

Biofeedback Treatment of Gastrointestinal Disorders¹

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Biofeedback has had a greater impact on gastroenterology than on any other medical subspecialty. Biofeedback is the treatment of choice for many of the most common types of fecal incontinence, and preliminary studies suggest that it is likely to become a preferred method for treating patients with constipation related to inability to relax the striated pelvic floor muscles during defecation. This dysfunction may account for up to 50% of patients with chronic constipation. Thermal biofeedback forms part of a multicomponent behavioral treatment for irritable bowel syndrome that is reported to be effective, and other promising applications of biofeedback for gastrointestinal disorders are under investigation.

Descriptor Key Words: biofeedback; gastrointestinal; fecal incontinence; constipation; irritable bowel syndrome; aerophagia.

Biofeedback has had a greater impact on the practice of gastroenterology than on any other medical subspecialty. In an early paper Engel, Nikoomanesh, and Schuster (1974) described the biofeedback treatment of patients with fecal incontinence, and this rapidly became, and remains, the treatment of choice for many types of fecal incontinence. Recently investigators in Europe (Emery, Descos, Meunier, Louis, Valancogne, & Weill, 1988; Louis, Valancogne, Loras, & Meunier, 1985; Bleijenberg & Kiuypers, 1987) and the United States (Wald, Chandra, Gabel, & Chiponis, 1987; Loening-Baucke, 1990) have suggested that biofeedback may also be the

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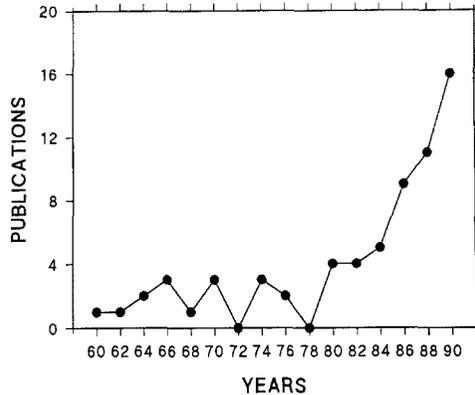


Fig. 1. Number of publications on psychosocial aspects of gastrointestinal disorders in the journal *Gastroenterology* for alternate years since 1960. The rise during the 1980s is believed to reflect the delayed impact of articles on the biofeedback treatment of fecal incontinence in 1974 and 1979.

most effective method of treating a common form of constipation in which the patient is unable to relax the striated pelvic floor muscles (or he may paradoxically contract those muscles) during attempts to defecate. Other applications of biofeedback for gastrointestinal disorders are also under investigation.

The positive impact that biofeedback has had on clinical practice has contributed to a general growth of interest in the psychosocial aspects of gastrointestinal disorders. Figure 1 shows the number of publications in *Gastroenterology*, which is the premier journal of this medical subspecialty, over the last 30 years. Prior to about 1980 there were few publications on the psychosocial aspects of gastrointestinal disorders, reflecting skepticism that psychologists had anything to offer in understanding or treating these disorders. However, beginning soon after the first publications on the biofeedback treatment of fecal incontinence, the number of publications on psychosocial topics has grown exponentially. An analysis of publications on gastrointestinal disorders in *Biofeedback and Self-Regulation* shows a similar trend. For the first 5 years of publication (1976-1980), publications on gastrointestinal disorders made up 2.9% of all citations; for the second 5 years, 2.1%; and for the most recent 5-year period, 6.0% of citations.

Because of the significant and expanding role that biofeedback plays in the management of gastrointestinal disorders, it seems appropriate to review for the readers of *Biofeedback and Self-Regulation* which applications

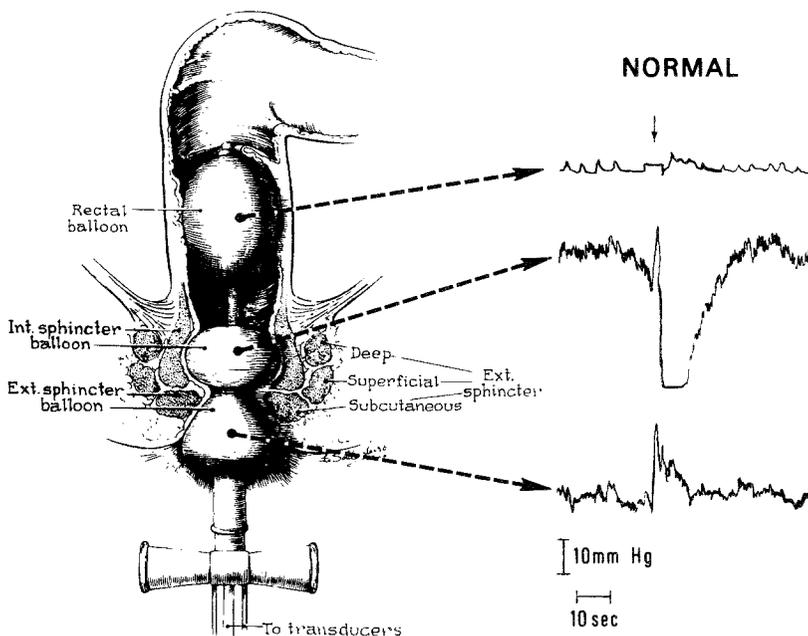


Fig. 2. Three-balloon rectal probe used for biofeedback training. The rectal balloon is briefly inflated with air to simulate the movement of stool or gas into the rectum. The middle balloon is partially surrounded by the internal anal sphincter and detects reflex inhibition of this sphincter in response to rectal distension. The lowest balloon is partially surrounded by the superficial bundle of the external anal sphincter and detects contraction of this sphincter muscle. (Figure reproduced with permission from Engel, 1978.)

have been most productive and which have yielded disappointing results, and then to suggest some directions for future research.

Fecal Incontinence

The seminal paper on the biofeedback treatment of fecal incontinence was the 1974 paper by Engel, Nikoomanesh, and Schuster. For biofeedback, these investigators adapted a procedure already in use to diagnose the causes of fecal incontinence. This involved inserting a tube containing three balloons into the anal canal and rectum and recording the pressures in the balloons as an index of the contraction or relaxation of the surrounding muscles (Figure 2). Previous research had established that fecal incontinence was often associated with an inability to contract the external anal sphincter with sufficient strength to keep the anal canal closed when the

rectum was distended by fecal material or gas (simulated during the test procedure by inflating a balloon in the rectum). Engel and his colleagues positioned their patients so that they could observe the polygraph tracing of balloon pressures and taught them by verbal shaping and visual feedback to contract the external anal sphincter in response to the sensation of rectal distension. They also instructed patients to practice this response daily at home in order to increase muscle strength.

In their initial report, Engel, Nikoomanesh, and Schuster (1974) studied 6 patients with fecal incontinence due to various etiologies and reported that 4 of 6 recovered continence and the remaining two improved. A follow-up publication (Cerulli, Nikoomanesh, & Schuster, 1979) described the use of the technique to treat a series of 50 patients and confirmed that 72% achieved continence or at least a 90% reduction in the frequency of incontinence. This larger series showed that outcomes varied as a function of the etiology of the incontinence: patients whose incontinence developed as a complication of anorectal surgery (hemorrhoidectomy was the most frequently mentioned) showed good outcomes in 92% of cases; those with incontinence related to medical disorders such as diabetes and irritable bowel syndrome showed intermediate but still quite good results, with 67% reporting continence or a 90% reduction in the frequency of soiling; and those with incontinence consequent to spinal cord injury showed the poorest outcomes, with $\geq 90\%$ improvement in only 45% of cases. The beneficial effects of biofeedback training in unselected series of patients with fecal incontinence were also confirmed by other laboratories (Goldenberg, Hodges, Hersh, & Jinich, 1980; Wald, 1981a).

Sensory Discrimination Training. The only significant revision in the biofeedback protocol recommended by Engel, Nikoomanesh, and Schuster (1974) occurred in response to the recognition that for a subgroup of patients, the cause of incontinence is not weakness of the external anal sphincter but loss or impairment of the ability to perceive the distension of the rectum. This is the cue that tells the patient when to contract the sphincter to avoid incontinence (Whitehead, Engel, & Schuster, 1981). Wald and Tunuguntla (1984) showed that sensory impairment is a common contributing cause of incontinence in diabetic patients, and we have noted sensory impairment frequently in patients whose incontinence develops following a stroke. Buser and Minor (1986) described another type of sensory impairment that contributes to incontinence, namely delayed appreciation of rectal distension resulting in a delayed contraction of the external anal sphincter.

The biofeedback treatment of these patients involves sensory discrimination training: In patients with decreased perception of distension but normal stimulus-response latencies, one begins by having the patient squeeze in response to large, easily discriminated distensions of the rectal

balloon and then progressively decreases the balloon volume until the sensory threshold is reached. Then distension stimuli are presented just above and just below this threshold in an effort to improve discrimination. In the patient with delayed appreciation of rectal distension, emphasis is placed on responding immediately to the stimulus. Wald and Tunuguntla (1984) showed that sensory discrimination training contributes to the recovery of continence in diabetic patients, and Buser and Miner (1984) and Miner, Donnelly, and Read (1990) reported that sensory discrimination training led to improvements in patients with idiopathic fecal incontinence. However, our experience with this technique is that it is only successful if the sensory impairment is moderate (sensory threshold of 30 ml or less in our laboratory). Patients with severe sensory impairment rarely improve sufficiently to recover continence.

Biofeedback Treatment of Fecal Incontinence in Geriatric Patients. The incidence of fecal incontinence increases with age, and it is especially prevalent in nursing homes (Van Nostrand, Zappoto, Hing, Bloom, Hirsch, & Foley, 1979). It was possible that the types of incontinence seen in the elderly might be less amenable to treatment with biofeedback. Consequently, Whitehead, Burgio, and Engel (1985) recruited an unselected group of 18 incontinent patients aged 65-93 years and tested them for cognitive impairment and depression prior to treating them. These patients were entered into a staged treatment protocol, which began with habit training and continued, in those patients who did not achieve continence with habit training, to biofeedback training as outlined by Engel, Nioomanesh, and Schuster (1974). Habit training is a behavioral treatment for constipation, which is frequently associated with fecal incontinence and is believed to contribute to the occurrence of bowel accidents by dilating the internal anal sphincter and stretching the rectum. Habit training consists of initially evacuating the lower bowel with one or more enemas and then having the patient attempt to defecate for 10 min immediately after breakfast each day. If no bowel movement occurs for two days, another enema is administered. We reasoned that this treatment would be appropriate for some incontinent older people, and since it is less costly and less invasive than biofeedback, it was offered first.

Of 18 geriatric patients studied, two became continent with habit training alone and were not treated with biofeedback. Three others were judged to be not amenable to biofeedback training because of severe cognitive impairment in two and absence of rectal sensation in one (diabetic) patient. In the 13 who were provided biofeedback training, 6 became continent and 4 others achieved at least a 75% reduction in the frequency of incontinence as judged by daily symptom logs. These improvements in continence were associated with significant increases in

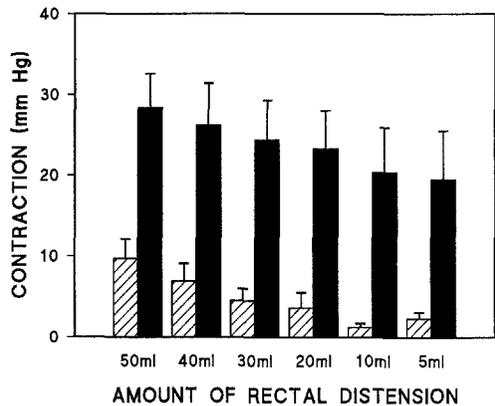


Fig. 3. Average amplitude (+ standard error) of external anal sphincter contractions before (striped bars) and after (solid bars) biofeedback training. Abscissa shows the volume of rectal distension to which the subject responded. (Adapted from Whitehead, Burgio, & Engel, 1985.)

the strength of sphincter contraction, as shown in Figure 3. We concluded from this study that habit training should be the first line of treatment for fecal incontinence in geriatric patients because it is less costly and less invasive than biofeedback training and may lead to continence in 10%. Patients with severe cognitive impairment appear not to be amenable to biofeedback training, but they probably account for less than 30% of fecally incontinent elderly patients even if one includes nursing home residents. Biofeedback resulted in clinically significant improvements in continence in 77% of patients treated, which is comparable to outcomes seen in younger age groups.

Spina Bifida. In the series of patients reported by Cerulli, Nikoomanesh, and Schuster (1979), the poorest outcomes were achieved in patients with spina bifida or other spinal cord lesions. Because spina bifida is a common birth defect and accounts for a large population of fecally incontinent patients, further research was undertaken to see if these outcomes could be improved. Initial results were very promising: both we (Whitehead, Parker, Masek, Cataldo, & Freeman, 1981) and Wald (1981b) reported that approximately 50% of children with myelomeningocele, the most severe form of spina bifida, achieved significant reductions in the frequency of soiling with biofeedback. However, in a subsequent study of a large series of children with myelomeningocele, we (Whitehead et al., 1986) separated the habit-training procedures, which had been incorporated into

earlier biofeedback training protocols, from the sphincter biofeedback training and found that most of the clinical improvements were attributable to habit training. A subgroup (27% of the children studied) were identified who received specific benefit from biofeedback training, and as one might expect, these were children who had lower, less complete lesions of the spinal cord and who were not constipated (two or more bowel movements per day). The majority of children with myelomeningocele did not have enough residual innervation of the external anal sphincter to benefit from biofeedback training. However, they tended to be constipated as a result of their spinal lesion and so were able to benefit from habit training. These results suggest that biofeedback is not the treatment of choice for patients with spinal cord lesions resulting in complete or near complete denervation of the sphincter.

Imperforate Anus. Another birth defect commonly associated with fecal incontinence is imperforate anus (also called anal atresia). In this congenital disorder, there is a missing segment of bowel so that the colon ends in a blind sack. Sometimes there is only a thin membrane closing off the colon which can be corrected surgically without significant risk of incontinence. However, when a significant portion of bowel is absent (high imperforate anus), the surgical correction involves first establishing a colostomy and then at about two years of age, bringing the healthy bowel down through the external anal sphincter and suturing it in place to create a neorectum. More than 60% of these children experience severe fecal incontinence. Our experience with this population (summarized in Whitehead & Schuster, 1985) suggests that their incontinence is due primarily to the inelasticity of the neorectum and the absence of a smooth muscle (internal anal) sphincter; neither external anal sphincter weakness nor impaired sensation is usually present, and so biofeedback is usually not appropriate.

EMG Biofeedback for Fecal Incontinence. The type of biofeedback training most frequently employed involves showing the patient a polygraph tracing of the pressures in balloons placed in the anal canal, as described by Engel, Nikoomanesh, and Schuster (1974). However, these feedback displays are complex, involving much irrelevant and distracting information, and it is often difficult to position the patient so that he can see the polygraph tracing clearly. A new approach to training that is under investigation is to apply skin surface electrodes adjacent to the anus or to insert an acrylic plug containing EMG electrodes into the anal canal and to train with relatively inexpensive EMG biofeedback devices which provide simple displays. These appear to work as well as manometric feedback, although there are few published data as yet (MacLeod, 1982). Equipment manufacturers are also developing computer-based feedback displays which have more motivational properties, especially for children.

Summary: Indications and Contraindications for Biofeedback Training in Patients with Fecal Incontinence. Research and clinical experience which is summarized above suggest that biofeedback training is the treatment of choice for most patients with fecal incontinence associated with weakness of the external anal sphincter or mild to moderate impairment in the ability to perceive distension of the rectum. This appears to constitute the majority of adult patients with fecal incontinence. However, significant cognitive impairment and possibly also significant depression may limit the effectiveness of this approach to treatment, which requires the active participation of a motivated patient. Other forms of fecal incontinence are not amenable to treatment with biofeedback; these include incontinence associated with chronic constipation resulting in a fecal mass in the rectum, complete or near complete denervation of the external anal sphincter, separation of the sphincter muscle so that it cannot contract circumferentially, inelasticity of the rectum, and severe impairment of the ability to perceive rectal distension.

Constipation due to Pelvic Floor Dyssynergia

The striated muscles of the pelvic floor include the puborectalis muscle which loops around the rectum and anchors to the symphysis pubis bone in front (Figure 4). This muscle is normally tonically contracted and causes the rectum to be pinched off from the anal canal and to form a 90° angle with the anal canal. During defecation, this muscle must be relaxed to allow the rectum to funnel into the anal canal so that formed stool can pass. The external anal sphincter which surrounds the anal canal is similar in that it normally is tonically contracted and must relax during defecation. Preston and Lennard-Jones (1985) discovered that in some patients with chronic constipation, the puborectalis and external anal sphincter do not relax during attempts to defecate but instead show a paradoxical contraction which obstructs defecation. They termed this "anismus" by analogy from vaginismus, but a more appropriate term is pelvic floor dyssynergia (Whitehead, Crowell, & Schuster, 1990). The prevalence of pelvic floor dyssynergia is unknown, there having been no systematic studies in large series of patients. However, the indications from published studies to date (Wald, Chandra, Chiponis, & Gabel, 1986; Loening-Baucke, 1989; Lestar, Penninckx, & Kerremans, 1989) are that approximately 50% of patients with complaints of chronic constipation may have pelvic floor dyssynergia as a cause of their complaints.

Clinical investigators were quick to recognize that pelvic floor dyssynergia is the kind of dysfunction for which biofeedback has been most

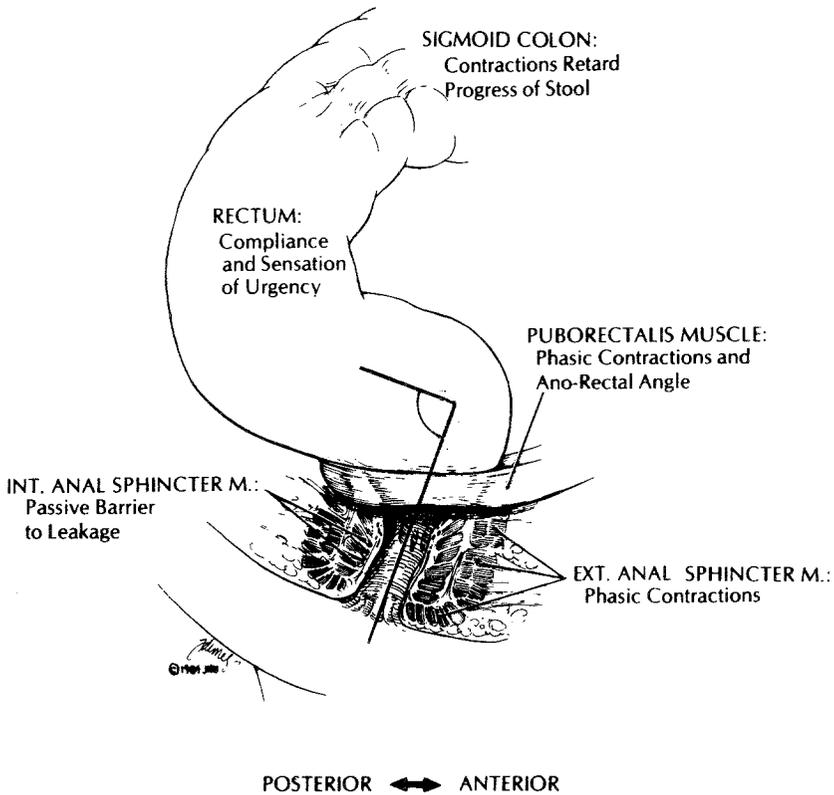


Fig. 4. Anatomy of the anal canal, rectum, and distal colon illustrating the mechanisms for preserving continence.

effective, involving as it does excessive tension or inappropriate contraction of striated muscles. Although additional studies are needed to fully establish the efficacy and the specificity of biofeedback for this type of constipation, initial studies have been very encouraging. They are summarized below:

The first controlled study was reported by Wald, Chandra, Gabel, and Chiponis (1987), who studied 50 encopretic children. The investigators first tested their subjects with a three-balloon rectal probe (Figure 2) and determined that 18 of 50 exhibited pelvic floor dyssynergia. Half of the children with dyssynergia and half of those with normal pelvic floor responses to straining were randomly assigned to receive biofeedback training while the remaining subjects received daily doses of mineral oil. Biofeedback training employed the three-balloon rectal tube. Patients were instructed to relax

and decrease the pressure in the external anal sphincter balloon while straining to defecate. The investigators reported that children with sphincter dyssynergia quickly learned to relax the pelvic floor muscles during straining. At the end of treatment the two interventions produced similar outcomes, but at long-term follow-up 6 and 12 months after treatment there was a strong tendency for patients who had exhibited pelvic floor dyssynergia prior to training to benefit more from biofeedback (67% improved at 6 months) than from mineral oil therapy (40% improved at 6 months), whereas children with other causes of encopresis benefited more from mineral oil (71% improved at 6 months) than from biofeedback (44% improved at 6 months). These data suggest that biofeedback was an effective treatment for encopresis in children with dyssynergia, but the differences were not statistically significant owing to small sample sizes.

A second controlled study, which obtained more definitive results, was reported by Loening-Baucke (1990). She randomly assigned encopretic children, all of whom had pelvic floor dyssynergia, to receive either conventional laxative treatment (milk of magnesia) or biofeedback combined with laxative therapy. Biofeedback consisted of showing children (aged 5-16 years) a polygraph tracing of both anal canal pressures recorded with a balloon and integrated EMG activity from skin surface electrodes placed over the external anal sphincter. Eighty-six percent of the children receiving 2-6 biofeedback training sessions (average of 3.2 sessions) learned to relax the external anal sphincter during attempts to defecate. In this study recovery was defined as ≥ 3 bowel movements per week and ≤ 2 soiling episodes per month while not receiving laxatives for 4 weeks. The proportion of children judged to be recovered was significantly greater for the biofeedback group than for the laxative-only group at 7 months follow-up (55% vs. 5%) and again at 12 months follow-up (50% vs. 16%). These results show that the majority of children with pelvic floor dyssynergia can learn to produce normal sphincter responses and that such learning is associated with clinical outcomes that are superior to laxatives alone.

In addition to these two controlled studies, there are several case studies and uncontrolled series which support the efficacy of biofeedback for the treatment of pelvic floor dyssynergia (see Whitehead, Crowell, & Schuster, 1990, for a review). Although additional studies are needed to demonstrate the efficacy and cost-effectiveness of biofeedback for treating adults with constipation, these preliminary studies provide a strong basis for inferring that biofeedback will become an accepted approach to treating pelvic floor dyssynergia.

The studies reviewed above have emphasized the role of pelvic floor dyssynergia in constipation and incontinence. Indirect evidence summarized by Whitehead et al. (1990) suggests that excessive tension in the pelvic

floor muscles may also be responsible for functional rectal pain (levator ani syndrome and proctalgia fugax). If future research confirms this, biofeedback training to relax the pelvic floor may prove effective in the relief of proctalgia as well as constipation.

Irritable Bowel Syndrome

Irritable bowel syndrome (IBS) is a disorder characterized by abdominal pain and altered bowel habits, either constipation or diarrhea or both in alternation, in the absence of any organic disease explanation for these symptoms. Because of concern that these diagnostic criteria are too general and may result in the inclusion of a heterogeneous group of patients, clinical investigators have developed more restrictive diagnostic criteria (Drossman, Thompson, Talley, Funch-Jensen, Janssens, & Whitehead, 1990), but the essential symptoms remain abdominal pain and altered bowel habits. IBS is very common, affecting 8%-19% of the general population (Thompson & Heaton, 1980; Drossman, Sandler, McKee, & Lovitz, 1982; Whitehead, Winget, Fedoravicius, Wooley, & Blackwell, 1982) and accounting for 20%-50% of consultations to gastroenterologists (Harvey, Salih, & Read, 1983; Mitchell & Drossman, 1987).

The IBS appears to be a good candidate for a psychological treatment because (1) 70%-100% of medical clinic patients with IBS have significant psychological symptoms (Whitehead, Enck, Anthony, & Schuster, 1989), (2) approximately 85% (Drossman, Sandler, McKee, & Lovitz, 1982) of IBS patients report that stress exacerbates their bowel symptoms, and (3) medical treatments often produce disappointing results. The kinds of psychological symptoms (and psychiatric diagnoses) that are most frequently seen are somatization disorder, depression, and anxiety (Whitehead, Enck, Anthony, & Schuster, 1989).

The first reports on the use of biofeedback to treat IBS involved specific forms of biofeedback training which were intended to modify colonic motility. Furman (1973) used an electronic stethoscope to teach 5 patients with diarrhea-predominant IBS to alternately increase and decrease bowel sounds, and he reported that all 5 reported symptom relief as they learned to control bowel sounds. However, other investigators (Radnitz & Blanchard, 1988, 1989; plus unpublished studies reported to the author as personal communications) have reported relatively weak treatment effects, and the technique is rarely used.

Bueno-Miranda, Cerulli, and Schuster (1976) employed a rectal balloon to provide visual feedback on contractions and reported that 14 of 21 IBS patients could learn to reduce contractile activity. However, a follow-up

study from the same laboratory (Whitehead, 1985) which compared this form of pressure biofeedback to progressive muscle relaxation training and systematic desensitization, showed that the simpler stress management procedure produced superior clinical improvements. On the basis of these studies, biofeedback intended to directly modify colonic motility is no longer recommended for the treatment of IBS.

More recent studies have used biofeedback as an aid to teaching relaxation and have combined biofeedback with cognitive therapy techniques. Blanchard's laboratory has reported a series of studies (Neff & Blanchard, 1987; Blanchard & Schwarz, 1987; Blanchard et al., 1991) on a multicomponent treatment program that includes four elements: (1) education about the relationship between psychological stress and exacerbations of bowel symptoms, (2) progressive muscle relaxation training via audiotaped instructions, (3) thermal biofeedback to teach relaxation, and (4) cognitive coping skills training to replace self-defeating thoughts with more positive thinking. In the first two studies outcomes were compared to changes seen in patients awaiting treatment. (This experimental design maximizes placebo effects since patients awaiting treatment have a negative expectancy of improvement.) Neff and Blanchard (1987) treated patients individually and reported that 11 of 21 (52%) showed a greater than 50% reduction in symptom severity. At follow up one year later 57% met the same criterion for clinical improvement (Schwartz, Blanchard, & Neff, 1986). In their second study, Blanchard and Schwarz (1987) treated patients in groups and reported that 9 of 14 (64%) improved by at least 50%.

A similar multicomponent treatment approach was tested by Lynch and Zamble (1989). However, they omitted the thermal biofeedback used by Blanchard and added assertiveness training. A composite measure of bowel symptoms improved significantly more in the treated group than in a control group awaiting treatment.

In a third study from Blanchard's laboratory (Blanchard, Schwarz, Suls, Gerardi, Scharff, Green, Taylor, Berreman, & Malamood, in press) IBS patients were randomized to three groups: in addition to the multicomponent behavioral treatment described above and a waiting list control group, they included a group who received an active placebo intended to mobilize expectancy effects without providing effective treatment. The placebo involved two components to make it comparable to the active treatment: there was a pseudomeditation component in which patients were instructed to attend to the tension in their muscles as in progressive muscle relaxation training but not to relax, and there was a biofeedback task in which patients were taught to *decrease* alpha EEG activity. The active treatment group improved more than the waiting list controls, but the placebo group were indistinguishable from the active treatment group. Blanchard

suggested that the patients in the placebo group may have been able to convert the placebo treatment procedures into an active treatment strategy, but the experiment also raises the possibility that expectancy effects may have contributed to the positive outcomes in previous studies. Thus, it has not yet been shown definitively that such a multicomponent treatment program is effective.

In selecting psychological treatments for patients with IBS, behavioral treatment programs involving biofeedback must be weighed against other effective approaches. Two controlled studies of brief psychotherapy have been reported. In the first study (Svedlund, Sjodon, Ottosson, & Dotevall, 1983), up to 10 sessions of dynamically oriented psychotherapy combined with standard medical therapy was compared to standard medical therapy alone. The group receiving psychotherapy showed significantly greater improvements in bowel symptoms, and the benefits of psychotherapy were not only maintained but enhanced at follow-up one year after treatment. In a similarly designed study, Guthrie, Creed, Dawson, and Tomenson (1991) compared 6 sessions of brief psychotherapy combined with medical therapy to medical therapy alone and reported greater short-term and long-term improvements for the group receiving psychotherapy.

Another psychological intervention that appears to be effective is hypnosis. Whorwell, Prior, and Faragher (1984) compared 7 sessions of hypnosis to a control condition consisting of administering inert (placebo) tablets plus meeting with the patients to discuss the role of emotions and stress in their bowel symptoms. Hypnosis consisted of suggestions to relax and the use of imagery to produce relaxation of the gastrointestinal tract. Patients were given audiotapes for daily practice of autohypnosis. The group receiving hypnosis reported significantly greater improvements, and these improvements were well maintained at one year follow-up (Whorwell, Prior, & Colgan, 1987). Whorwell's results have been replicated by another group (Harvey, Hinton, Gunary, & Barry, 1989), which showed that hypnotherapy provided in small groups was as effective as individual hypnosis.

Aerophagia

A promising new area for the application of biofeedback is aerophagia. This term refers to the swallowing of excessive amounts of air which usually occurs as a consequence of an unconscious high rate of swallowing. Each swallow carries 3-5 ml of air into the stomach (Maddock, Bell, & Tremaine, 1949), and it is estimated that 50%-70% of the gas in the gastrointestinal tract comes from swallowed air (Roth, 1973). A second

mechanism for excessive air swallowing involves conscious, abnormal swallows in which the head is extended to open the upper esophageal sphincter and the rib cage is expanded to suck large quantities of air into the esophagus, after which the patient swallows to carry the air into the stomach by peristalsis. This type of aerophagia appears to be confined primarily to institutionalized, retarded individuals who may engage in it as a self-stimulatory behavior.

Aerophagia may be a relatively common cause of gastrointestinal symptoms. We found that 21% of patients referred to our Digestive Disease Clinic with upper gastrointestinal symptoms swallowed excessively (Whitehead, Chami, Crowell, & Schuster, 1991); and Calloway, Fonagy, and Pounder (1982) reported that excessive swallowing is associated with hiatal hernia and peptic ulcer disease. The mechanism for this association is not known, but the authors speculate that distension of the stomach by air may stimulate gastric acid secretion and may promote the ballooning of the stomach through the diaphragm to cause hiatal hernia.

To date only one study has been published in which biofeedback was used to treat aerophagia (Calloway, Fonagy, Pounder, & Morgan, 1983). The authors randomly assigned 12 patients with hiatal hernia who had previously been shown to swallow excessively to one of two behavioral treatment protocols. Half of the patients were taught general relaxation with the aid of a GSR biofeedback device, and half were instructed to decrease the frequency of swallowing with the aid of auditory feedback based on a microphone applied to the neck. In both groups, patients received three training sessions in the laboratory and were instructed to practice twice daily at home. Patients in the swallow biofeedback group were significantly more successful at reducing the rate of swallowing, and a higher proportion of them reported improvement of their gastrointestinal symptoms. Although the sample size was too small to adequately assess the clinical value of the technique the results suggest that simple, noninvasive biofeedback techniques may be useful in the management of this common gastrointestinal disorder.

False Starts: Unsuccessful Applications of Biofeedback for Gastrointestinal Disorders

Some of the earliest studies of biofeedback for gastrointestinal disorders were aimed at the treatment of peptic ulcer disease by teaching patients to control gastric acid secretion. These studies showed that it is possible to teach healthy subjects (Whitehead, Renault, & Goldiamond, 1975; Gorman, 1976) and patients with peptic ulcer disease (Welgan, 1974)

to increase and decrease the rate of gastric acid secretion with biofeedback, although it is technically difficult to do so. These biofeedback techniques have not found any application because they are not cost-effective by comparison with pharmacological treatment, which is now quite effective.

In a similar vein, researchers have shown that it is possible to teach subjects to modify gastric motility (Whitehead & Drescher, 1980) and the amplitude of the electrogastrogram (Deckner, Hill, & Bourne, 1972), which is an indirect measure related to gastric motility. Subjects learned to alter these physiological parameters with relative ease, but there is no recognized medical disorder for which they are relevant. The contractile activity of the stomach is only weakly correlated with the rate of gastric emptying, so these techniques are unlikely to be useful in the treatment of delayed gastric emptying.

In an early study, Schuster, Nikoomanesh, and Wells (1973) reported that normal controls and patients with gastroesophageal reflux disease (inflammation of the esophagus from reflux of gastric acid) could learn to increase the pressure in the area of the lower esophageal sphincter which normally prevents reflux. The clinical benefits of such training were not described in the initial report, and there have been no follow-up reports.

Inflammatory bowel disease, characterized by symptoms of abdominal pain and bloody diarrhea, is thought by some to be linked to psychological symptoms and to be exacerbated by stress, although empirical studies have not consistently supported either of these contentions (Whitehead & Schuster, 1985). On the assumption that psychological stress does play a role, Schwarz and Blanchard (1991) tested the multicomponent treatment package they had developed for IBS. Symptom diaries kept by patients suggested that the patients in active treatment were *less* likely to improve than patients in a waiting-list control group. Thus, one cannot be optimistic about the prospects for biofeedback therapy in this patient population.

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

In no other medical subspecialty has biofeedback had a greater impact than in gastroenterology. The biofeedback treatment of fecal incontinence, first described by Engel, Nikoomanesh, and Schuster in 1974, continues to be the treatment of choice for the majority of patients with adult-onset fecal incontinence. Research over the past 17 years has served primarily to define the indications and the limitations of the technique in specific populations. Recent results suggest that biofeedback may also become the preferred method for treating many patients with constipation; an estimated 50% of chronically constipated patients are constipated because they are unable to relax the striated pelvic floor muscles during

defecation, and training patients to relax tense striated muscles is an area in which biofeedback excels. Aerophagia, which affects an estimated 21% of patients with upper gastrointestinal disorders, represents another potential new application of biofeedback. Biofeedback also forms part of a multicomponent behavioral treatment program for irritable bowel syndrome, which Blanchard's group has shown to be effective, although the role of expectancy effects remains to be resolved. Thus, the opportunities for biofeedback clinicians and researchers to contribute to the management of patients with gastrointestinal disorders continue to multiply.

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