Eur Arch Psychiatry Clin Neurosci (1995) 245:152–158

ORIGINAL PAPER

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Electrodermal and vascular orienting response in schizophrenic patients: relationship to symptoms and medication

Received: 14 July 1994 / Accepted: 16 February 1995

Abstract Peripheral indicators of autonomic nervous system activity, including electrodermal activity and finger-pulse volume, were investigated in 100 schizophrenic inpatients. Healthy siblings of the patients and healthy subjects matched for age and gender served as control groups. Acoustic stimuli (70 dB) were presented and orienting response (OR) parameters were determined independently for the two response systems. The relationship of both OR measures to negative symptoms and medication was studied. The two OR measures were found to be not interrelated, i.e. most of the subjects were discordant with regard to presence or absence of their OR in the two different response systems. The electrodermal, but not the vascular OR, differed between patients and control groups. Among patients receiving medication with anticholinergic effects there were significantly more electrodermal nonresponders than among patients without such medication. There was no indication that electrodermal nonresponders show more negative symptoms or generally more severe psychopathology than electrodermal responders.

Key words Autonomic orienting response · Medication · Schizophrenic patients · Negative symptoms

Introduction

A substantially larger proportion of schizophrenic patients than of healthy subjects (approximately 50%; e.g. Gruzelier and Venables 1972; Bernstein et al. 1982; Dawson et al. 1989) have consistently been found to show no electrodermal orienting responses to mild nonsignal auditory stimuli (nonresponders, or NRs). According to Gruzelier (1976) electrodermal responders are rated by nurses as more manic, anxious, aggressive and belligerent than nonresponders. Straube (1979) and Bernstein et al. (1981) reported electrodermal NRs to have higher ratings on the Brief Psychiatric Rating Scales (BPRS; Overall and Gorham 1962) on emotional withdrawal, conceptual disorganization, motor retardation, depressed mood and affective blunting. While these results indicate that NRs have more negative symptoms than responders, Green and Nuechterlein (1988) and Green et al. (1989) were the first to use scales specifically designed to assess negative vs positive symptoms (SANS and SAPS; Andreasen 1982 and 1983, respectively). They found NRs to be generally more disturbed with regard to both positive and negative symptoms.

Electrodermal nonresponding is not specific to patients with schizophrenic disorder. The proportion of NRs is similar in depressed patients (Bernstein et al. 1988). Bernstein compared schizophrenic and depressed patients and normal controls both with regard to their electrodermal and their vascular (i.e. finger-pulse volume, or FPV) orienting response. Most previous studies had examined only electrodermal OR parameters. Bernstein and coworkers hypothesized that schizophrenic nonresponders are determined by a central deficit of the orienting response, whereas nonresponding in depressed patients might be the effect of peripheral, e.g. cholinergic, mechanisms. In line with this hypothesis schizophrenic patients typically showed consistent orienting deficits in both electrodermal and vascular parameters, whereas depressed patients more often failed to show an electrodermal orienting response while the finger-pulse response was intact. A more recent paper on the same topic (Bernstein et al. 1990) with larger samples replicated these results, confirming that a higher proportion of schizophrenic electrodermal nonresponders (35 of 44; 79%) also failed to give a FPV-OR, whereas only 14 of 41 depressed electrodermal nonresponders (34.1%) and 7 of 19 healthy electrodermal nonresponders (36.8%) were also FPV nonresponders.

Electrodermal nonresponding may reflect a peripheral (cholinergic) deficit, which is caused by medication. Al-

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though various studies reported similar proportions of electrodermal NRs in medicated and unmedicated samples (see Nuechterlein and Dawson 1984; Zahn et al. 1991), indicating that it is not merely a side effect of neuroleptic medication, some drugs may significantly increase the incidence of nonresponding. Considering that acetylcholine is the primary transmitter substance affecting the activation of the sweat glands, such effects are extremely plausible. Drugs applied to reduce the parkinsonian side effects of neuroleptics (benztropines) as well as several neuroleptics (e.g. thioridazine or clozapine) are known to have strong anticholinergic effects. Accordingly, Green and coworkers (1988, 1989) compared patients who received highly anticholinergic medication with another group receiving medication low in its anticholinergic effects. The two subsamples did not differ with regard to symptoms, age, gender or years since first hospitalization; but the proportion of electrodermal nonresponders was significantly higher in the high anticholinergic medication group. The vascular indicator of the OR can be assumed to be uninfluenced by anticholinergic medication, because constriction of blood vessels is controlled by adrenergic and not by cholinergic transmitter substances.

The aim of this study was to shed further light on the association between the failure to show an OR and negative symptoms. Because confounding effects of anticholinergic medication on electrodermal activity have been demonstrated in previous studies, a second indicator of the OR (vascular OR), which is assumed to be independent of these effects, was included and medication was carefully documented for possible anticholinergic effects. To reduce the heterogeneity with regard to possible determinants of negative symptoms we excluded on the one hand patients who were long-term hospitalized, and on the other hand, patients with clearly prevalent positive symptoms, possibly eliciting certain negative symptoms as strategies to cope with these experiences.

Subjects and methods

The results presented here were obtained in an ongoing longitudinal study on the course and the correlates of negative symptoms. Autonomic responsivity was measured as a part of this study, which also includes a number of neuropsychological, neurological and psychopathological assessments not directly associated with the data reported in this paper.

A total of 100 inpatients with a schizophrenic disorder from two psychiatric state hospitals in Germany participated in the study. They were diagnosed according to DSM-III-R criteria on the basis of an interview (Present State Examination; Wing et al. 1973) and of additional anamnestic information. Patients were excluded from the study if they were older than 35 years, if they had been hospitalized for more than 12 months within the previous 2 years or if they had not been engaged in some type of regular occupational or occupation-like activity during the previous year. These criteria served to exclude disabilities arising from prolonged institutionalization or social isolation. Patients with a diagnosed neurological disorder or with mental retardation were also excluded. Patients were tested when acute psychotic symptoms were markedly reduced and discharge from the hospital was being considered.

The mean age of the schizophrenic patients was 27.4 years (SD 4.5 years), and 63% were male. Mean duration of education was 10.6 years (SD 1.6 years). They had been ill for an average of 4.8 years (SD 4.3 years) with a mean total duration of hospitalization of 8.2 months (SD 11.3 months). At the time of testing all except two patients were under neuroleptic medication. The median neuroleptic dosage was 326.5 mg chlorpromazine equivalent (CPE) (Q1–Q3: 200–500 mg CPE). A total of 64 patients were receiving medication with highly anticholinergic effects, including antiparkinsonian medication (n = 17 patients), clozapine (n = 30 patients) standard neuroleptics with strong anticholinergic effects (e.g. chlorpromazine, thioridazine, levomepromazine, perazine; n = 15 patients), or tricyclic antidepressants (n = 2).

A total of 58 healthy volunteers, comparable to the patients with regard to mean age and gender distribution, served as controls. Of these, 54% percent were male, the mean age was 26.8 years (SD 5.6 years) and the mean duration of education was 10.8 years (SD 1.8 years). Subjects were asked if they had suffered any mental illness in the past that had required psychological or psychiatric treatment, or if they were currently seeking help because of mental problems. None of the controls reported any history of psychiatric disorder and/or treatment.

Finally, a group of 40 healthy siblings of our schizophrenic patients were examined. Although all siblings of our patients were asked to participate in the study, many refused. The mean age of the siblings was 26.3 years (SD 5.4 years), 42% were male and mean duration of education was 11.3 years (SD 1.85 years). The screening procedure for psychiatric disorders was identical to that applied with normal controls. None of the siblings reported any history of psychiatric disorder or treatment.

Procedure

Subjects were seated in a comfortable chair. Electrodes were attached and the measurement techniques briefly explained. Subjects were asked to relax and to sit quietly for the next 10–15 min. They were told that a number of tones would be presented at irregular intervals; they should remain as relaxed as possible and not focus their attention on these acoustic events. The experimenter remained in the experimental room sitting next to the subject and controlling the apparatus.

Apparatus and recording methods

Picker (Picker, Munich) (Ag/AgCl) electrodes (6 mm in diameter) filled with hypotonic electrode cream (Unibase with 0.05 M/1 NaCl) were attached to the medial phalanges of the third and fourth fingers of the left hand. Skin conductance was measured by a constant voltage coupler (Rimkus Medizin-Technik, Munich). The FPV was recorded using a transilluminated photoplethysmographic transducer (Zack, Simbach) placed on the second finger of the left hand. Furthermore, respiratory amplitude and frequency was registered using a breathing belt (Zack).

All signals were digitized and stored at a rate of 25 Hz by a personal computer 80386. The experimental session was segmented into 18 "trials", each lasting 10 s, during which data were sampled. In half of the trials a tone was presented, each of which was preceded by a 10 s period without a stimulus serving as a baseline. The onset of both periods was triggered by a respiratory maximum. The baseline thus controlled for respiratory effects in the FPV. A series of nine 500-Hz sine-wave tones of 1 s duration, with an intensity of 70 dB and controlled 25-ms rise and decay times, was presented binaurally over headphones. The interstimulus intervals varied between 30 and 60 s.

Scoring and data reduction

A skin conductance response (SCR-OR) was defined as an increase in conductance of at least 0.025 microSiemens (μS) initiated within 1–2.4 s after stimulus onset (Levinson and Edelberg

1985). Following Bernstein et al. (1990) finger-pulse amplitudes were determined automatically from the first to the seventh second of the baseline. These amplitudes served to predict the pulse amplitudes in the seconds after stimulus presentation. An FPV response was scored when a constriction of at least 2 SD below the predicted amplitude level appeared 1–7 s after the tone. Subjects who failed to respond to either of the first two stimulus presentations where classified as nonresponders.

Psychopathology and negative symptoms

To assess present psychopathology a semistructured interview was conducted with the patients within 1 week of the experimental session. The videotaped interviews of the patients were rated for negative symptoms by two trained psychologists and psychiatrists on three different rating scales: the SANS (Scale for the Assessment of Negative Symptoms; Andreasen and Olsen 1983), the PANSS (Positive and Negative Symptom Scale; Kay et al. 1987) and the BPRS (Brief Psychiatric Rating Scale; Overall and Gorham 1962). The ratings of the 100 schizophrenic patients on these items were submitted to Principal Component Analysis. Three components were extracted and rotated according to VARIMAX criteria, representing different aspects of negative symptoms: (1) Diminished Expression (variance explained by factor: 33%), (2) Social Dysfunction (17%) and (3) Cognitive Disorganization (10%). The factor Diminished Expression is determined by variables describing affective expression and responsiveness of the subjects. Social Dysfunction involves social contact, occupational status, intimacy and closeness, and sexuality. Cognitive Disorganization includes inattentiveness, impaired abstract thinking and poverty of content of speech. A more detailed description of the three factors is presented in Table 1. The following analyses are based on the factor scores of the 100 schizophrenic patients on these three orthogonal components. To allow for comparisons with previous studies autonomic orienting activity was also related to the five BPRS factors (Guy 1976): "Activation", "Hostility/Suspiciousness", "Thought Disturbance", "Anxiety/Depression" and "Anergia".

Medication

The total amount of neuroleptic medication was expressed in CPEs according to a table developed by Gaebel (personal communication), which also included equivalents for clozapine. Anticholinergic effects of medication were specified according to Richelson (1984). Antiparkinsonian drugs, clozapine, thioridazine, chlorpromazine, levomepromazine or perazine were classified as high anticholinergic medication, whereas haloperidol, pimozide, fluphenthixol, benperidol or perphenazine were classified as low anticholinergic medication.

Data analysis

Because electrodermal parameters are likely to be influenced by the menstrual cycle (see e.g. Venables and Christie 1973), male

Table 1 Principal component analysis: items of negative symptoms from SANS, PANSS and BPRS (see text for definitions). Factor loadings of VARIMAX rotated factors

Scale	Items	Diminished expression	Social dysfunction	Cognitive disorganization
SANS	Paucity of expressive gestures	0.82	− 0.02	− 0.05
SANS	Unchanging facial expression	0.76	0.26	0.09
SANS	Decreased spontaneous movements	0.74	− 0.15	− 0.22
SANS	Lack of vocal inflections	0.73	0.14	0.13
SANS	Poverty of speech	0.73	0.31	0.24
SANS	Affective nonresponding	0.69	0.38	0.15
SANS	Poor eye contact	0.65	0.06	0.18
SANS	Reduced relationship friends/peers	0.60	0.49	− 0.10
SANS	Increased latency response	0.40	0.06	0.16
BPRS	Blunted affect	0.88	0.20	0.10
BPRS	Motor retardation	0.80	0.15	0.02
BPRS	Emotional withdrawal	0.71	0.36	0.35
PANSS	Blunted affect	0.87	0.27	0.06
PANSS	Lack of spontaneous conversation	0.74	0.37	0.26
PANSS	Poor rapport	0.65	0.45	0.29
SANS	Grooming and hygiene	− 0.02	0.77	0.03
SANS	Physical anergia	0.44	0.68	0.01
SANS	Reduced recreational interests/activities	0.54	0.65	0.07
SANS	Impersistence at work/school	− 0.14	0.63	− 0.06
SANS	Lack of intimacy and closeness	0.42	0.56	0.03
SANS	Reduced sexual interests/activities	0.34	0.40	− 0.22
BPRS	Self-neglect	0.05	0.70	0.07
PANSS	Emotional withdrawal	0.45	0.68	0.05
PANSS	Passive-apathetic social withdrawal	0.52	0.62	0.04
SANS	Inattention during testing	− 0.04	− 0.10	0.72
SANS	Social inattentiveness	0.29	0.45	0.52
SANS	Reduced content of speech	0.38	0.26	0.41
PANSS	Impaired abstract thinking	0.13	0.01	0.85
Percent of variance explained		32.7%	17.8%	10.3%

NOTE: The following items were excluded from the analysis because of their extremely small variance: SANS Inappropriate Affect, SANS Blocking; BPRS Disorientation, BPRS Distractibility; PANSS Stereotyped Thinking

Table 2 Proportion of electrodermal nonresponders and responders in schizophrenic patients with low and high anticholinergic medication, healthy controls and healthy siblings

	Schizophrenic patients ($n = 90$)	Schizophrenic patients with high anticholinergic medication ($n = 56$)	Schizophrenic patients with low anticholinergic medication ($n = 34$)	Healthy controls ($n = 53$)	Healthy siblings ($n = 33$)
Electrodermal nonresponders	70%	79%	60%	43%	34%
Electrodermal responders	30%	21%	40%	57%	66%

and female subjects were considered separately in the statistical evaluation. When ANOVAs were calculated gender was included as an independent factor. Main effects and interactions for this variable will be reported when significant.

Results

Because of technical failures and/or movement artefacts, data of some subjects were lost. Valid electrodermal *and* finger-pulse-response measures were obtained from 89 schizophrenic patients, 53 healthy controls and 35 healthy siblings of the schizophrenic patients.

Electrodermal nonresponding and its relationship with medication

Of the schizophrenic patients 70% were nonresponders. This proportion is significantly higher than in both control groups ($\chi^2 = 16.7$; $df = 2$; $P < 0.001$; see Table 2 for details). The proportion of electrodermal nonresponders was higher among schizophrenic women than among schizophrenic men (85% compared with 60%; $\chi^2 = 5.44$; $df = 1$; $P < 0.05$). Results were virtually the same when "nonresponding" was more liberally defined covering responses within a larger latency window of 1–5 s after stimulus onset.

The overall amount of neuroleptic medication (mg CPE) did not differ between electrodermal responders and nonresponders ($F(1,91) = 0.00$; $P = 0.99$) or between male and female patients ($F(1,91) = 1.67$), but the proportion of electrodermal NRs in the subgroup of patients receiving medication with high anticholinergic effects was significantly higher (79%) than in the group of patients with low anticholinergic medication (60%; $\chi^2 = 4.03$; $df = 1$; $P < 0.05$).

The proportion of electrodermal NRs among the group *low in anticholinergic medication* (60% NRs) was still higher than the proportion of electrodermal NRs among normal controls (43% NRs; $\chi^2 = 2.06$; $df = 1$; $P = 0.15$) and healthy siblings (35% NRs; $\chi^2 = 4.46$; $P < 0.05$), but only the comparison with the siblings revealed significant differences. For an overview see Table 2. There were slightly more electrodermal nonresponders among patients receiving clozapine than among patients receiving standard neuroleptics ($\chi^2 = 2.7$; $df = 1$; $P = 0.10$). Patients receiving medication with high vs low anticholinergic effects did not differ with regard to age, duration of illness, duration of hospitalization, age of disease onset, negative symptoms or general psychopathology (all Wilcoxon z-values < 1).

Finger-pulse-volume orienting response (FPV-OR)

Table 3 shows the proportion of FPV-OR nonresponders in schizophrenic patients (39%), healthy controls (43%) and healthy siblings (52%). There was no significant difference between the groups ($\chi^2 = 1.60$; $df = 2$). In neither group was there a significant difference between males and females in the proportion of FPV-OR nonresponders ($\chi^2 \leq 0.25$; $df = 1$). For the FPV-ORs no associations were obtained with either amount of medication ($F(1,88) = 0.27$) or anticholinergic effects ($\chi^2 = 0.98$; $df = 1$). The association between ORs in the two modalities (SCR and FPV) was low. When all schizophrenic patients were considered (regardless of medication), a concordance rate of 51% was obtained; when only the 34 patients receiving medication with low anticholinergic effects were considered, the concordance rate was 62% (Fisher Exact $P = 0.08$). The concordance rate of 47% among healthy controls indicates that there is no correlation between the two variables. A higher concordance rate of 71% was found for the healthy siblings of schizophrenic patients ($\chi^2 = 7.44$; $df = 1$; $P < 0.01$). No systematic gender difference could be ascertained.

Table 3 Proportion of vascular nonresponders among schizophrenic patients, healthy controls and healthy siblings

	Schizophrenic patients ($n = 89$)	Healthy controls ($n = 53$)	Healthy siblings ($n = 35$)
Vascular nonresponders	39%	43%	51%
Vascular responders	61%	57%	49%

Negative symptoms, general psychopathology and electrodermal nonresponding

Because of the significant association between the electrodermal OR and medication with anticholinergic effects, we only consider schizophrenic patients low in anticholinergic medication when we examine the association between SC-OR and negative symptoms. The factor scores of the three principle components from clinical ratings of negative symptoms were submitted to separate two-way ANOVAs with the independent factors SC-OR ($df = 1$) and gender ($df = 1$). No significant main effects or interactions were obtained for SC-OR on any of the three components of negative symptoms. There was, however, a slight tendency for electrodermal nonresponding to be associated with higher ratings on "Cognitive Disorganization" ($F = 2.58$; $df = 1/34$; $P = 0.12$).

Several previous studies had used BPRS symptom ratings to compare electrodermal responders and nonresponders. To allow for a better comparison with these studies the five factors of these BPRS ratings (Guy 1976) were submitted to a MANOVA. Neither the main effects for electrodermal nonresponding and gender nor the interaction between the two factors were statistically significant (all F-values ≤ 0.47; $df = 5/27$). Furthermore, when comparisons of electrodermal responders with nonresponders (SCR-OR x gender ANOVAS) were performed for single BPRS items only one significant difference emerged for the item excitement ($F(1/35) = 4.58$; $P < 0.05$), indicating that electrodermal nonresponders received lower ratings there.

Discussion

Our data offer strong support for the notion that electrodermal responsivity can be influenced by medication. Schizophrenic patients receiving medication with high anticholinergic effects are more likely to be electrodermal nonresponders than patients without such medication. This result supports former studies that have already shown that the incidence of electrodermal nonresponding is increased not only by classical "anticholinergics", i.e. congentin, but also by neuroleptics with high anticholinergic potency (e.g. clozapine, thioridazine; Green et al. 1988, 1989; Spohn et al. 1989; Zahn and Pickar 1993). We cannot conclude from our data that electrodermal nonresponding in schizophrenia is simply an artefact of medication, because we did not include a subgroup without neuroleptics. Additionally, we did not directly test the influence of anticholinergic medication by applying a within-subjects-design comparable to that applied by Zahn and Pickar (1993), so that we cannot exclude the effect of sampling variables. Nevertheless, our results emphasize the importance of possible medication effects, necessitating careful control of this effect in future studies on electrodermal abnormalities in clinical populations. When in the present study only the subgroup of schizophrenic patients with low anticholinergic medication was considered, the incidence of electrodermal nonresponding was still higher than in siblings and in controls, although the comparison with the latter group only approached statistical significance. Most likely, this failure can be accounted for by the higher-than-typical rate of nonresponding among the controls (cf. e.g. Bernstein et al. 1982). Because we did not assess mental status of the healthy control groups more systematically, we cannot exclude the possibility that we underestimated psychopathology in these groups. But it seems unlikely that this accounts for the high nonresponder rates in normal controls.

We generally found considerably higher nonresponder rates than the majority of previous studies. We cannot offer an explanation for this result, because the characteristics of our stimulus as well as our recording procedures were comparable with other studies (e.g. Bernstein et al. 1982). Furthermore, it seems unlikely that some undetected failure of the apparatus is responsible for the discrepancies: Our measurements were carried out in two different hospitals and we did not find any differences between the two centres in nonresponder rates ($\chi^2 = 0.69$; $P = 0.41$). Also, there are other studies that obtained higher-than-usual nonresponder rates in both patients (Katsanis and Iacono 1994) and controls (Dawson et al. 1992).

According to expectations the vascular OR, which is assumed to be strictly adrenergic was uninfluenced by anticholinergic medication. The vascular OR did not differentiate schizophrenic patients from the control group. There were approximately 40% vascular nonresponders in both investigated groups. This is at variance with findings of Bernstein et al. (1981, 1988), who reported approximately 70% FPV nonresponders schiyophrenic patients in contrast to approximately 15–25% FPV nonresponders among normal controls. Öhman et al. (1989) found that the FPV-OR recorded from the left hands, but not the right hand, separated schizophrenic patients from controls, a striking lateral assymmetry that was not reported by the study of Bernstein et al. (1981).

Furthermore, our data do not replicate the finding of Bernstein et al. (1988, 1990) that electrodermal nonresponding is closely associated with FPV nonresponding in schizophrenic patients. Close to 50% of our investigated subjects were discordant with regard to presence or absence of an electrodermal or vascular OR, whereas Bernstein et al. (1990) reported only approximately 30% discordance among both schizophrenic and normal subjects. The only subgroup from their study that reaches our figures with regard to discordant nonresponding was the group of depressed patients, for whom the authors postulated a peripheral (cholinergic) deficit that should explain the increased number of electrodermal, but not vascular, nonresponding. For the subgroup of schizophrenic patients who received medication with low anticholinergic effects, the concordance rate between the two measures increased to some degree (from 50% [$n = 89$] to 62% [$n = 35$]), although the correlation does not reach statistical significance. Low correlations between different autonomic response systems have been reported previously by other authors (Furedy and Gagnon 1969; Bernstein et al.

1971; Bernstein et al. 1981; Öhman et al. 1989). These results indicate that SCOR and FPV-OR tap essentially independent components of the OR. Such an interpretation is supported by our finding with the healthy control group, in whom the concordance rate was very low as well. In summary, the conflicting evidence on the degree of concordance between electrodermal and cardiovascular measures of the OR in the literature makes it difficult to interpret the results of the present investigation.

The primary goal of this study was to further investigate the relationship of autonomic nonresponding with symptomatology especially with negative symptoms. We did not find an association between negative symptoms and electrodermal nonresponding. None of our three orthogonal factors of negative symptoms differentiated between electrodermal nonresponders and responders, even when medication was controlled for anticholinergic effects. These data are inconsistent with results obtained by Bernstein et al. (1981) and Straube (1979), who found distinctively high levels of emotional withdrawal for electrodermal nonresponders. One reason for this discrepancy might be that patients investigated by Bernstein et al. (1981) were exclusively chronic schizophrenics who were on average 5 years older than the patients examined in the present study. Our study excluded the most chronic deficit cases, a procedure that might have narrowed the variance of negative symptomatology in the investigated sample. It should be noted, however, that the patients investigated by Straube (1979) were comparable to our sample with regard to age and duration of illness. Neither of the two previous studies used scales specifically designed to assess negative symptoms, which is a methodological difference to the present study that might also account for the varying results. Green et al. (1989) using rating scales for both positive and negative symptoms (Andreasen 1981, 1983), investigated a group of 75 schizophrenic patients and failed to demonstrate a significant association between negative symptoms and electrodermal nonresponding. If anything, electrodermal nonresponding tended to be related to general symptom severity in the Green et al. study, but the results were not statistically reliable. Additionally, Katsanis and Iacono (1994) investigating chronic schizophrenic patients did not find an association between habituation rate (85 dB) and the SANS total score. In the present study the only significant association with symptoms was found for the BPRS item excitement, which is in line with results reported by Dawson et al. (1992) for inpatient BPRS ratings.

In summary, the present results indicate that various autonomic measures are independent indicators of the OR. A failure to show an electrodermal OR is not necessarily an indicator of a general OR deficit as Bernstein et al. (1988, 1990) have already shown for depressed patients. Secondly, electrodermal activity seems to be influenced by medication with anticholinergic effects. The validity of electrodermal measures may therefore be seriously impaired when schizophrenic patients are studied under neuroleptic medication. Thirdly, the present data do not support the assumption that electrodermal nonresponders have more negative symptoms than responders.

Acknowledgement This research was supported by the Bundesministerium für Forschung und Technologie, Federal Republic of Germany.

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