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Abstract

Eleven schizophrenic psychotic and 11 manic psychotic patients have been compared with each other and with a reference group of 34 dentists with respect to their emotional experience of seven complex nonverbal sounds. A rating form was used which measures three factors of emotional perception: tension – relaxation (factor I), gaiety – gloom (factor II), and attraction – repulsion (factor III). Analyses of variance of the factor scores revealed main tendencies between the psychopathological groups in factor I and III, i.e. schizophrenic psychotics rated the sounds generally as more tense and more attractive than manic psychotics. The manic psychotics rated the sounds as generally less tense and very much more attractive than the other groups. In factor II the manic psychotics rated one piece as significantly more gay than the other groups. It is discussed in what ways these differences of complex sound perception may be related to characteristic symptoms of the psychopathological states. No convincing evidence may be drawn from this study supporting the assumption that the two psychopathological groups might differ in a specific way in relation to any elementary structural property of the sounds.

Introduction

The stimulation by nonverbal complex sound, as e.g. sounds from enviromental sources, music etc., has a great communicative power. The complex pattern of sounding elements, structured in time, amplitude, and frequency spectra, evokes an immediate impression which is interpreted at various levels and sites within the nervous system. Psycho-

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logical responses occur, perceptual analysis takes place, emotional experiences are felt, cognitive processes are set to work, and as a result of the association of these events, different meanings arise [1]. This fact has been used for assessing differences of perception in healthy subjects and patients with psychopathological symptoms. Music preference tests seldom show differences in these respects though Biller [2] found some between schizophrenic psychotics and normals in ratings of emotional content such as pleasant – happy, serious – sad etc. Cattell and McMichael [3] by using the IPAT music preference test found various differences between clinical groups of schizophrenics, psychoneurotics, affectives etc. DeWolfe et al. [4] reported that reactive schizophrenics preferred relaxed music and process schizophrenics preferred tense music. Iwata [5] described that a rating of mood on semantic differentials varied considerably between neurotic groups, especially when divided into stress and nonstress groups. Similarly Mitchell and Zanker [6] showed that music has varying stimulating and sedative effects on psychopathological groups. This was also assessed by Peretti and Swensson [7] in studies of effects of music and anxiety as determined by physiological skin responses. According to an investigation by Nielzén and Cesarec [8] schizophrenic psychotics rate complex music as more attractive than any other psychopathological group or group of normal subjects. In the same study manic psychotics like depressives show an inability to rate music of a happy mood as being so. The latter finding probably has something to do with the phenomenology investigated by Stein and Thomson [9]. They found gross deviations in the perception by psychotic groups and argued that perceptual deficits by manic psychotics depend on an incorrect evaluation of time processes and tempo. Steinberg et al. [10] have worked with several music perception and performance tests in connection with clinical groups. They comment that impairment due to schizophrenic or affective disorders seems to change the cognitive processes of understanding music. These changes are reversed at the remission of the disorder.

In experimental research there is a need for stimuli with relatively short durations. Otherwise structural content may be difficult to describe and the registration expands beyond practical boundaries. Interpretations become complicated too. In a new series of experiments of ours it has been shown that complex sounds even as short as 0.5 s differentiate the emotional response within groups of normal subjects, comparable to the situation when stimuli of longer excerpts of orchestral music are used [11]. In the present study sounds with a duration of 3 s are used.

Aims of the Study

The aim of this study is to investigate if different complex nonverbal sounds of 3 s duration discriminate the emotional perception of them by schizophrenic psychotics, manic psychotics, and subjects of a reference group. On the basis of the investigations referred to in the introduction, it is assumed that significant differences between the groups of subjects will occur. It is further hypothesized that contrasting results may be obtained, which could reflect specific and separating traits between the clinical groups.

Methods

Stimuli

Seven complex sounds were generated by means of the program MIDMAC Patch Editor on a DX 7 Yamaha synthesizer. These sounds are technically described in a study of perception on normal subjects

Table 1. Rating variables of structural content grouped by factor analysis

Factor I, complexity	Factor II, color	Factor III, pliancy
Complex – simple	light – dark	hard – soft
Irregular – regular	low volume – high volume	dissonant – consonant
Complex – simple	high pitch – low pitch	modern – traditional
Incoherent – coherent	major-like – minor-like	nonmelodious – melodious
Vivid – placid	variable – unvariable	

[11]. They were chosen in order to represent a great variation regarding the content of frequency, amplitude spectrum, envelope and so forth. A description of the structural content of the sounds is presented in the following by means of an operational procedure. By this, and by the following verbal description, the reader may get an image of the content of the sounds. For a physical description of the sounds the reader is referred to Nielzén and Olsson, [11]. Thirteen music students, 6 women and 7 men between 18 and 24 years of age, were asked to complete a form of 11 semantic differential scales with seven steps [12]. These are as follows; low volume – high volume, high pitch – low pitch, irregular – regular, complex – simple, incoherent – coherent, vivid – placid, variable – unvariable, dissonant – consonant, modern – traditional, major-like – minor-like, melodious – nonmelodious. A correlation matrix of the ratings of the seven sounds was computed and factor analysis was made. Three factors with eigenvalues greater than 1.0 emerged and the matrix was rotated according to the Varimax method [13]. Loadings higher than 0.6 in one factor and lower than 0.35 in both the others were accepted to represent this one factor of the rotated matrix. With this criterion all variables of the present sample became included in one of the factors. The structural factors were interpreted to describe complexity, color and pliancy. The pieces of music may by the use of factor scores be assigned an individual position in a multidimensional factor space. The three factors explained 64.5% of the variance in the rotated matrix. The factors are presented in table 1 and mean factor scores of the variables are presented in table 2 [8]. In the computation process the mean factor scores are normalized to a distribution with mean = 0 and SD = 1.

A verbal description of the sounds is as follows: Sound number 1: Synthetic trumpet sound. The quality is clear and bright. Sound number 2: Female voice (like vox humana) with a fairly marked even vibrato. It is light in color. Sound number 3: This sound has a metallic, buzzing character with a wobbling harsh quality. A fairly prominent tonal background is heard. Sound number 4: It has a repetitive structure like a fast alternation between low-pitched syllables, something like a phonation of 'wove-wove-wove' etc. by a stiff male voice. Sound number 5: Resembles synthetic small chimes with their typical clear attack and swift fading. Sound number 6: This sound gives an impression of a warm broad and dark chord played on a Fender Rhodes electric piano. Sound number 7: A mechanical alarm-clock sound with a sharp rim shot attack.

Table 2. Mean factor scores and standard deviations of structural ratings of the seven pieces of sound for the three factors

Piece No.	Factor A complex – simple	Factor B light – dark	Factor C hard – soft
1	1.03 (0.25)	0.16 (0.18)	0.10 (0.22)
2	0.33 (0.25)	0.29 (0.24)	0.14 (0.30)
3	0.38 (0.25)	0.00 (0.19)	0.44 (0.20)
4	0.15 (0.24)	1.17 (0.26)	0.48 (0.17)
5	0.83 (0.18)	0.86 (0.21)	0.49 (0.25)
6	0.70 (0.18)	0.53 (0.27)	1.00 (0.31)
7	0.69 (0.14)	0.41 (0.21)	0.65 (0.17)

Equipment

The sounds were created and generated on a Yamaha DX7 digital FM synthesizer. The programming work was done on an Apple Macintosh Plus computer by means of the Midimac DX/TX Patch Editor [14] music software. The sounds were recorded and played

Table 3. Some identifying and background variables of the subjects with psychopathological symptoms

	Sex		Age		Admissions		Medication							
	M	F	mean	SD	1–2	3–4	LN, mg		HN, mg		TH, mg		No	Lith
							<10	>10	<100	>100	<100	>100		
SP	8	3	33	12.7	8	3	6	2	1	1	–	–	11	–
MP	6	5	40	12.8	6	5	1	–	2	6	1	–	–	4

M = males, F = females, SP = schizophrenic psychotics, MP = manic psychotics, LN = low-dose neuroleptics; HN = high-dose neuroleptics, TH = thymoleptics; Lith = lithium; No = no medication.

back on a Revox A-77 2-track tape recorder and were listened to through loudspeakers (Heybrook HB 1, with a Yamaha CA 610 amplifier).

Procedure

The subjects were exposed to one piece of sound at a time in a satisfactorily soundproof room. The sounds were presented in a random order. The mean sound pressure level was approximately 70 dB SPL. A simple clinical test (hearing of whispered numbers at a distance of 3 m) was performed to reveal possible hearing inability of the probands.

After each presentation the probands completed the rating forms to assess their emotional experience. The rating form has been used in earlier studies and it consists of 12 scales with 7 steps. Four of the scales (tense – relaxed, violent – peaceful, hard – soft and threatening – enticing) represent a factor tension – relaxation (factor I), the next four (happy – sad, humorous – serious, impulsive – controlled, active – passive) a factor called gaiety – gloom (factor II) and the remaining four scales (rich – poor, beautiful – disgusting, profound – superficial, clear – diffuse) a factor attraction – repulsion (factor III) [8]. The factor scores may theoretically vary from 4 to 28 in each factor; low scores signify more tension, gaiety and attraction experienced respectively, and high scores the opposite, i.e. more relaxation, gloom and repulsion. The mean time for the rating of all 14 pieces of sound was about 20 min. The rating numbers were transformed into scores of the pertinent experiential factor and these scores constituted the basis for analyses of variance that were later on performed [15]. These analyses were applied between the ratings of the psychotic groups and of the reference group and between the ratings of the psychotic groups.

Subjects

The reference group consisted of 34 healthy females and males. There were 15 women and 19 men and the age range was from 21 to 50 years. No one in the group had a history of neurological or mental disorder, and all were free of medication. Eleven schizophrenics and 11 manic psychotics were included in the study. The schizophrenics and manics were inpatients at the time of testing and the ages ranged from 19 to 55 years (table 3).

The patients were selected at a ward department where classification is made according to ICD 9 [16]. All cases with signs of cognitive impairment or a history of drug or alcohol abuse were excluded. However, groups of schizophrenic psychotics contain several subgroups. In research work dealing with problems of attention in schizophrenia it is presently common to distinguish between positive, negative, and paranoid states [17–22]. With reference to this kind of diagnostic categorization, one would assume that these patients, according to their symptoms, belong to the group of 'positive' schizophrenics. Furthermore, in this case the ward personnel was asked to consider that the schizophrenic psychotic patients suffered from delusions, hallucinations and/or major thought disorders during the onoging episode of the illness. By this definition the diagnosis of these patients corresponds to the criteria of schizophrenic psychotic disorder in DSM-III [23]. The manic patients were selected in a similar way and the ward personnel was asked to ascertain that the patients had demonstrated flight of ideas, physical restlessness, and distractability. All patients took part in the study in accordance with their personal consent. The testing was performed no later than 1 week after admission, but, as may be noted from table 3, sometimes after medication to counteract the acute and often violent symptomatology.

Table 4. Factor I: Tension – relaxation (mean values and standard deviations)

	Sounds						
	1	2	3	4	5	6	7
RG	10.27	18.93	12.68	12.32	17.23	20.66	10.70
SD	4.11	4.82	3.91	4.30	3.48	5.08	3.21
S	8.09	19.09	15.18	7.36	16.00	18.00	12.00
SD	3.92	3.53	4.67	3.88	8.17	6.39	4.53
t value btw. RG/S	−1.60	0.10	1.83	−3.50	−0.77	−1.47	1.90
Significance				0.001			
M	11.64	18.09	14.36	12.00	19.64	20.73	16.36
SD	5.39	4.42	5.52	4.89	6.79	6.26	5.85
t value btw. RG/M	0.92	−0.53	−1.17	−0.21	1.66	0.04	4.36
Significance							0.000
t value btw. S/M	1.75	−0.59	−0.38	2.46	1.13	1.01	1.55
Significance			0.023				

RG = Reference group; S = schizophrenic; M = manic.

Results

The results of the ratings are presented in tables 4 (factor I), 6 (factor II), and 8 (factor III). The results of the two-way analyses of variance of the ratings of perception between all groups and sounds are presented in tables 5, 7, and 9. In a one-way analysis of variance, one group of data, in this case the rating scores of different pieces of sound, is studied to reveal if these represent different populations. In a two-way analysis of variance two groupings of data are compared, in this case two groups of subjects studied as one grouping and the seven sounds as the second grouping. The mean factor scores between the two groups of probands may differ, be higher or lower for all sounds. This is referred to as a 'significant main tendency'. When the scores vary due to differences of the ratings between single sounds, the analysis of variance may result in a significant, so-called 'interaction', independently of whether there is or is no main tendency at the same time.

Table 5. Analyses of variance for factor I

	Betweeen		Interaction	
	F ratio	p	F ratio	p
RG/S	2.465	0.089	3.305	0.004
RG/M	7.556	0.006	1.558	0.158
S/M	6.927	0.009	0.954	0.459

For abbreviations see table 4.

In tables 4, 6, and 8 it can be seen that there is a fairly great difference in the degree of tension, gaiety, and attraction rated of the various sounds (means of factor I varying from 10.27 to 20.66, $F = 34.27$, $p = 0.000$; factor II from 11.34 to 19.33, $F = 15.12$, $p = 0.000$; factor III from 10.43 to 18.66, $F =$

Table 6. Factor II: Gaiety – gloom (mean values and standard deviations)

	Sounds						
	1	2	3	4	5	6	7
G	14.14	19.33	16.07	15.48	11.34	17.27	13.30
SD	3.62	3.50	3.34	4.12	3.44	4.12	3.68
S	14.82	17.00	14.36	16.00	12.46	19.27	12.55
SD	4.10	5.99	3.44	4.63	5.72	3.44	4.28
M	14.72	15.27	17.00	15.27	13.27	16.36	14.00
SD	2.87	4.15	3.85	6.04	4.47	3.98	3.89
t value btw. RG/M	0.50	−3.90	0.80	−0.13	1.57	0.66	0.65
Significance		0.002					

For abbreviation see table 4.

28.98, p = 0.000, one-way analysis of variance). This means that the perception is significantly differentiated due to the various sounds in the reference group. The variation of mean rating scores has a similarly wide range. The psychopathological groups rated certain single pieces in a significantly different way, compared to the reference group. The t values were consequently computed to show which sounds caused the significant main tendency or interaction, once they had been revealed by the analysis of variance.

Table 5 shows the result of analysis of variance for factor I. There is a significant interaction between the reference group and the schizophrenic psychotic group, which is primarily caused by sound number four (see table 4 for t value and significance). The significant main tendencies between the manic psychotic group versus the reference group and the schizophrenic psychotic group are due to the fact that the manic psychotics rate most pieces of sound as more relaxed (higher factor scores) than the latter two groups.

The mean values and standard deviations of the ratings of factor II (gaiety – gloom) are more similar between the groups than in factor I and factor III. As one significant interaction occurred in the analyses of variance of this factor, the t values in question are indicated in table 6.

Table 7. Analyses of variance for factor II

	Between		Interaction	
	F ratio	p	F ratio	P
RG/S	0.016	0.901	1.426	0.203
RG/M	0.083	0.774	2.255	0.038
S/M	0.012	0.913	1.007	0.423

For abbreviations see table 4.

Table 7 the results of the analysis of variance of factor II are presented. Only one significant result appeared, namely the interaction between the reference group and manic psychotics. From table 6 it may be seen that most importantly sound number two contributed to this result. The manic psychotic group rated this piece as more gay.

In table 8 it may be seen that great differences between the groups are at hand. As all

Table 8. Factor III: Attraction – repulsion (mean values and standard deviations)

	Sounds						
	1	2	3	4	5	6	7
RG	16.30	15.16	18.20	17.71	13.66	10.43	18.66
SD	3.00	3.63	3.35	3.02	3.07	3.98	3.87
S	17.73	12.82	17.18	17.64	13.00	12.54	14.27
SD	3.20	4.77	3.80	5.45	5.18	4.23	5.04
t value btw. RG/S	1.40	−1.80	−0.88	−0.06	−0.55	−1.56	−3.16
Significance							0.003
M	13.00	12.00	14.18	13.18	12.00	9.18	13.45
SD	4.84	5.16	4.49	4.21	3.03	3.22	5.60
t value btw. RG/M	−2.86	−2.37	−3.33	−4.09	−1.61	−0.96	−3.63
Significance	0.006	0.022	0.002	0.000			0.001
t value btw. S/M	−2.70	−0.39	−1.69	−2.15	−0.55	−2.10	−0.36
Significance	0.014			0.044		0.049	

For abbreviations see table 4.

subsequent comparisons by analysis of variance became significant the results of consequent t values were computed and are presented in the table.

Table 9 shows the results of the analysis of variance for factor III. The significant interaction between the reference group and the schizophrenic psychotic group means that the schizophrenic psychotic group rated most pieces as more attractive, especially sound number seven (table 8). The significant main tendencies in the rest of the comparisons mean that the manic psychotics rated all pieces of sound as more attractive than the other two groups.

An important information may further be drawn from all tables and figure 1, regarding the resulting relative parallelism of the ratings by the two psychopathological groups. There are no significant interactions between the groups of manic and schizophrenic psychotics in any factor, but significant main tendencies in factors I and III. This means that these groups react similarly to the individual sounds (clearly observable by studying the figures, e.g. the four rated as tense sounds, the two rated as most gay, and the two rated as the most attractive ones). The implication of this observation is commented upon in the last part of the discussion.

Table 9. Analyses of variance for factor III

	Between		Interaction	
	F ratio	p	F ratio	p
RG/S	2.258	0.097	3.167	0.005
RG/M	50.403	0.000	1.382	0.221
S/M	12.712	0.000	0.790	0.579

For abbreviations see table 4.

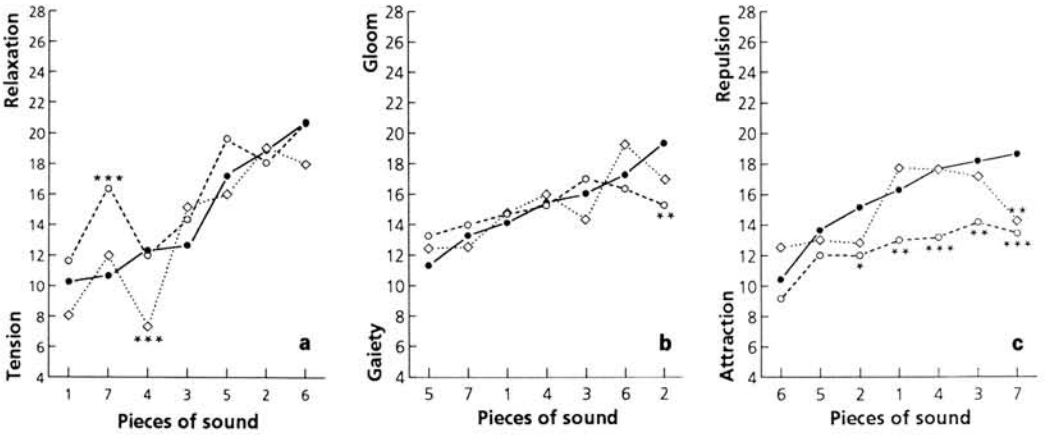

Fig. 1. a–c Mean rating scores for factors I, II, and III. The sounds are ordered according to increasing value of the mean rating scores in the reference group. Significant differences between the psychopathological group and the reference group are marked with stars. Finely dotted line = Schizophrenic psychotic group; coarsely dotted line = manic psychotic group; solid line = reference group. * p = 0.05; ** p = 0.01; *** p = 0.001.

Discussion

The present investigation underlines the fact that short complex sounds give rise to different emotional experiences in two psychopathological groups as compared to a reference group. The responses are assumed to correspond to some aspects related to the symptoms of the diseases. The differences seen in this study could not be revealed in previous studies where excerpts of orchestral music were used as stimuli [8]. It is supposed that shorter stimuli are more easily judged and paid attention to by subjects disturbed by psychopathological symptoms. The shortness of the present stimuli may therefore have contributed to a clearer result. In schizophrenia there is a disturbance of the mental processes of integration. The presence of delusions and hallucinations is accompanied by an emotional insecurity regarding the self and the environment, sometimes making it hard for the patient to evaluate the degree of reality of different percepts. He may become insecure, tense, anxiety-ridden and vague. However, in many cases no emotional disturbance is at hand and the perceptual pathological processes are interpreted as being real by the patient who then is said to lack insight into the pathology.

Manic psychosis is characterized by a number of disturbances of temporal perception, both of relatively long and shorter processes. Similarly physiological regulation mechanisms are changed with symptoms of insomnia, inverted hormonal day and night rhythms, increased appetite etc. as a consequence. The inner tempo is raised, the feeling of well-being, activity and health is strengthened and there is a high level of agitated nervousness and restlessness. Sometimes these patients become irritable, paranoid or aggressive, at other instances they may become euphoric. They are less critical than in their nor-

mal state and flattened in their affectivity, combined with distractability and loss of concentration ability. Their attention is easily drawn to varying external stimuli in contrast to that of schizophrenic psychotics, which is mostly directed inwards or to insignificant details of the perceptive field.

The patients taking part in this study were psychotically ill at the time of testing, but they had no difficulty in understanding the instruction or in judging the emotional impression the sounds induced. If this had been the case the results would have become distributed at random between and within the groups. Their mental functioning seems to be sufficient to handle the rating situation in spite of disturbing pathological symptoms. Only 1 schizophrenic patient was unable to perform the test, but had to postpone it to a later occasion when he had received medication. The question of medication then becomes interesting.

In an earlier study this problem has been investigated for pieces of orchestral music. Neither within normal subjects or depressives receiving thymoleptics nor within schizophrenic psychotics receiving neuroleptics was there found any significant difference for the three factors of emotional experience as compared to a reference group. It may, therefore, not be suspected that in the present instance the medication may play such a great role as to cause the clearly significant results of this study. It has, on the other hand, repeatedly been shown that gross psychopathology causes great differences in music and sound perception, far exceeding factors like medication, education, personality, age, sex, and other background factors [24, 25].

In factor I the group of schizophrenic psychotics shows an interaction with the reference group. Sound number four is rated as more tense by the schizophrenics. It may be supposed that schizophrenic psychotics are especially sensitive to the voice character of the sound as they tend to be frightened at human contacts, but such a hypothesis has to be confirmed by further experiments. The manic psychotic patients show a significant main difference in relation to both the reference group and the group of schizophrenic psychotics in this factor. Their shorter span of concentration ability, carelessness, and euphoria may cause their rating of less tension.

In factor II only one significant difference occurred and no main tendencies. The mood quality in music and sound perception largely depends on dynamic elements of the stimulus. Fast, pulsating tempo, vivid rhythm, and other elements that are associated with dynamic properties, contribute to a happy feeling of the sounds [26]. Sound number two contains a rapid vibrato to which the manic psychotics have responded by rating the piece as more gay. Stein and Thomson [9] have shown that manic psychotics respond in a similar way as normals to music if it has the same tempo as their own inner optimum tempo. But they are unable to correctly estimate both slower and faster tempos. Also, they describe all surrounding processes as being very slow. Further, they fail to rate happy and dynamically rich music as being so [8]. These perceptive characteristics may be related to their raised inner tempo and euphoria. In this case a minute dynamic feature may have appealed to them for similar reasons and caused the ratings of more happiness.

In the factor measuring attractivity (factor III) two significant main tendencies appeared implying that the manic psychotic patients rated all pieces of music as more attractive. When stimulated with long sounds – orchestral pieces of music in the above-mentioned study [8] – manic psychotics rated the stimuli similarly to the subjects of the reference group. In is possible that, by the shortness of the present sounds, the manic psychot-

ics have avoided to be irritated and bored by the stimuli and therefore rated them in accordance with a euphoric affect caused by the illness. The specific features of the sounds such as brightness, complexity etc. seem to have influenced their judgement to a lesser extent compared with the schizophrenic psychotic group who rated the sounds in a more differentiated way [8].

The schizophrenic psychotic group rated in a similar way compared with the reference group in factor III (attraction – repulsion) except for piece number seven. In the abovementioned study of stimulation with orchestral music [8] the schizophrenic psychotics rated pieces with very complex structure as attractive, in contrast to the subjects of the reference group, who found them most repulsive. Similarly, in the present study they find a harsh, irritating, dissonant sound (sound No. 7) beautiful and attractive in contrast to the reference group of normal subjects. According to Arieti [27] the ideal listener 'must be ready to emphatetically endoceive while remaining in auditory contact with the sound source from which the stimuli issue'. The schizophrenic listener may not be an ideal one. As he points out at another place, schizophrenics in a certain stage of their illness are inclined to be exposed to 'fusion, diffusion, and misidentification' [27]. In neurophysiology such particularities of their mental functioning are referred to a postulated deficiency of filtering mechanisms of the nervous system [28, 29]. These patients may in their auditory functioning be accustomed to stimuli of psychotic origin and therefore be abnormally influenced by unusual, odd, and complex external stimuli.

It may be concluded that the stimuli used in this study have been suitable for differentiating the emotional experience of manic and schizophrenic psychotics from a reference group. The emotional experience of the sounds may be related to characteristics of emotional state and symptoms of the respective groups. The second hypothesis of this study, namely that separating experiences between the clinical groups would arise in relation to specific sounds or acoustic elements, has not been confirmed. The psychotic groups responded in parallel ways to the single sounds but at different levels. However, the impressingly deviating ratings by the schizophrenic psychotics of sounds number four and seven could perhaps be taken as a starting point in constructing new sounds – with greater variations in the components of them – in order to be able to bring about qualitatively different reactions.

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