forty-two percent of these participants reported having received no previous treatment for stuttering, 24% less than two years, and 34% more than two years of treatment.

The study was conducted according to the principles of the declaration of Helsinki with permission of the ethics committee of the Medical Faculty at Goethe University Frankfurt (no. 290/10). All participants gave their written consent.

2.2. Questionnaires

An invitation letter together with the agreement statement form and the questionnaire were administered to the participants. The documents were drafted in German and translated into English, French, Hebrew, and Dutch by the authors' teams. Non-native speakers (reported among the Danish, Italian, and Persian participants) confirmed that they were sufficiently proficient in the language of their country of residence to fully understand the content of the questionnaires. The documents were administered either as paper-and-pencil questionnaires or, more often, by the online survey portal SurveyMonkey. For the latter, participants received a link via e-mail after they had declared their willingness to participate.

In the invitation letter, participants were asked to name a corroborator—if available. The corroborators, who all reported to know their designated recovered person well since childhood, received a questionnaire by the study team which asked them to evaluate the recovered person with respect to his/her speech symptoms during childhood and at present.

The corroborators' questionnaire, which was an adapted version of the *Speech Behavior Checklist* (Finn, 1996), consisted of 14 items about the *past* speech of the participant and 14 identical items about the *current* speech. Seven items asked for the occurrence of stutter-typical symptoms, another seven items about speech symptoms not typical of stuttering (see Appendix 1). The stutter-typical and not stutter-typical items were mixed and not labeled with respect to stutter-typicality. Instead of the original dichotomous answer format a 4-point rating scale (1 = definitely true, 2 = probably true, 3 = probably not true, 4 = definitely not true) was used. Such a scale contains more information than a dichotomous scale and provides options for more effective statistical procedures.

The questionnaire for the recovered person consisted of questions about biographic information, age at onset of stuttering and at

Table 2
Percentages of participants who reported the reason or occasion to which the reduction in disfluencies was attributed (% answering "probably true" or "definitely true"); importance of item indicated in last data column as product of loading and frequency of use; if no entry in last two data columns, item did not load on any of the main components with > .50; item descriptions occasionally slightly abbreviated.

Reason or occasion to which disfluency reduction was attributed	%	Loading	Importance
Component I: Life Change			
I started at a new workplace	18	.82	14.8
I finished school	18	.82	14.8
I met a new partner	12	.80	9.6
I changed my residence	11	.90	9.9
I moved into a country with another language	5	.78	3.9
Component II: Attitude Change			
My self-confidence increased	56	.63	35.3
I did not evaluate my speech negatively any longer	28	.82	23.0
I became insensitive about reactions by others to my stuttering	22	.75	16.5
I no longer accepted that I was one who stuttered	22	.67	14.7
Component III: Social Support			
I decided to change something about my stuttering	35	.53	18.6
I was motivated by persons who were important to me	29	.83	24.1
I told a person important to me that I was working on my stuttering	15	.85	12.8
I had counseling by a psychologist/psychotherapist	8	.68	5.4
Items not loading sufficiently on any main component			
I decided to treat my stuttering my own way	40		
I accepted the fact that I was one who stuttered	33		

the experience of recovery, and two questions about the current stuttering ("Currently I have a tendency to stutter", "I stutter when I am nervous or under pressure", both with the response categories "never", "seldom", "sometimes", "often", "very often"). In addition, the questionnaire included 14 items for the corroborator about the current speech of the participant. Finally, the questionnaire contained in its major section 49 items about techniques various individuals have reported they used to achieve fluency (see Table 1) and 15 causal attributions, that is, reasons or occasions which they believed may have contributed to their recovery or improvement (see Table 2). Of these 64 items, nine were taken from Finn (1996), 32 stemmed from informal interviews of one of the authors (RZ), herself a recovered person, with other persons who stuttered or had stuttered, and 23 items from interviews of the same author with speech-language pathologists. The 5-point rating answer format of these 64 items were "definitely not true" (1), "probably not true" (2), "don't know" (3), "probably true" (4), and "definitely true" (5).

2.3. Statistical analysis

The reported techniques as well as the causal attributions were each subjected to a Principal Component Analysis (PCA). A PCA reduces a larger set of possibly correlated variables into a smaller set of values of uncorrelated variables called principle components. It is, thus, an algorithmic reduction procedure which is less susceptible to biases than the traditional procedure to group observations intuitively. A factor-analytic reduction of self-reported techniques for late recovery and of causal attributions can only be as good as its input, and it arrives at a reliable solution only when the sample size is relatively large. In order to determine the number of cases sufficient for a reliable solution, a preliminary PCA was run when $N = 78$ cases were in the data file. For this sample size, the Kaiser-Meyer-Olkin (KMO) index as an indicator of sample adequacy was below 0.50, both for the techniques as well as for the causes. Kaiser (1974) recommends accepting values < 0.5 as barely acceptable. Values below 0.50 should lead to either collect more data or rethink which variables to include. Therefore, it was decided to keep collecting data instead of reducing the number of variables, and with a three-digit sample size ($N > 100$) the KMOs exceeded .50, namely .75 for the techniques and .62 for the causes (see Results, Section 3.2 and 3.3).

The present study employed a closed response set using a graded scale, with a collection of questions, as large as possible, about techniques and causal attributions, in a sample sufficiently large to be confident in the reliability of the results of the reduction procedure.

Given the 5-point rating format, the PCA was based on the polychoric correlation matrix (Olsson, 1979), which is appropriate to ordinal data and helped to prevent bias due to wrongly assuming interval scale and normal distribution (Bernstein & Teng, 1989). The optimal number of components was determined by Horn's (1965) Parallel Analysis (PA) approach with $k = 10000$ permutations of the original data. PA is superior in dimensionality determination compared to other approaches like the eigenvalues > 1 criterion (Garrido, Abad, & Ponsoda, 2016; Hayton, Allen, & Scarpello, 2004).

3. Results

3.1. Validity of corroborator reports

Completed questionnaires were obtained from 31 corroborators. Eleven corroborators reported only about either early or current speech of the participant. Thus, 20 corroborators provided complete information.

For the past speech of the recovered persons, the corroborators gave a mean rating of 2.92 ($N = 26$) on the seven items about stutter-typical signs and a mean rating of 1.15 ($N = 25$) on the seven items about signs not typical of stuttering. The difference (t-test for dependent measures) was significant ($t = 8.47$, $p < .001$), with a Cohen's effect size of $d = 2.35$. The available corroborator reports thus confirmed that the rated participants' past speech was characterized mainly by stuttering but not by other speech problems.

As to the current speech of the recovered persons, the corroborators gave a mean rating of 1.49 on the stuttering items and 1.31 on the non-stuttering items. The rating difference between stuttering and non-stuttering items did not reach statistical significance ($p = .092$).

As for the direct comparison between past and present speech problems in the reports of the corroborators, the difference between past and present stuttering problems was significant ($M = 2.92$ vs. $M = 1.50$, $N = 20$, $t = 8.30$, $p < .001$, $d = 2.37$). The difference score was positive for all recovered persons with respective corroborator reports ($M = 1.39$, range 0.29–3.00, $N = 21$). The difference between past and present non-stuttering speech problems was significant as well ($N = 20$, $M = 1.69$ vs 1.39, $t = 3.07$, $p = .006$, $d = 0.76$). This latter finding reflects common and usually temporary problems with articulation in childhood, as is evident when looking at the two items which drove this difference: Speech sounds were uttered incorrectly and were slurred together or unclear.

The mean ratings of the corroborators about past stuttering problems correlated significantly with the mean ratings of the recovered persons themselves ($r = .46$, $p = .017$, $N = 26$). As to the single items, all showed positive correlations and were highest for the item "said words or phrases with force or effort" ($r = .56$, $p = .005$). As to past non-stuttering speech problems, the correlation between corroborators and recovered persons was not significant ($r = .21$, $p = .32$).

3.2. Techniques used

The 49 techniques which the participants had rated as to their past use was subjected to a PCA (varimax rotation with Kaiser normalization). Because missing values occurred in 11.8% of the cases and in 0.3% of all cells, the correlation matrix was estimated

using the full information maximum likelihood estimation (Enders & Bandalos, 2001). The Kaiser-Meyer-Olkin test as an index of sampling adequacy was .75 and thus sufficient.

Table 1 shows the self-reported techniques that were used to achieve fluency and the percentages of participants who reported having used them. The percentages given are the participants who had marked the use of a particular technique as "probably true" or "definitely true". The percentages do not add up to 100 because the participants could tick more than one technique as "probably true" or "definitely true". As can be seen, there is no single favorite technique used by the majority of participants, but eight of the 49 techniques were used by at least a third of the participants. None of the listed techniques were used by no participant.

According to the PA, six components was the optimal number to retain with respect to the techniques used. In Table 1, the items of each component are ordered according to their importance, defined here by the product of percentage of use and of loading (last data column in Table 1). Component A accounted for 16.2% of the variance and consisted, among others (in the following text we only refer to the most important items; for all items see Table 1), of the following items: "Stretched out the beginnings of words"; "Slurred speech gliding smoothly from syllable to syllable"; "Connected the end of a word with the beginning of the next one"; "Changed word accent"; "Spoke with a deeper voice"; "Spoke rhythmically without an external pacemaker". Because many of such techniques, especially those reported most frequently, are ones employed in speech restructuring therapies, like fluency shaping or similar treatments, we labeled this factor "Speech Restructuring".

The second component (B) accounted for 15.1% of the variance and contained, among others (see Table 1), the following items: "Tried to be more relaxed at all"; "Took care to make enough speech breaks"; "Took more time for thinking beforehand what to say and how to say it"; "Always tried to concentrate on my speaking manner"; "Concentrated on even and relaxed breathing while speaking"; "Reduced speech tempo". Because most items refer to a slow, calm, concentrated, but relaxed speaking manner, we called this component "Relaxed/Monitored Speech". As shown in Table 1, this component B is comprised of techniques which are used most often.

The third component (C) accounted for 10.9% of the variance and contained, among others (see Table 1), the following items: "Read aloud or to someone"; "Analyzed sounds and words with which I had problems"; "Read poems"; "Read texts aloud together with a fluent speaker"; "Talked to myself in front of a mirror". We called this component "Elocution".

The fourth component (D) accounted for 7.5% of the variance and contained, among others, the items "Took singing lessons" and "Took acting lessons". We called this component "Stage Performance".

The fifth component (E) accounted for 7.1% of the variance and contained the following items: "Held public speeches"; "Participated actively in discussions"; "Participated purposely in difficult speech situations". We called this component, which consisted of items used second most frequently, "Sought Speech Demands".

The sixth and last component (F) accounted for 6.9% of the variance and contained, among others, the following items: "Made eye contact seconds before speaking in order to ease speech onset"; "Tried to keep eye contact, especially when I stuttered or expected to". We called this component "Reassurance".

All six components together explained 63.7% of the total variance. Another eight components would have had eigenvalues > 1, but according to PA were considered a product of chance and therefore disregarded.

3.3. Causal attributions for the recovery

The participants were also asked for the reasons they believed might have prompted their recovery or improvement, in 15 items with the same answer format as for techniques. Table 2 shows the percentages of participants who had marked an item as "probably true" or "definitely true". Again, the percentages do not add up to 100.

For the PCA of the reasons and occasions the same procedure as the one for techniques was applied. Missing values occurred in 23% of the cases and in 13% of all cells. According to the PA, it was optimal to retain three components for the PCA. The Kaiser-Meyer-Olkin test as an index of sampling adequacy was .62 and thus sufficient.

Table 2 shows the items and the components, analogous to Table 1. The first component (I) accounted for 24.1% of the variance and consisted of the following items: "I started at a new workplace"; "I finished school"; "I changed my residence"; "I met a new partner"; "I moved into a country with another language". We called this component "Life Change".

The second component (II) accounted for 17.9% of the variance and contained the following statements: "My self-confidence increased"; "I did not evaluate my speech negatively any longer"; "I became insensitive about reactions by others to my stuttering"; "I no longer accepted that I was one who stuttered". We called this component "Attitude Change".

The third component (III) accounted for 16.0% of the variance and contained the following statements: "I was motivated by persons who were important to me"; "I decided to change something about my stuttering"; "I told a person important to me that I was working on my stuttering"; "I had counseling by a psychologist/psychotherapist". We called this component "Social Support".

3.4. Age and gender effects

The wide age range of the participants (14–75 years) provided the possibility to detect age effects with respect to the frequencies of reported techniques and causal attributions. The participants were divided at the median (44.5 years) into younger and older participants. Age differences, as well as gender differences, were tested non-parametrically with the Mann-Whitney *U* test The problem of multiple comparisons was handled with controlling for the false discovery rate by adjusting *p*-values with the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995), rather than controlling for the familywise error rate. The Benjamini-Hochberg adjustment is less strict than the Bonferroni correction, thus reduces the number of false negative tests while taking account of the

problem of multiple comparisons.

As to reported techniques, there were no significant differences on any item, neither for age nor for gender. As to causal attributions, there were no gender differences, but one item showed an age difference (adjusted $p = .015$): Older participants, more than younger participants, reported more often to have become insensitive about reactions by others to the own stuttering.

4. Discussion

The purpose of this study was to investigate adults who had stuttered and reported"spontaneous" late recovery, that is, independent of current or recent formal treatment, after the age of 11 years and to determine the self-reported techniques they used to overcome stuttering as well as the reasons or occasions to which they attributed their recovery. A PCA and a Horn's PA of the 110 returned and analyzable questionnaires identified six components of self-reported techniques (Speech Restructuring; Relaxed/Monitored Speech; Elocution; Stage Performance; Sought Speech Demands; Reassurance), which accounted for 63.7% of the variance. The same data reduction procedure identified three components for perceived reasons for recovery and occasions when it occurred (Life Change; Attitude Change; Social Support), which accounted for 58.0% of the variance.

4.1. Comparison with previous findings

Only few previous studies (Finn, 1996, 1997; Finn et al., 2005) have reported on techniques which have been used by persons with late recovery from stuttering. The most common techniques were a slowed speech rate, a changed speech pattern, and controlled speech breathing. Less common were relaxation (one of 15 participants), a change in attitude towards self, environmental change, and learning to play a wind instrument, the latter reported by two of 14 participants. The present results confirmed the popularity of slowed speech rate and changed speech pattern, as seen in the collection of items in the component Speech Restructuring (component A in Table 1). Contrary to these previous findings, techniques of relaxation were not rare, but were the most popular ones, as seen in various items of the component Relaxed/Monitored Speech. Techniques of training rhetorical skills (component Elocution) and seeking out situations with high speech demands, which were reported relatively frequently in the current study, were not highlighted in previous findings (Anderson & Felsenfeld, 2003; Finn, 1996; Finn et al., 2005; Shearer & Williams, 1965; Sheehan & Martyn, 1996; Wingate, 1964).

As to causal attributions for late recoveries, previous studies listed as most common increased confidence, particularly self-confidence, increased motivation to change speech, and direct speech changes (Anderson & Felsenfeld, 2003; Finn, 1996). Less common causal attributions were relaxation and a greater understanding of one's speech problem (Finn, 1996; Shearer & Williams, 1965). The current study clearly confirms the prominent role for the attribution of self-confidence, with an increased self-confidence reported most frequently (56%). The desire to change is confirmed as well. In addition, and not highlighted particularly in previous studies, external life changes are listed as causes for the recovery, albeit not frequently so.

In addition to the item comparisons between current and past findings, this study employed an analysis that algorithmically groups the techniques and the attributions. This analysis extracts coherent strategies from the various techniques and coherent implicit theories about the causes of recoveries from stuttering. If, for example, a participant reports to have used a particular technique to combat disfluencies, he or she is more likely to also have used another technique from the same component than a technique from a different component. The knowledge about strategies and implicit theories can yield new insights, for example with respect to the question whether the reported techniques mirror stuttering treatments.

4.2. Do the components mirror stuttering treatments?

Our findings may lead to the question to what extent the dimensions of the reported "spontaneous" late recovery resemble components of successful stuttering therapies, and whether these insights can inform treatment development. Self-reported strategies for "spontaneous" late recovery from stuttering could be similar to effective stuttering treatment methods, for two reasons. First, extant treatment methods are based not only on theoretical considerations and empirical findings, but also on positive experiences PWS made with certain techniques and approaches. Second, it cannot be taken for granted that all reported late recoveries were truly "spontaneous". Rather, it may be assumed that many persons who report "spontaneous" recoveries employed to some extent techniques which they had learned in previous treatments or from other sources. The most effective and popular treatment methods for stuttering in adolescents and adults are primarily speech restructuring methods, like fluency shaping or prolonged speech, and secondarily stuttering restructuring methods, like stuttering modification, as has been shown by a recent systematic review on the efficacy or effectiveness of stuttering treatment methods (Neumann et al., 2016, 2017). Thus, strategies for "spontaneous" late recovery are expected to contain techniques which mirror components of effective and popular stuttering treatments and may help to streamline therapies to their essential components.

The first component of self-reported techniques, labeled here Speech Restructuring, consisted mainly of items which are typical of speech restructuring treatment approaches. Such items referred to stretching out word onsets, slurred speech gliding smoothly from syllable to syllable, connecting the end of a word with the beginning of the next one, and changing word accents or voicing. The efficacy of techniques incorporating gentle voice onset, prolonged speech, and similar methods to restructure speech (for example, Camperdown Program, O'Brian, Onslow, Cream, & Packman, 2003; Comprehensive Stuttering Program, Langevin et al., 2006; Kassel Stuttering Therapy, Euler, Wolff von Gudenberg, Jung, & Neumann, 2009; Smooth Speech Program, Block, Onslow, Packman, Gray, & Dacakis, 2005; Dutch Precision Fluency-Shaping Program, Franken, Boves, & Peters, 1997) has been supported in the literature

since the 1970s (Andrews, Guitar, & Howie, 1980).

Another treatment method, albeit an old-fashioned one (Duchan, 2012), is reflected in the dimension called Elocution, which traditionally refers to the art of delivering speeches, that is, the skill of clear and expressive speech, especially of distinct pronunciation and articulation. Training vocal and rhetorical skills, as employed in acting schools (articulation, inflection, accent, speech rhythm, recitation, reading verse, good voice, proper gestures) was a popular treatment for stuttering ("speech correction") up to the middle of last century, as vividly shown by the therapist Lionel Logue in the movie *The King's Speech* (Bowen, 2011; Duchan, 2012). Elocutionist training for the treatment of stuttering cannot claim much evidence for efficacy, but it seems to have some popular appeal. For example, in Germany and Switzerland the so-called *Naturmethode* has its supporters, who make references to Muirden (1971) and who advocate a pleasing and full, resonant voice while maintaining appropriate prosodic variations over the whole sentence. These skills can be achieved through vocal training and stage language practice.

The second component (Relaxed/Monitored Speech), which was reported most often, does not seem to mirror a formal treatment method but is likewise popular as a self-administered technique bundle. The term "Monitored speech", in this component, does not refer to the techniques of prolonged speech (Harrison, Onslow, Andrews, Packman, & Webber, 1998) or smooth speech (Craig et al., 1996), because essential items referring to soft voice onset and continued phonation do not appear in this component, but in component A (Speech Restructuring). Instead, items are listed which reflect an intuitive approach to treating disfluencies as temporary instances of muddled speech, like the erroneous assumption that thinking must precede speaking and that speaking cannot be done casually in passing but requires careful concentration. The items contained in the dimension of Relaxed/Monitored Speech are also ones mentioned most often in previous studies about subjects' perceived reasons for late recovery from stuttering, as listed in Finn (2004): speaking more slowly, deliberately, with careful planning (Shearer & Williams, 1965). Finally, the frequent theme of relaxation appearing in this dimension is a common component of many stuttering treatments, particularly those which expressly incorporate anxiolytic principles of behavior therapy.

The analysis of the reasons or occasions assumed by the participants to be causal for the recovery yielded three distinctive and coherent clusters: Life Change, Attitude Change, and Social Support. All three make therapeutic sense, and a change in attitude about self and one's own speaking have been reported before as among the main assumed causes for late recovery from stuttering (Wingate, 1964).

4.3. Attribution biases

As to the real causes of recovery, it is important to note that a retrospective subjective causal attribution to reasons or circumstances is just that and is not to be taken at face value as the functional cause. This caution might apply less to the reported techniques because the question there was about actual behavior, not assumptions or explanations. As a large body of social psychological research has shown, subjective causal attributions may be distorted by several biases. First, a common attribution bias is to causally attribute an unusual behavior to unusual circumstances prevailing at the time (Gilbert & Malone, 1995). A major life change, like finishing school or making an important decision, is such an unusual event which "attracts" causal attributions for a contemporaneous unusual change in behavior, for example, recovering from stuttering. Second, a causal attribution is post hoc; it makes subjective sense and tends to mitigate uncertainty. It makes beliefs compatible with one another and thus reduces uncomfortable cognitive dissonance (Festinger, 1957). Third, causal attributions may suffer from a self-serving bias. Successes tend to be attributed to internal factors, like a personality trait or a particular motivation, whereas failures tend to be attributed to external factors, like unfavorable circumstances or fate (Weiner, 1985).

The susceptibility of causal attributions to various biases might explain contradictions found in the data. For example, one would expect that the statement "I accepted the fact that I was one who stuttered" would correlate negatively with the statement "I no longer accepted that I was one who stuttered", but it did not ($r = .05$, n.s.). The susceptibility of subjective causal attributions to biases has rendered these causes questionable in the behavioral sciences. Acceptable causes are those attributed to evolution (differential selection), to developmental events, and most often to so-called proximal factors, like genes, hormones, brain mechanisms, psychological processes, and environmental stimuli (Tinbergen, 1963). However, subjective causes are a category in their own right (Wozniak, 2009) and indispensable in psychotherapeutic endeavors.

4.4. Validation of former stuttering of the participants

How certain can we be that the self-reported late recoveries were true recoveries and not whitewash? The reports of corroborator give a clear answer. The corroborators responded to 14 items with a 4-point rating scale about the past speech and identical 14 items about the present speech of the participants, seven items about stutter-typical symptoms and seven items about speech symptoms not typical for stuttering. The mean rating for past stutter-typical symptoms was $M = 2.92$, for current stutter-typical symptoms $M = 1.50$. The effect size of this difference is very large and corresponds to a difference of almost three standard deviations. With respect to not stutter-typical symptoms, the difference between past and present symptoms was only moderate and corresponds to less than one standard deviation. The corroborators thus discriminated well between the two types of symptoms, which were presented to them mixed and unlabeled. This discrimination verifies the assumption that the corroborator reports are valid. Even if there were biases in these reports, for example, due to low return rate, it is unlikely that such a bias could account for the huge difference between past and present stuttering symptoms.

4.5. Strengths and limitations of the study

The current study has several strengths. It is sufficiently powered for a Principal Component Analysis. It employs transparent reduction algorithms instead of subjective categorizations, which is not to disparage qualitative research approaches (Finn & Felsenfeld, 2004) but to complement them at another level of evidence. The participants were recruited from various Western countries. The employed reduction methods result in components each consisting of items which tend to co-occur with other items of the components and to co-occur negatively with items from other components. The components for used techniques thus can be viewed as distinct strategies consisting of concrete and coherent tactics. The components for causal attributions, that is, for assumed reasons of and occasions for reported recovery, can be viewed as implicit, naive theories of causes for the recovery from stuttering. The information about strategies to combat stuttering and about implicit theories to explain recovery from stuttering adds knowledge beyond the mere listing of single techniques and causal attributions.

One limitation of the study is the meaning of recovery. As has been pointed out by others (Finn, 1997, 2004; Finn & Felsenfeld, 2004; Finn, Ingham, Ambrose, & Yairi, 1997; Ingham et al., 2005), it remains in doubt whether a complete and unequivocal recovery without any stuttering tendencies, like those observed in children, is possible. If it is, it is not known in how many persons who claim to have recovered this is actually the case. The comparison of the responses to the two questions "Currently I have a tendency to stutter" and "I stutter when I am nervous or under pressure" may shed some light on this question. Altogether, 58% of the participants gave the same response to both questions, but 39% gave a higher score for the second than for the first question. For example, of the 62 participants who responded with "rarely" to the question of the current tendency to stutter, 26 wrote that "sometimes" they stuttered when nervous or under pressure. Thus, if formerly stuttering people consider themselves recovered, occasional stuttering in stressful situations obviously does not diminish this achievement.

A second limitation is the meaning of "spontaneous" in the context of recovery. It is a common finding in social psychology that people tend to remember the information or fact but forget the source (Schacter, 2001) and thus are likely to assume to have generated fact or information themselves. Moreover, a major part of the participants (52%) had received a formal treatment for stuttering in their past, albeit more than 6 months previously. Although all included participants reported some kind of recovery, only 24% reported complete recovery, whereas 51% reported to stutter rarely and 25% sometimes, particularly in emotional situations. The current findings are thus limited in that the influence of previous treatments cannot be generally excluded, because the recovery was mostly a partial one, and the verification of past stuttering and current recovery could be obtained from corroborators of only a fraction of all participants. Nevertheless, the numbers of corroborators' reports were large enough to allow for meaningful statistical analyses. These analyses confirm the assumption that the participants' reports of their past and present stuttering are valid. Thus, because there were no indications that the low return rate introduces a bias and because no comparative other data are available except for those of Finn (1996) with smaller sample sizes, the data of the corroborators may be seen as adding to the validity proof of our assumption.

A further limitation is that no diagnoses of former stuttering of the participants performed by a speech-language pathologist (SLP) were available. However, there are three reasons which strongly support their former stuttering: (1) 58% of the participants had undergone a former stuttering treatment that usually is based on a diagnosis made by an SLP, (2) the validation procedure by Finn (1996) we used has been shown to reliably separate formerly stuttering people from non-stuttering ones in the original publication. (3) The recruitment procedure which involved SLPs, professional and self-help organizations, and the authors who are experts in the field of stuttering, makes it unlikely that participants were involved who had not stuttered in the past.

4.6. Conclusion and future directions

The techniques and causal attributions the recovered persons reported in this study fit into our current understanding of stuttering as a complex disorder integrating sensorimotor and social, motivational, and neuroanatomical circuitries in a large neurobiological framework whose functional status depends on situational, emotional, attentional, and linguistic factors (Chang et al., 2018; Neumann & Foundas, 2018). This framework helps to explain the basis for stuttering onset, persistence, and recovery.

We have studied in a large international sample of "spontaneously" and lately recovered adults and adolescents employed techniques as well as reasons or occasions which the participants reported as having been causal to overcome their stuttering. Because our sample was large enough to apply a statistical data reduction procedure, we identified quite robust and inherently consistent dimensions which are shared by many of these people. These dimensions may guide, enrich, and refine elements of current stuttering treatments. To explore in depth how this may be done could be the topic of another study but was not our focus here. But we can give an outlook. We pointed out that (1) two components for self-assisted techniques (Speech Restructuring; Elocution) reflect constituents of current speech restructuring methods and surprisingly also of an outdated treatment approach. (2) Another component (Relaxed/Monitored Speech) consists mainly of items that reflect a common, non-professional understanding of effective management of stuttering, which could be used in various stuttering treatment approaches. (3) The components of the perceived reasons for recovery (Life Change, Attitude Change, and Social Support) reflect lay theories of causes for recovery from stuttering that could be exploited in various treatments of stuttering. Thus, the study supports treatment elements that are partially already in use but could be emphasized and could get a stronger focus.

The findings of our study could also inform brain imaging studies on recovery of stuttering. In a recent study, Kell et al. (2018) reported speech-related fMRI findings of adults who had reported "spontaneous" late recovery from stuttering compared with those of stuttering adults before and after a successful fluency-shaping treatment. While a disturbed auditory-motor integration (merging the auditory feedback with the speech motor cortex) normalized in both groups compared to the pre-treatment stuttering condition in the

treatment group, the "spontaneous" recovery group additionally showed a functional isolation of malfunctioning parts of the speech production networks—a left orbitofrontal-cerebellar circuitry—from the rest of the speech production network. This may be a functional indicator of "spontaneous" long-term recovery. It would be an advantage in the treatment of stuttering if further studies, where therapy protocols focus on the findings of the study presented here (e. g., speech restructuring, elocution techniques, training of relaxed self-monitored speech) could demonstrate such a cerebral disconnection together with a marked reduction of stuttering symptoms.

CRediT authorship contribution statement

Katrin Neumann: Project administration, Conceptualization, Methodology, Supervision, Resources, Writing - original draft, Writing - review & editing. **Harald A. Euler:** Conceptualization, Methodology, Data curation, Formal analysis, Validation, Visualization, Writing - original draft, Writing - review & editing. **Rebekka Zens:** Conceptualization, Methodology, Investigation, Writing - original draft. **Bernhard Piskernik:** Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Ann Packman:** Investigation, Validation, Writing - original draft, Writing - review & editing. **Kenneth O. St. Louis:** Investigation, Validation, Writing - original draft, Writing - review & editing. **Christian A. Kell:** Writing - original draft, Writing - review & editing. **Ofer Amir:** Investigation, Validation, Writing - review & editing. **Michael Blomgren:** Investigation, Validation, Writing - original draft, Writing - review & editing. **Véronique Aumont Boucand:** Investigation, Validation. **Kurt Eggers:** Investigation, Validation, Writing - original draft, Writing - review & editing. **Steen Fibiger:** Investigation, Validation. **Audrey Fourches:** Investigation, Validation. **Marie-Christine J.P. Franken:** Investigation, Validation, Writing - original draft, Writing - review & editing. **Patrick Finn:** Conceptualization, Methodology, Resources, Writing - original draft, Writing - review & editing.

Appendix 1 Items for the corroborators about the past and the current speech (grammar changed accordingly) of the participant (adapted from the *Speech Behavior Checklist,* Finn, 1996)

Items about *stutter-typical* symptoms (past speech):
(1) He/she held lips, tongue, or jaw in a rigid position before speaking or when getting stuck on a word.
(2) … repeated a sound or word with effort.
(3) … made sudden jerky or forceful movements with his/her head, arms, or body during attempts at speaking.
(4) … said words or phrases with force or effort.
(5) … forced out sounds.
(6) … felt strained to talk without being able to make a sound.
(7) … prolonged a sound or word while trying to push it out.
Items about speech symptoms *not typical* of stuttering (past speech):
(8) His/her voice sounded too high-pitched for his/her age and gender.
(9) … grammar and word selection were often confusing and not correct for his/her age.
(10) … speech sounds were said incorrectly (e. g., r's or s's).
(11) … voice sounded too low-pitched for his/her age and gender.
(12) … voice often sounded scratchy or hoarse.
(13) … speech sounds were slurred together or unclear.
(14) … speech was marked by an unusual accent.

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