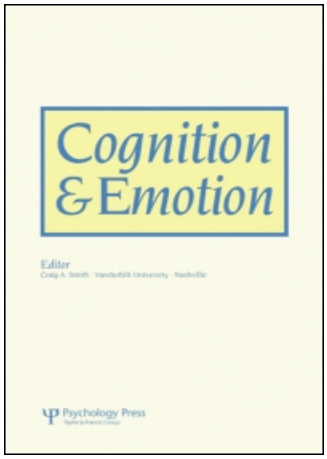

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Spinal cord lesions, peripheral feedback, and intensities of emotional feelings

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Spinal Cord Lesions, Peripheral Feedback, and Intensities of Emotional Feelings

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The emotional excitability of patients with spinal cord injury was studied. In contrast to what might be expected according to Hohmann (1966) and various emotion theories, the results of this study demonstrated that spinal cord lesions do not result in an overall reduction of emotional excitability. According to the opinion of the spinal cord lesioned patients themselves, their overall emotional excitability was increased after injury, rather than decreased.

INTRODUCTION

Hohmann (1966) interviewed 25 patients with spinal cord lesions and asked them to compare the intensity of various emotional feelings as experienced before injury with comparable post-injury experiences. The patients reported a decline in the intensities of feelings of anger, fear, and sexual arousal. They further reported an increase in intensities of feelings of sentimentality, i.e. the tendency to cry easily over moving situations. The reported changes were on the average more marked the higher the lesion (higher lesions result in more severe decreases in neural innervation as well as neural feedback).

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†Deceased.

Finally, some of Hohmann's patients reported that they regularly expressed emotions in the absence of the corresponding emotional feelings in order to be taken seriously. On the strength of these results, Hohmann concluded that spinal cord lesions result in an overall reduction of emotional excitability.

The assumption that peripheral feedback from somatic emotional responses induces or intensifies the emotional feeling has a long tradition, is widespread in contemporary psychology, and is part of almost all emotion theories with the exception of the cognitive emotion theories, see Bermond and Frijda (1987). However, as emotional feelings are private experiences, it is almost impossible to test the peripheral feedback hypothesis. Lindsley (1951), for instance, called it an "untestable philosophical idea".

Until now, Hohmann's 1966 publication is the only study in which the peripheral feedback hypothesis was tested directly and it is for this reason that Hohmann's study is frequently quoted and mentioned in various textbooks (for instance Carlson, 1980; Atkinson, Atkinson, Smith, & Hilgard, 1987). However, publications which have found results pointing to contradictory conclusions (Dana, 1921; Linton, 1974; Lowe & Carroll, 1985; Bermond, Nieuwenhuyse, Schuerman, & Fasotti, 1987; Richards, Hirt, & Melamed, 1982) are seldom referred to and not mentioned in the textbooks when referring to Hohmann's 1966 publication.

Considering its theoretical and clinical significance, it is strange that Hohmann's 1966 study has never been replicated, especially as this study has been criticised severely by various authors for its methodological weakness (Trieschmann, 1980; Tucker, 1980; Reisenzein, 1983). Furthermore, Trieschmann already had stated in 1980 that Hohmann's study had to be duplicated because if Hohmann's conclusion is wrong, it would lead to incorrect therapeutic strategies.

For these fairly urgent clinical, as well as theoretical reasons, we have replicated Hohmann's (1966) study. However, in order to avoid the methodological shortcomings, as mentioned by Trieschmann and Reisenzein, we have opted for a systematic, rather than an exact replication.

METHODS

Differences Between Hohmann's and Our Method

The Interview Structure. Hohmann, and ourselves, used structured interviews in order to ensure that the patients would more or less "re-live" the emotional experience under examination. Hohmann did not describe the interview structure he used; however, we think it is useful that we provide such a description. During our interviews, questions were asked

about the following subjects:

1. the cause of the emotional experience;
2. the feelings experienced;
3. the associated thought or fantasies;
4. the emotional actions;
5. the latency time (the time between eliciting stimulus and the first emotional experience);
6. the duration of the emotional feeling; and
7. whether there was a change in the quality of the emotion (for instance from anger to fear).

If patients confirmed the last question, then the preceding six questions were repeated for the second emotion.

The Interviewers. Hohmann interviewed the patients himself. In our study, interviews were held by psychological assistants specially trained for this purpose. These interviewers were briefed with regard to central as well as peripheral emotion theories. However, in order to avoid a biasing of views, it was stressed that both points of view were equally valid.

Instruction Given to the Spinal Cord Lesioned Patients. Hohmann asked his patients to compare the intensity of the pre-injury experience with the intensity of a comparable post-injury experience. We clarified the term "comparable" by saying that the two experiences had to be similar with regard to eliciting situation and personal interest. This was, further, illustrated by describing emotional experiences with equal eliciting situations but different levels of personal interest.

Sample Variables. The mean duration since injury (10 years) and range (2 to 17 years) in Hohmann's study were rather large. We have kept the post-injury periods within the limit of 9 years (mean duration since injury of 4.9 years; s.d., 2.3 years; range, 1.2 to 9.0 years).

All patients in Hohmann's study had complete lesions on one segmental level except the higher cervical lesions. Since Zola (1982) has proposed that it is the disablement itself rather than the reduced peripheral feedback which induces the reduction in emotional excitability, we wanted to separate possible relationships between spinal cord lesions and emotional changes into sensory, and motor effects of the lesions. For this reason, patients with complete as well as "partial" lesions (lesions starting on one spinal level to become complete at some lower level) were included in our study. Those patients with partial lesions were chosen, in which, according to the information from the clinics, there was a substantial discrepancy between the reductions in motor and sensory capacities.

Emotion Intensity Measurement. In order to avoid social desirability bias (Trieschmann, 1980; Reisenzein, 1983), we quantitatively measured the various emotion intensities separately, so that the comparisons could be made objectively rather than by the subjective impressions of the patients or their interviewer.

These emotion intensities were measured by the use of questionnaires based upon *The language of emotions* (Davitz, 1969). This study contains, for various emotions, sets of statements, and each set covers a number of different aspects of that particular emotion. The patients were asked to indicate for each statement whether or not it was applicable to the emotional experience at issue, or to indicate that they did not know. Responses of the latter type were scored as non-applicable.

The various statements could be sorted into two categories: (1) *somato-sensory emotional experiences*, statements referring to either peripheral autonomic arousal ("My blood-pressure went up, blood seemed to rush through my body"), or changes in striated muscles ("My hands were shaky"); and (2) *pure mental emotional experiences*, either referring to action tendencies ("I wanted to be comforted and helped by someone", "I wanted to say something nasty, something that would hurt someone"), or to appraisals ("There was a sense that I had no control over the situation", "Everything seemed out of proportion"). This was done because it is known that spinal cord lesions block innervating as well as sensory nerves. Thus, less somato-sensory emotional experiences have to be expected. The important question is, therefore, whether the reductions in these experiences have consequences for the mental emotional responses, as suggested by the peripheral feedback hypotheses and Hohmann (1966). With the help of these emotion questionnaires four scores were obtained for each emotion: two for intensity of mental responses (before and after injury); and two for intensity of somatic responses.

Emotions Studied. Hohmann studied five emotions (fear, anger, sexual arousal, grief, and sentimentality). Because pilot studies had shown that our method was too demanding for most patients, we had to limit ourselves to the two emotions for which Hohmann's study had demonstrated the greatest decline: fear and anger. Like Hohmann, we were also interested in other emotions as well as the opinions of the patients themselves with regard to possible changes in their emotional excitability. We asked our patients for the following five emotions, fear, anger, joy, grief, and sentimentality, to be indicated on 20 five-point-scales (ranging from "strongly increased" to "strongly reduced"), whether there had been changes after injury in: (1) the intensity of the feeling; (2) the latency of the emotional feeling; (3) the duration; and (4) the frequency of occurrence. Finally, some of Hohmann's patients reported that after their injury they often pretended to be emotionally excited in order to be taken seriously.

For this reason we asked our patients to indicate on five-point scales (also ranging from "strongly increased" to "strongly reduced"), for each of the five emotions mentioned, whether there were any changes in the frequencies of pretended emotions after their injury.

Subjects

Thirty-seven patients with spinal cord lesions participated in this study. All had taken part in rehabilitation therapy for about one year. At the time of the study, they were all living outside the clinics, either on their own or in a family setting.

Spinal Cord Lesion Variables

The method of Kendall and Kendall (1971), with regard to the spinal segmental supply of correlated skeletal muscles, was employed to measure the remaining motor capacities. The remaining sensory capacities were measured by Oosterhuis' method (1977). The lesion level was defined by the highest spinal segment at which loss in motor and/or sensory capacities was measured.

Experimental Procedure

All patients were visited at home. The remaining intact sensorimotor capacities were measured between 9.10 a.m. and 10.30 a.m. Following a short break of 15 minutes the emotion interviews and emotion measurements were commenced.

Before lunch, inquiries were made concerning the emotions fear and anger as experienced after spinal cord injury. The same procedure was repeated after lunch for comparable (with regard to eliciting situation and personal interest) fear and anger emotions, as experienced before injury. This was followed by a tea break. In the late afternoon the subjects were asked to complete all five-point self-rating scales, referring to possible changes in emotional excitability and pretending to be emotionally excited. This programme was too exhausting for some patients, in particular for those with higher lesions. In these cases, more pauses were included and, if necessary, the programme was spread out over two successive days.

Statistics

Differences in mean values (before vs. after injury) were tested for significance by means of the *t*-test for correlated means. Possible relationships between emotional intensities, or changes in emotion intensities with

spinal cord lesion variables, were tested for significance by Spearman rank correlation coefficients. Rank correlations were used because the spinal cord lesion variables are of ordinal level. Increases or decreases in emotional excitability or frequencies of pretending, as indicated on the five-point self-rating scales, were tested for significance by the binomial test or Wilcoxon signed ranks test.

Because it is known that spinal cord lesions reduce innervation as well as feedback, one-tailed tests were used for changes in somatic emotional responses as well as for the correlations between scores for the lesion variables and those for the somatic emotional responses after injury. All other statistical testing was two-tailed.

RESULTS

Fear

Twenty-three of the 37 patients could remember two fear experiences that were equal with regard to eliciting stimuli and personal interest. The relevant subject characteristics of this subgroup are presented in Table 1. As can be seen from Table 1 there was, within this group, a more or less equal distribution of the lesions over the spinal cord, except for the sacral end. These patients, were not represented in the sample because, lacking serious complaints, they seldom apply to the rehabilitation clinics. The scores for the various fear intensities are presented in Table 2.

As shown in Table 2, the mean intensity score for the mental fear responses was significantly increased after injury, while there was no change in mean score for the somatic fear responses. The correlation coefficients between fear intensities and spinal cord variables are represented in Table 3.

TABLE 1
Means, s.d.s, and Ranges for the Level of Lesions, Ages at Time of Injury, and Years since Injury of Patients who could remember 2 Comparable Fear Experiences: 1 from the Period before and 1 from the Period after Injury

	Mean	*s.d.*	*Range*
Lesion level	T. 4.1	6.5 (Vertebrae)	C4–L4
Age at moment of injury	31.5	12.1	17.1–55.7
Years since injury	5.1	2.4	1.2–9.0

TABLE 2
Mean-values and s.d.s for Fear Scores, together with *t*- and *P*-values concerning the Change in Fear since Injury

	Before Injury		*After Injury*		*t-value Change*	*P-value Change*
	$\bar{X}$	*s.d.*	$\bar{X}$	*s.d.*		
Mental responses	10.8	6.0	13.1	4.5	2.31	< 0.05
Somatic responses	7.6	4.0	7.6	3.6	0	> 0.40

TABLE 3
Spearman Rank Correlations between Scores for Lesion Variables and Scores for Fear Intensities

	Lesion Level	*Remaining Sensor Capacities*	*Remaining Motor Capacities*
Before injury			
Mental responses	−0.18	−0.27	−0.11
Somatic responses	−0.08	−0.02	−0.11
After injury			
Mental responses	0.09	−0.05	−0.01
Somatic responses	0.50[b]	0.31	0.33
Change since injury			
Mental responses	−0.17	−0.17	−0.08
Somatic responses	−0.40[a]	−0.16	−0.06

[a] $P < 0.01$; [b] $P < 0.05$.

Calculation of correlations provided only two results of significance, namely the correlation between somatic fear responses after injury and lesion level, and between the change in somatic fear responses since injury (pre-injury score minus post-injury score) and lesion level. This corresponds to what would be expected on the basis of the lesion-induced reduction of functional nerve connections.

Anger

Thirty-two out of the 37 patients could remember two anger experiences that were comparable with regard to eliciting situation and personal interest. The relevant subject characteristics of this subgroup are rep-

TABLE 4
Means, s.d.s, and Ranges for the Level of Lesions, Ages at Time of Injury, and Years since Injury of Patients who could remember 2 Comparable Anger Experiences; 1 from the Period before and 1 from the Period after Injury

	Mean	*s.d.*	*Range*
Lesion level	T. 4.6	6.5 (Vertebrae)	C4–L4
Age at moment of injury	30.4	10.1	17.2–55.7
Years since injury	4.7	2.2	1.2–8.7

resented in Table 4. The characteristics of this anger subgroup are comparable to those of the fear subgroup. The scores for the various anger intensities are represented in Table 5.

Mental responses in anger were also increased after lesioning, together with more or less constant mean scores for somatic anger responses. However, the increase in mental anger responses was far from significant. Calculation of correlation coefficients between anger intensities and spinal cord variables provided only one result of significance. All coefficients were extremely low (< 0.15), except those for somatic responses for the period after injury. Correlation coefficients for the somatic responses mentioned with lesion level, remaining sensory capacities, and remaining motor capacities, 0.21, 0.24, and 0.30 respectively; P-values, $0.25 > P > 0.1$, $0.1 > P > 0.05$, and $P < 0.05$).

TABLE 5
Mean-values and s.d.s. for Anger Scores, together with t- and P-values concerning the Change in Anger since Injury

	Before Injury		*After Injury*		*t-value Change*	*P-value Change*
	$\bar{X}$	*s.d.*	$\bar{X}$	*s.d.*		
Mental responses	14.8	6.8	16.7	7.9	1.24	> 0.2
Somatic responses	4.7	3.0	4.8	3.1	0.23	> 0.4

Changes in Emotional Excitability as Indicated on the Self-rating Scales

All 37 patients completed the self-rating scales concerning possible changes in emotional excitability. However, by mistake, two patients did not complete the questionnaires concerning joyfulness and grief, and furthermore some of the patients made occasional mistakes. For these reasons, the real number of patients varied over the various scales from 34 to 37. Table 6 presents the relevant characteristics of the total group. The results concerning those self-rating scales are summarised in Table 7.

As can be seen from Table 7 quite a number of scores indicated no change, although this varied from scale to scale. Even so, the mean scores on only two scales (the duration of fear and joy) pointed to a decreased level of emotional excitability, whereas the mean scores on all other 18 scales pointed to an increased level of emotional excitability following the lesion (higher scores for excitement, duration, and frequencies, and lower scores for latency times). The two-tailed probability for this and more extreme distributions is 0.0002. Testing the various individual scales for significance by aid of the Wilcoxon signed ranks test showed that the reported increase corresponded with P-values < 0.05, for 9 out of the 20 scales used (fear: frequency; anger: intensity of feeling; grief: intensity of feeling, latency, duration, and frequency; sentimentality: intensity of feeling, latency, and frequency), the scores for the intensity of the feeling of joyfulness provided a two-tailed P-value of 0.068. The scores on the other 10 scales did not indicate a decreased emotional excitability which had been expected on the basis of Hohmann's results and the peripheral feedback theories. Statistical testing of the decrease hypothesis, provided P-values of 0.470 or more.

These results are just the opposite of what had been expected from Hohmann's conclusion. The same statistical analyses were, therefore, repeated for the subgroup with cervical lesions, because this subgroup has the most pronounced reductions in functional nerve connections. There

TABLE 6
Means, s.d.s, and Ranges for the Level of Lesions, Ages at Time of Injury, and Years since Injury in the Total Group

	Mean	*s.d.*	*Range*
Lesion level	T. 5.2	6.1 (Vertebrae)	C4–L4
Age at moment of injury	29.9	11.4	17.1–55.7
Years since injury	4.9	2.3	1.2–9.0

TABLE 7
Distributions of Scores in the Total Group, in the 5-point Self-rating Scales for indicating Changes in Emotional Response after Spinal Cord Injury, with Corresponding *P*-values

		*Scale Points**					
		1	*2*	*3*	*4*	*5*	*P-value (2-tailed)*
Fear	Intensity	3	2	19	8	4	0.251
	Latency	4	1	15	14	3	0.150
	Duration	2	7	22	3	2	0.470
	Frequency	3	0	17	9	7	*0.033*
Anger	Intensity	1	4	17	10	4	*0.042*
	Latency	4	4	15	9	4	0.529
	Duration	3	2	25	3	3	0.891
	Frequency	4	6	10	12	4	0.450
Grief	Intensity	0	0	19	7	8	*0.000*
	Latency	0	3	14	11	6	*0.001*
	Duration	1	1	16	10	6	*0.004*
	Frequency	1	2	14	5	12	*0.001*
Sentimentality	Intensity	0	5	16	8	7	*0.007*
	Latency	1	2	13	13	7	*0.001*
	Duration	3	6	14	6	7	0.241
	Frequency	1	6	10	12	8	*0.006*
Joyfulness	Intensity	0	5	18	8	3	0.068
	Latency	1	5	18	8	2	0.320
	Duration	2	6	20	5	1	0.527
	Frequency	2	5	14	11	2	0.310

*1 Corresponds with a very strong decrease in emotional response since injury (decrease in either: intensity, duration, and frequency; or increase in latency time), 5 corresponds with a very strong increase in emotional response, and 3 corresponds with no change.

were 14 patients with cervical lesions in our group. However, for the reasons mentioned earlier, the real number of patients varied over the various scales from 12 to 14. The analyses provided comparable results, as indicated in Table 8. The mean scores on 16 out of the 20 scales pointed to an increased emotional excitability, while the mean scores on the other 4 scales (duration and frequency of joyfulness, and latency and frequency of anger) pointed to a decrease in emotional excitability. The probability of this and more extreme distributions is 0.0118. Testing the various individual scales for significance showed that the reported increase corresponded with P-values < 0.05 for 7 out of the 20 scales used (grief: intensity of feeling, latency, duration; and frequency; sentimentality: intensity of feeling, latency, and frequency). In addition, the scores on the other 13

TABLE 8
Distributions of Scores in the Cervical Lesion Group, on the 5-point Self-rating Scales for indicating Changes in Emotional Response after Injury, with Corresponding *P*-values

		*Scale Points**					
		1	*2*	*3*	*4*	*5*	*P-value (2-tailed)*
Fear	Intensity	2	0	4	4	3	0.359
	Latency	2	0	3	7	2	0.240
	Duration	1	2	7	1	2	0.844
	Frequency	2	0	4	3	4	0.301
Anger	Intensity	1	2	5	5	1	0.533
	Latency	4	1	4	5	0	0.348
	Duration	1	1	9	1	2	0.719
	Frequency	3	2	3	5	1	0.798
Grief	Intensity	0	0	6	3	3	*0.031*
	Latency	0	2	1	5	4	*0.024*
	Duration	0	1	3	5	3	*0.023*
	Frequency	0	1	3	3	5	*0.016*
Sentimentality	Intensity	0	0	6	2	5	*0.016*
	Latency	0	1	1	6	5	*0.003*
	Duration	3	2	1	3	4	0.677
	Frequency	0	1	2	7	4	*0.004*
Joyfulness	Intensity	0	4	4	2	2	0.640
	Latency	0	3	5	4	0	0.812
	Duration	1	4	4	3	0	0.460
	Frequency	2	3	2	4	1	0.846

*1 Corresponds with a very strong decrease in emotional response since injury (decrease in either: intensity, duration, and frequency; or increase in latency time), 5 corresponds with a very strong increase in emotional response, and 3 corresponds with no change.

scales did not point to a decrease in emotional excitability. Statistical testing of the decrease hypothesis provided *P*-values of 0.348 or more.

One has to be careful with conclusions regarding individual scales, because for the total group, as well as for the subgroup of cervical lesions, 20 statistical analyses were carried out. However: (1) overall testing (lumping all scales together) provided clear significant results in both patient groups; (2) testing the various scales separately provided 9 *P*-values < 0.05 in the total group and 7 in the cervical lesions group, while the expected number of such *P*-values is 1 in each group; (3) testing the decrease hypothesis resulted in *P*-values of 0.348 or more.

Together, these results clearly indicate that the spinal cord lesioned patients themselves are convinced that their overall emotional excitability

is either not changed or increased following the lesion, but is certainly not decreased.

Changes in Pretending to be Emotionally Excited as Indicated on the Self-rating Scales

All patients completed the five self-rating scales concerning possible changes in frequencies of pretending. Only in 16.7% of the cases was a change in these frequencies observed. If all five scales are taken together, then the number of reported increases is exactly that of the reported decreases. The mean scores per scale pointed twice to a small increase, twice to a small decrease, whereas the mean score for one scale indicated no change at all. Testing the five scales for significance separately by aid of Wilcoxon signed ranks test provided insignificant results.

DISCUSSION

The results concerning the emotion of fear clearly demonstrate that it is useful to discriminate between mental and somatic emotional responses. The intensity of the mental responses increased after spinal cord lesioning, but this increase does not correlate with any of the spinal cord lesion variables. The mean score for the intensity of the somatic fear responses remained unchanged after injury. Yet the scores for somatic fear responses for the period after injury as well as the scores for the change in these responses since injury (pre-injury score minus post-injury score) correlated significantly with scores for the level of the lesion in the spinal cord.

It is not surprising that patients with lesions high in the spinal cord experience less somatic emotional responses, because these lesions block most of the innervating as well as the sensory nerves. On the basis of the reduced number of functional nerves an even more extensive reduction could be expected. However, looking back, the discrepancy between expected and measured reduction in somatic responses can be explained. Sjören and Egberg (1983) studied sexual responses in spinal cord lesioned patients and described phantom feelings in the penis during sexual activity. Our patients also described emotional feelings in parts of their bodies where, according to their lesions, they could not feel anything any more. Furthermore, independently from one another, two rehabilitation physicians told us that phantom feelings were well-known phenomena in their clinics. Finally, spinal cord lesions result also in a disinhibition of various spinal reflexes due to loss of central control over these reflexes. These disinhibitions result in stronger somatic sensations in the unaffected parts of the body. For these reasons, spinal cord lesioned patients may well

experience more somatic sensations than expected on the basis of the reduction in functional nerves alone.

The results concerning anger are, although less clear, comparable to those for fear. As for fear, there was an increase in the mean score for mental responses after injury (though not significant), and a significant correlation between the scores for the somatic responses after injury and one of the spinal cord lesion variables. Finally, as in fear, there was no change of any importance in the mean number of somatic anger responses after injury.

However, two differences between the results for fear and those for anger deserve attention: (1) the correlations between somatic anger responses after injury and the lesion variables are all lower than the corresponding correlations concerning fear; (2) the highest correlation for somatic anger responses after injury is with remaining motor capacities, while that for fear was with lesion level. The first result is in line with a study by Shields (1984), showing that somatic fear responses are much better perceived than somatic anger responses. The second result suggests that somatic anger responses and somatic fear responses are of different types. Somatic anger feelings might correspond to changes in the muscular skeletal system, whereas fear feelings might correspond with changes in the automatic nerve system. This suggestion is in line with the results of Ax (1953) showing that anger induces muscular tension while fear induces an activation of the sweat glands.

The results from the 20 self-rating scales demonstrated clearly that most of the patients with spinal cord lesions are themselves convinced that their overall emotional excitability has either not changed or has increased since injury. This was observed for the entire patient group as well as for the subgroup with cervical lesions. The significant increases found, support previous studies reporting such increased emotional reactions after exhaustion or prolonged stress (Frijda, 1986, p. 175).

Further, the scores on the 20 self-rating scales did not provide a single indication for the presumed reduction in emotional excitability. Statistical testing of this assumption produced *P*-values of 0.348 or more.

Finally, contrary to what was expected on the basis of Hohmann (1966), we found no indication whatsoever for the presumed increase in frequency of pretending to be emotionally excited after injury.

In conclusion, first, we may say that our overall results point more to an increase in emotional excitability after spinal cord injury instead of the presumed decrease. Secondly, although there is a decrease in somatic emotional responses in patients with higher lesions this decrease was, in contrast to what had to be expected on the basis of various theories and Hohmann (1966), not associated with a reduction in the intensity of mental emotional reactions.

Our conclusion is in agreement with a number of reports in the literature: (1) Dana (1921) failed to observe any decrease in the intensities of the emotional feelings in one patient with a cervical lesion in the year after injury; (2) McKelligott (1959, unpublished, but mentioned by Hohmann, 1966) failed to do so in a group of spinal cord lesioned patients; (3) Linton (1974) failed to demonstrate differences in reaction to slides of sexual content between a group of 20 able-bodied men and a group of 20 male quadriplegics; (4) Lowe and Carroll (1985) failed to register a change in imaginary emotional responses in a group of 29 spinal cord lesioned patients (16 cervical, 12 thoracic, and 1 lumbar lesion) and who were asked to imagine situations and rate 8 imaginary emotional reactions which might have been experienced recently and before injury (affection, anger, enjoyment, excitement, fear, grief, guilt, and hate). Neither did they find less imaginary emotional responses in the cervical group compared to the thoracic/lumbar group; (5) Bermond et al. (1987) failed to demonstrate an overall reduction in mood states in a group of 42 spinal cord lesioned patients. Finally, (6) they seem to be in line with the results of Richards et al. (1982) who demonstrated that the reduced somatosensory stimulation to the central nervous system in paraplegic, as well as in quadriplegic patients, does not result in a decreased central alertness.

It is less clear how our results relate to those of Jasnos and Hakmiller (1975). Their publication covers three studies. In the first study, they asked 24 spinal cord lesioned patients (lesion level ranging from L1 up to C5) to describe their most intense experience of anger, irritation or fear since injury. In the second one, they asked these patients to report their thoughts and feelings in response to slides of clothed or nude attractive women. In the third study, they asked their patients to report their thoughts and feelings in response to slides depicting injured females. The responses in these three studies were rated for arousal and discomfort by judges (13 undergraduate psychology majors). Only the results from the second study (clothed and nude women) provided results which demonstrated a significant decrease in rated arousal for the cervical patients compared to the thoracic and lumbar patients.

The authors accepted their results as a clear indication for a decreased ability in spinal cord lesioned patients to experience emotional feelings. For various reasons we do not agree with Jasnos and Hakmiller.

One: roughly speaking, the patients could express their emotional feelings by their mental emotional responses and/or by their somatosensory emotional reactions. The actual number of the last type of responses is reduced by the lesions and this reduction increases as the level of the lesion increases. Thus, the implicit assumption that the number of possible ways to describe the intensity of the emotional feeling was independent of the lesion level was incorrect. It cannot be avoided, therefore, that the judges

in this double-blind test considered the descriptions of patients with high lesions as less intense, compared to those of patients with lower lesions, simply because the first group describes less somatosensory responses. Furthermore, Jasnos and Hakmiller instructed their judges to rate for arousal, instead of intensity of the feeling, thereby emphasising once more the importance of the somatosensory responses.

Two: in the Jasnos and Hakmiller study subjects were asked to imagine that they were alone with the women on the slides and that these women were sexually available. It is self-evident that sexual initiative and sexual behaviour become more difficult as (with increasing lesion level) the motor paralysis and sensory deficit increases. This is especially true for the group with cervical lesions, which are either paralysed in all their limbs (high cervical lesions) or have only a very clumsy motor control left in their arms and hands (low cervical lesions).

Three: all cervical patients were hospitalised, while most other patients were visited at home. The hospital situation is most probably less appropriate for sexual phantasies than the private home situation, and the mean score in the home environment was actually higher in the Jasnos and Hakmiller study compared to the mean score in the hospital environment.

Four: Sexual activity results in a stimulation of the pituitary-gonadal axis, whereas long-term sexual inactivity results in an inhibition of this endocrine system (Fox et al., 1972; Kraemer et al., 1976; Bermond, 1983). There are reasons to assume that long-term changes in activity of the pituitary-gonadal axis result in corresponding changes in libido (Persky et al., 1978; Skakkebaek, Bancroft, Davidson, & Warner, 1981; Bermond, 1982; Bancroft & Wu, 1983). As stated earlier, without exception, cervical patients were hospitalised. Further, the time-period since their injury was quite long; the mean injury-duration being 109.6 months (comparable values in the thoracic/lumbar group 37.5% hospitalised, and mean injury-duration 37.2 months). Although the authors do not give any data on this, it has to be assumed, for the reasons mentioned, that the period of sexual abstinence immediately preceding the actual study of Jasnos and Hakmiller was substantial in the cervical group and much smaller or nonexistent in the thoracic/lumbar group, and, therefore, differences in libido between groups have to be expected. Summarising the last three points we, may say that it is very unlikely that the appraisal values of the slides of clothed or nude attractive women were independent of the level of the lesion, as was implicitly assumed by Jasnos and Hakmiller.

For the four reasons mentioned above we think that the results of Jasnos and Hakmiller do not indicate that spinal cord lesions necessarily lead to reductions in subjective emotional feelings.

Our results are in conflict with those from research inspired by the theory of Schachter and Singer (1962) as, for instance, the studies by Zillmann, Katcher, and Milavsky, 1972; Zillmann, Mody, and Cantor, 1974; Cantor and Zilmann (1973); Zilmann and Bryant (1974); Jaffe, Malamuth, Feingold, and Festbach (1974); White, Fishbein, and Rutstein (1981); Reisenzein and Gattinger (1982). These studies demonstrated that arousal due to physical exercise or a preceding emotion intensifies the feeling of an immediately succeeding emotion. However, the enhancement of the emotional feeling, as measured in the studies mentioned, may not be due to the peripheral feedback from the preceding arousal, as Valins (1966) has demonstrated that false peripheral feedback (fake heart-rate increases, presented by loudspeakers) had a similar effect. The increase in the subjective feeling may therefore not be induced by the peripheral feedback itself, but by an increase of attention (Barefoot & Straub, 1974), or by appraisal of the peripheral responses (Bermond & Frijda 1987) (see Reisenzein, 1983 for a further critique).

Hohmann (1966) stated that spinal cord lesioned patients are reluctant to talk to most able-bodied people who might wish to interview them. For this reason Hohmann, himself a paraplegic, considered himself as the ideal interviewer and he assumed that McKelligott got negative results because he was an able-bodied person; to cite Hohmann: "Finally, it should be restated that one of the by-products of this investigation served to substantiate the assumption that produced it, i.e. that McKelligott's subjects were not cooperative in interviews. Some of his subjects frankly admitted to the writer that they had given false information to McKelligott." To us, these statements are surprising. Perhaps these statements were valid in the late-1950s when the prospects for spinal cord lesioned patients were much less encouraging than today. Furthermore, none of our interviewers (all able-bodied) ever got the impression that the issue of able-bodied or not was a disturbing factor during the interviews, and we do therefore not believe that this explains the difference between our results and those of Hohmann. On the contrary, on the basis of the statements of patients that Hohmann quoted in his article, we have the impression that, although we come to opposite conclusions our results do not, at least partly, basically differ from those of Hohmann. We should like to repeat here the quotations of Hohmann's patient with the highest lesion (C3–C4). Concerning fear this patient said: "I sit around and build things up in my mind and I worry a lot, but it is not much but the power of thought". Concerning anger this person reported: "I get thinking mad, not shaking mad and that's a lot different". As was stated before by Lloyd, Mayes, Manstead, Meudall, and Wagner (1984, p. 449) these quotations point to reduced somatic emotional responses together with full-blown mental emotional responses. The quotations of the other patients in Hohmann's study point in the same direction, although the reported decrease in somatic responses diminished

as the lesions were lower in the spinal cord. These results are therefore quite comparable with those in our study. The only essential difference between Hohmann's patients and ours is that those in Hohmann's study stressed the reduction in somatic responses more than our patients and, furthermore, Hohmann's patients claimed that these reductions had consequences for the intensities of their subjective feelings. Two explanations could be given for these discrepancies.

1. Hohmann instructed his subjects: "to recall and discuss any emotional experience which had been particularly notable prior to the injury and a comparable incident following the injury". In other words, the intensity of the first (pre-injury) experience had to comply to certain requirements (it had to be an intense one), while such demands were not made for the second (post-injury) experience. The only demand made here was that it had to be a comparable one. As "comparable" was not specified, some subjects at least might have searched for an experience with a comparable eliciting situation only; thereby neglecting the importance of comparable personal interest. If so, less intense emotional feelings for the second (post-injury) experience have to be expected for these subjects on the basis of the instruction alone, no matter what has happened in the period between the two experiences.

2. Trieschmann (1980) stated that Hohmann's results could easily be the product of experimental or social desirability bias, as Hohmann was the interviewer as well as the person formulating the hypothesis of lesion-induced reduction in emotional excitability. For two reasons we are inclined to follow Trieschmann in this proposition. First, as mentioned before, there is: (1) the phenomenon of "phantom feelings"; and (2) the phenomenon of stronger somatic sensations in unaffected parts of the body of spinal cord lesioned patients, due to disinhibitions of spinal reflexes. The fact that Hohmann's patients stressed the reduction in somatic emotional responses so much more than our patients did, while at the same time they did not mention any of the phenomena mentioned, vindicates the assumption that Hohmann has most probably over-accentuated the importance of the reduction in peripheral feedback during the interviews. Secondly, in exit-interviews in which the purpose of this study was explained and in which was mentioned that most emotion theories stress in one way or another the importance of peripheral feedback for the intensity of the emotional feeling, about 20% of our spinal cord lesioned patients "spontaneously" changed their point of view regarding their own emotional excitability.

The question remains as to why these spinal cord lesioned patients so easily changed their opinion regarding their own emotional excitability.

The answer could be found in the work of Tyrer (1985). Tyrer has done much research into the effects of beta-blockers and beta-mimetics (see, for example, Tyrer, 1976). If used by anxiety neurotics the effects of these drugs are more or less clear. The beta-mimetics induce anxiety; the beta-blockers reduce subjective fear feelings. However, the effects in controls are far from clear. In most studies only a few show the same reactions as the patients mentioned; in most they have no effect (Pitts & Allen, 1980). Tyrer asked his controls, before treating them with beta-mimetics, whether they measured their fear intensities by their somatic or by their mental anxiety responses. Only those who were inclined to estimate their intensities by their somatic responses were sensitive to the drugs.

This leads, in our opinion, to the following conclusion: Appraisal value can be attached to the somatic emotional responses, when occurring, the feedback of which adds to the intensity of the emotional feeling. This is however, not a biological but a psychological mechanism, as appraisal value is only added if, for some reason, the person attached personal interest to the somatic emotional responses.

CONCLUSIONS

1. Spinal cord lesions do not necessarily result in an overall reduction in emotional excitability.

2. Peripheral neural feedback is not necessarily relevant to the experienced intensity of emotional feelings.

3. Like other stimuli, somatic emotional responses can be appraised. They therefore can influence the intensity of the subjective emotional experience if the person considers them to be important and attaches personal interest to these responses.

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