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Social cognitive bias and neurocognitive deficit in paranoid symptoms: evidence for an interaction effect and changes during treatment

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Abstract

Persistent paranoid symptoms are best understood as having multiple causal mechanisms. An enhanced multidimensional understanding of paranoia may result from the convergence of two distinct measurement paradigms, experimental psychopathology and social cognitive research. This study investigated the role of neurocognitive deficits and emotion misperception bias as they relate to paranoid symptoms at two different time points in a sample of individuals with severe mental illness (primarily schizophrenia spectrum disorders [$N = 91$]) undergoing intensive psychosocial rehabilitation. Before intensive rehabilitation (but after initial stabilization), paranoid symptoms were related to a tendency to misperceive emotion as disgust. The impact of this social cognitive bias was amplified by perseveration (as measured by the COGLAB Card Sorting Task). Perseverative errors were associated with paranoid symptoms at both time points. After 6 months of treatment, there were significant reductions in paranoid symptoms and perseverative errors but no significant changes in emotion misperception biases. This study is one of few to date to evaluate the contribution of both neurocognitive deficits and social cognitive biases to paranoid symptoms. The results demonstrate how social cognitive biases can interact with neurocognitive deficits in expression of paranoid symptoms, and how these relationships change during treatment.

Keywords: Paranoid symptoms; Social cognition; Neurocognition; Emotion bias; Perseveration

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1. Introduction

Several aberrant cognitive processes are implicated in paranoid symptoms.[1] These include disrupted processes at neurocognitive (e.g., McCormick and Broekema, 1978; Spaulding et al., 1999a) and social cognitive levels (e.g., Bentall et al., 2001; Randall et al., 2003; Smari et al., 1994). Disruptions in these processes may result from a *deficit* (e.g., poor attention), a *bias* (e.g., an exaggerated attribution style; see Penn et al., 1997; Pinkham et al., 2003) or a combination of the two.

Reasoning abilities (e.g., inductive and probabilistic reasoning) play a crucial role in social cognitive tasks involving person perception, attributions and related abilities with which individuals with paranoid symptoms demonstrate difficulties (Bentall et al., 2001). Garety and Freeman (1999) and Mujica-Parodi et al. (2000) reported that, on reasoning tasks, individuals with paranoid symptoms demonstrate a tendency to "jump to conclusions" (JTC), not seek counter examples, and make stronger judgments of certainty about their responses. These abnormalities are more pronounced when reasoning tasks involve emotional material (Mujica-Parodi et al., 2000; Young and Bentall, 1997).

There are striking parallels between the JTC response pattern and experimental psychopathology research on information processing anomalies in paranoid symptoms (McCormick and Broekema, 1978; McDowell et al., 1975). A JTC response pattern in part may explain how perseverative errors on the Wisconsin Card Sorting Task (WCST) are related to severity of paranoid symptoms (Spaulding, 1978; Spaulding et al., 1999a).[2] Perseverative errors result from a failure to correct a conclusion about a sorting rule with additional information and feedback. This research generally suggests "paranoids rely on a rigid conceptual process without adequate constraint from perceptual data" (Magaro, 1981, p. 650). Such cognitive rigidity is consistent with the inflexibility associated with paranoid symptoms and the conviction with which paranoid delusions are held (Cromwell and Pithers, 1981; Spaulding, 1978; Spaulding et al., 1999a).

Examples of social cognitive biases in paranoid symptoms include exaggerated tendencies to attribute positive events to oneself and negative events to other *people* as opposed to situations (i.e., a self-serving and personalizing bias; Kinderman and Bentall, 1997). Individuals with paranoid symptoms also evaluate others more negatively and believe others hold more negative evaluations of them (Chadwick and Trower, 1997), judge pictures of facial emotion as more angry (Smari et al., 1994) and express more unfavorable feelings about pictures of faces (Izard, 1959). These findings suggest a "tendency to exaggerate, distort or selectively focus on the hostile or threatening aspects of others" (Fenigstein, 1997, p. 91).

Research into the construct of hostility sheds further light on these findings. Hostility is associated with "negative beliefs about others" and "attributional biases that make it more likely that the behavior of others will be interpreted as antagonistic or threatening" (Barefoot, 1992, p. 14). Key emotions associated with hostility include anger, disgust and contempt (Barefoot, 1992; Izard, 1991; Brummett et al., 1998). Arguably, hostility in paranoia involves a tendency to misperceive emotion seen in others as anger, disgust or contempt. In turn, the evidence for perseveration and executive functioning deficits suggests that the misperception of emotion would be exacerbated by a rigid cognitive style. That is, cognitive rigidity could contribute to persistent beliefs and misperceptions that would normally be corrected by further information.

Previous research has evaluated the accuracy of emotion perception in paranoia (e.g., Davis and Gibson, 2000; Larusso, 1978; Lewis and Garver, 1995) as distinct from biases. The latter are usually studied by analyzing patterns of emotion perception errors (see Kohler et al., 2003; Mandal et al., 1998). Both factors may contribute to paranoid symptoms, but the focus of the present study is on emotion misperception bias.

[1] Although previous work has primarily focused on the paranoid subtype, recent papers have identified methodological concerns with use of the paranoid subtype as a categorical independent variable (Salinas et al., 2002; Zalewski et al., 1998). Consistent with a continuum model of paranoia (van Os and Verdoux, 2003) the present study analyzes paranoid symptoms as a continuous variable.

[2] The criterion of "perseverative errors" in this context is consecutive responses previously correct that are incorrect after a category modulation. This is different from the criterion in common use (Heaton, 1981), but was the original criterion in early WCST research.

The purpose of the present study is to investigate the role of a rigid cognitive style and emotion misperception bias as they relate to paranoid symptoms in a sample of individuals with severe mental illness (schizophrenia spectrum disorders). The sample was engaged in a rehabilitation outcome study that included longitudinal assessment data, allowing for evaluation of how variables changed with treatment and rehabilitation (Spaulding et al., 1999b). Using responses from an emotion recognition task, anger and disgust misperceptions (i.e., the tendency to respond with "anger" or "disgust" when making an error) were used as an index of social cognitive bias. These emotions are associated with hostility (Izard, 1991) and these response biases are hypothesized to reflect social cognitive biases associated with paranoid symptoms as they represent interpersonally threatening emotion (i.e., displaying "anger" or "disgust" toward the participant). The study hypotheses are:

1. Perseverative errors, as well as anger and disgust misperception, are associated with paranoid symptoms at time 1 and time 2.
2. The interaction of perseverative errors and emotion misperception account for additional variance in paranoid symptoms, and this interaction is unique to paranoid symptoms, as opposed to other symptoms.
3. Interrelationships between the measures of interest change as paranoid symptoms decrease in response to treatment and rehabilitation.

2. Subjects and method

2.1. Sample

Data from 91 participants with severe mental illness (primarily schizophrenia spectrum disorders) in a controlled treatment and outcome study (Spaulding et al., 1999b) were analyzed in the present study. This sample represents a severe and treatment refractory subpopulation. Diagnoses were made using the Structured Clinical Interview for DSM-III-R-Patient Edition (SCID; Spitzer et al., 1990) by a psychiatrist formally trained on this instrument. Table 1 shows the participant demographics and clinical characteristics for the present analyses.

Table 1
Descriptive statistics for sample

Demographic and clinical characteristics	*N*	%	
Gender (male/female)	56/35	61.5/38.5	
Race/ethnicity			
Caucasian	80	88	
African American	9	10	
Hispanic	1	1	
Native American	1	1	
DSM diagnosis			
Schizophrenia, undifferentiated type	38	42	
Schizophrenia, paranoid type	26	29	
Schizoaffective disorder	10	11	
Schizophrenia, disorganized type	4	4.4	
Psychosis, NOS	6	6.6	
Bipolar disorder	2	2	
Other DSM disorder	4	4	
	Mean	S.D.	Range
Age (years)	35.7	9.7	18.6–71.6
Education (years)	11.9	2.0	6–17
Chlorpromazine equivalent daily dosage[a]	1639.25	1822.43	0–7650

[a] Although this dosage appears unusually high, none of the participants were determined to be obtunded or overmedicated by the treating psychiatrist or the consulting research psychiatrist (Spaulding et al., 1999b).

2.2. Treatment program and measures

In the original outcome study, participants were randomly assigned to a cognitive therapy intervention or a control condition (supportive therapy). All participants were involved in a comprehensive psychiatric rehabilitation program. Assessments were administered by research staff trained to criterion levels of inter-rater reliability. This study analyzed data collected after initial stabilization (time 1) and after 6 months of intensive treatment and rehabilitation (time 2).

To evaluate symptoms, the Brief Psychiatric Rating Scale-Expanded Version (BPRS-E; Lukoff et al., 1986) was used. Factor analyses have yielded four and five factor solutions of symptom items that include a paranoid factor (e.g., Guy, 1976). In the current sample, a similar paranoid factor was derived using a standard principal components analysis of BPRS-E items (Spaulding et al., 1999b). The paranoid factor score was the primary measure of interest. Items loading on the paranoid factor included: hostility, suspiciousness, uncooperativness, tension and excitement.

To assess cognitive rigidity, the COGLAB Card Sorting Task (Spaulding et al., 1989) was used. This computer task is a modification of the WCST and has been used extensively in psychopathology research though less extensively than the Heaton (1981) version. The number of perseverative errors was used as an index of cognitive rigidity (Spaulding, 1978; Spaulding et al., 1986).

To measure emotion misperception bias, the Ekman and Friesen (1976) facial affect slides were used. This measure consists of 110 slides that depict six emotion types (happy, sad, fear, anger, surprise, disgust or neutral). Based on reliability studies, all slides were judged to show the intended emotion by at least 70% of two samples of college students (Ekman and Friesen, 1976). Based on errors, misperceptions for anger and disgust were tabulated and the proportion of each type of misperception was calculated (i.e., the percentage of total misperceptions which were "disgust" or "anger" misperceptions). For example, if a participant selected "disgust" instead of the correct response, this was counted as a "disgust" misperception. Table 2 shows the means and standard deviations for the preceding measures.

Table 2
Descriptive statistics for measures at time 1

Measure	Mean	S.D.	Range
BPRS-E total symptoms score	43.9	9.71	20–68
BPRS-E paranoid factor score[a]	9.48	3.3	5.1–18.2
Suspiciousness item	1.56	0.78	1–4
Hostility item	2.72	1.40	1–6
Uncooperativeness item	1.56	0.98	1–5
Tension item	2.39	0.95	1–5
Excitement item	1.73	1.07	1–5
COGLAB perseverative errors[a]	19.72	10.75	3–46
Percentage anger misperceptions[a]	19.01	13.1	0–51.3
Percentage disgust misperceptions	21.59	13.01	0–53.9

BPRS-E = Brief Psychiatric Rating Scale-Expanded.
[a] Reflects values after data cleaning procedures.

Table 3
Correlations between emotion misperceptions, perseverative errors and paranoid factor scores at time 1 and time 2 ($N = 79$)

	Paranoid factor score
Time 1	
Disgust misperceptions	0.22 (0.05)
Anger misperceptions	– 0.06 (0.60)
Perseverative errors	0.20 (0.08)
Time 2	
Disgust misperceptions	0.01 (0.92)
Anger misperceptions	0.06 (0.59)
Perseverative errors	0.27 (0.02)

Correlations with p values in parentheses.

2.3. Statistical analyses

The data was screened for outliers using Tukey's hinges and, when possible, outliers were included after a windsorizing procedure (Hoaglin et al., 1983). Following data cleaning, all variables had acceptable skewness statistics (< 1.0). Using SPSS version 11.5, correlations, multiple regression analyses and repeated-measures ANOVA were conducted. New variables representing interaction terms were computed by multiplying the raw scores of the variables of interest (e.g., perseverative errors and anger misperceptions) and used in subsequent regression analyses.

3. Results

3.1. Correlations

As seen in Table 3, at time 1, disgust misperceptions were significantly correlated with the paranoid factor score and the correlation between perseverative errors and paranoid factor scores approached statistical significance. Contrary to hypothesis, the correlation between anger misperceptions and paranoid factor scores was not significant. At time 2, perseverative errors were significantly correlated with paranoid factor scores; however, anger and disgust misperceptions were not. Time 1 perseverative errors were significantly correlated with time 2 paranoid factor scores ($r(71)=0.27$, $p=0.02$) which further supports the relationship between perseverative errors and paranoid factor scores.

3.2. Analyses at time 1

To assess the unique effect of these variables and their interactions on paranoid symptoms, the paranoid factor score was regressed onto perseverative errors, disgust misperceptions and their interaction in a stepwise fashion. This stepwise analysis compares a main effects model (individual variables only) to a full model (individual variables and their interaction) such that the effect of the interaction can be determined by the R^2 change and F change statistics. As predicted, the interaction term of perseverative errors and disgust misperceptions accounted for additional variance in paranoid factor scores (R^2 change = 0.08, F change = 6.46, $p=0.01$). As shown in Table 4, regression weights in the full model demonstrate that the individual variables and the interaction term were significant predictors. Evaluation of the pattern of the interaction reveals that with higher cognitive rigidity there was a positive linear relationship between disgust misperceptions and paranoid symptoms ($\beta=0.6$, $t=3.19$, $p<0.01$). Conversely, with lower cognitive rigidity there was no relationship between disgust misattributions and paranoia ($\beta=0.009$, $t=0.07$, $p=0.95$).[3] The same analysis was repeated substituting anger misperception scores for disgust. Results of this analysis failed to support the hypotheses of the study (see Table 4).

To verify that the observed pattern of results were unique to paranoid symptoms, multiple regression analyses were repeated using the other BPRS-E symptom factor scores as criterion variables (disorganization, blunted affect, anxiety/depression and hallucinations/delusions). None were significant.

Table 4
Summary of two multiple regression analyses for variables predicting paranoid factor scores at time 1 ($N=72$)

Variable	β	$t(p)$
Step 1 (Adjusted $R^2=0.07$, $F=3.53$, $p=0.04$)		
Perseverative errors	0.21	1.82 (0.07)
Disgust misperceptions	0.21	1.86 (0.07)
Step 2[a] (Adjusted $R^2=0.13$, $F=4.7$, $p=0.005$)		
Perseverative errors (PE)	0.23	2.12 (0.04)
Disgust misattributions (DM)	0.31	2.63 (0.01)
PE × DM	0.30	2.54 (0.01)
Step 1 (Adjusted $R^2=0.03$, $F=2.13$, $p=0.13$)		
Perseverative errors	0.24	2.04 (0.05)
Anger misattributions	−0.07	−0.55 (0.59)
Step 2[b] (Adjusted $R^2=0.02$, $F=1.5$, $p=0.22$)		
Perseverative errors (PE)	0.25	2.08 (0.04)
Anger misattributions (AM)	−0.07	−0.54 (0.59)
PE × AM	0.06	0.52 (0.61)

[a] $\Delta R^2=0.08$, $\Delta F=6.46$, $p=0.01$.
[b] $\Delta R^2=0.004$, $\Delta F=0.27$, $p=0.61$.

3.3. Analyses at time 2

To assess the impact of treatment on the above relationships, the same multiple regression analyses were repeated using time 2 data. As seen in Table 5, the overall model using anger misperceptions was significant and the overall model using disgust misperceptions approached significance. However, the regression weights indicate that only perseverative errors significantly contributed to both models, whereas emotion misperceptions or the interaction terms did not. As a post hoc analysis, time 2 paranoid factor scores were regressed onto predictors from the significant time 1 model. The overall model was significant (see Table 5). Time 1 perseverative errors predicted time 2 paranoid symptoms. The interaction between perseverative errors and disgust misperceptions was in the expected direction, though not significant; disgust misperceptions alone did not contribute significantly.

[3] This procedure (see Aiken and West, 1991) tests whether simple regression slopes of disgust misperceptions and paranoid symptoms are significantly different from zero at different levels of perseverative errors. Perseverative errors were “recentered” around a point one standard deviation above the mean for the first analysis and one standard deviation below the mean for the second analysis. New interaction terms were then computed based on the “recentered” variables. Paranoid factor scores were then regressed onto the “recentered” perseverative errors, disgust misperceptions, and the new interaction term. The β weights and subsequent significance test allows one to compare how the relationship between disgust misperceptions and paranoid symptoms differs at different levels of perseverative errors.

Table 5
Summary of three multiple regression analyses for variables predicting paranoid factor scores at time 2 ($N=74$)

Variable	β	$t(p)$
Full Model (Adjusted $R^2=0.05$, $F=2.39$, $p=0.08$)		
Time 2 perseverative errors (PE)	0.29	2.52 (0.01)
Time 2 disgust misperceptions (DM)	0.02	− 0.17 (0.87)
Time 2 PE × DM	− 0.14	− 1.20 (0.23)
Full Model (Adjusted $R^2=0.07$, $F=2.87$, $p=0.04$)		
Time 2 perseverative errors (PE)	0.33	2.79 (0.01)
Time 2 anger misperceptions (AM)	0.15	1.27 (0.21)
Time 2 PE × AM	0.15	1.29 (0.20)
Full Model[a] (Adjusted $R^2=0.07$, $F=2.87$, $p=0.04$)		
Time 1 perseverative errors (PE)	0.30	2.57 (0.01)
Time 1 disgust misattributions (DM)	0.08	0.66 (0.51)
Time 1 PE × DM	0.20	1.68 (0.10)

Only full models are reported here as none of the ΔR^2 scores were significant.
[a] This model used significant predictors from time 1 (perseverative errors, disgust misperceptions and their interaction) to predict paranoid factor scores at time 2.

Finally, because of the previous finding of a reduction in paranoid symptoms with this sample during the 6-month treatment period (Spaulding et al., 1999b), a 2 (experimental condition) × 2 (time 1 and time 2) repeated-measures ANOVA was used to determine how other variables changed as a result of treatment. There was a significant main effect for time ($F(4,63)=5.4$, $p=0.01$) but not for condition ($F(4,63)=0.74$, $p=0.57$) or the time × condition interaction ($F(4,63)=0.68$, $p=0.61$). There was a significant reduction in perseverative errors from time 1 to time 2 ($F(1,66)=7.71$, $p=0.01$), but there were no significant changes in disgust or anger misperceptions ($F(1,66)=0.08$, $p=0.77$ and $F(1,66)=0.10$, $p=0.75$, respectively). Thus, there were experiment-wide reductions in perseverative errors and paranoid symptoms, but no differential treatment effect for these changes as evidenced by the nonsignificant interaction term.

4. Discussion

The present study represents an integration of social cognitive and experimental psychopathology research paradigms in paranoid symptomatology and yields findings consistent with both lines of research. Results replicate previous findings concerning the relationship between cognitive rigidity and paranoid symptoms (Spaulding, 1978; Spaulding et al., 1986, 1999a). Perseverative errors predicted paranoid symptoms before and after 6 months of intensive treatment and rehabilitation. In addition, time 1 perseverative errors also predicted time 2 paranoid symptoms. Finally, perseverative errors and paranoid symptoms both showed a reduction across treatment.[4]

At the social cognitive level, there is evidence of a biased misperception of emotion, although inconsistent across time. As predicted, at time 1, paranoid symptoms were related to a tendency to misperceive emotion as disgust. This finding is consistent with current social cognitive theories that use a schema-based understanding of paranoid symptoms (Bentall et al., 2001; Chadwick and Trower, 1997; Fenigstein, 1997). Thus, disgust misperceptions reflect biased beliefs about others' evaluations of the perceiver. Bentall et al. (2001, p. 1169), suggest these biased beliefs are a "default option" and utilized particularly when an individual experiences cognitive strain.

Contrary to hypothesis, anger misperceptions were not associated with paranoid symptoms. Emotion literature suggests considerable overlap between anger and disgust (Izard, 1991; Nabi, 2002); however, anger is more indicative of behavioral intention than disgust (Horstmann, 2003). Anger may represent a physical threat and disgust an emotional threat, consistent with negative self-evaluations underlying paranoid attributions (e.g., Bentall et al., 2001; Chadwick and Trower, 1997).

While social cognitive biases make a modest contribution to paranoid factor scores at time 1, their impact is amplified by cognitive rigidity as evidenced by the significance of the interaction of perseverative errors and disgust misperceptions. This finding resonates with evidence suggesting that paranoid symptoms are associated with cognitive rigidity that may result from a neurocognitive deficit (i.e., poor set shifting; Spaulding et al., 1999a) and a low tolerance for ambiguity (Bentall et al., 2001; Magaro, 1981).

[4] The 6-month interval between COGLAB assessments and no evidence of practice effects in previous studies makes practice or familiarity artifact highly unlikely.

Therefore, with greater cognitive rigidity, individuals with paranoid symptoms are more likely to "jump" to the conclusion that the displayed emotion was "disgust," consistent with their paranoid schema. Results of this study may have been impacted by the use of an emotion task as JTC reasoning deficits in paranoid symptoms are more pronounced when reasoning tasks involve affect-laden material (Mujica-Parodi et al., 2000).

This emotion misperception bias may also interfere with accurate emotion perception. While some research indicates that individuals with the paranoid subtype are generally more accurate on emotion perception tasks (e.g., Lewis and Garver, 1995), understanding paranoid symptoms as a continuous dimension reveals that individuals with more severe symptoms in fact show poorer emotion perception (Combs et al., 2004). As a post hoc analysis, one-way ANOVAs were used to determine how paranoid symptoms related to overall accuracy on the emotion perception task. Based on median splits of the paranoid factor scores at times 1 and 2, high and low paranoid groups were formed. Consistent with Combs et al. (2004), at both time points, those high in paranoid symptoms performed worse on the emotion recognition task than those low in paranoia ($F(1,72) = 136.04$, $p < 0.001$ and $F(1,77) = 156.69$, $p < 0.001$ respectively).

The fact that the relationship between emotion misperception biases and paranoid symptoms was not consistent across time is congruent with current social cognitive models of paranoid symptoms. Social cognitive processes implicated in paranoid symptoms represent "dynamic" constructs as opposed to "stable trait[s]" (Bentall et al., 2001, pp. 1166–1167). As such, the present data suggest that social cognitive biases may fluctuate in a less consistent manner than perseveration during treatment due to their more dynamic, or state-like, nature. Furthermore, the fact social cognitive bias is a significant predictor at time 1, where mean paranoid factor scores are higher, suggests that this type of bias is state-like and more apparent during greater symptom exacerbation. In contrast, the stability of the relationship between perseveration and paranoid symptoms may reflect a more trait-like construct.

Given that paranoia in this sample represent chronic medication resistant symptoms, future studies should evaluate how cognitive rigidity and emotion misperception bias are related to acute paranoid symptoms. Regarding treatment implications, future research should evaluate how variables change as a result of social cognitive level interventions targeting paranoid symptoms (e.g., CBT). Given CBTs focus on modifying false beliefs, one would predict change in emotion misperception bias. However, change may be dependent on individuals' level of cognitive flexibility, which is a positive prognostic factor in CBT interventions (Garety et al., 2000). Given the reductions in perseverative errors as a result of intensive psychosocial rehabilitation, combining these interventions may result in increased effectiveness in treating paranoid symptoms. Finally, future studies with greater power and more frequent assessments are needed to detect effects of psychosocial interventions on social cognition, neurocognition, symptoms and their interrelationships. Larger longitudinal studies could also identify subpopulations of individuals with paranoid symptoms who differ in social cognitive and neurocognitive profiles and patterns of change over time.

The present study has several limitations. First, the emotion misperceptions were derived post hoc. This is an arguably valid index of social cognitive bias but other more sensitive affect bias measures exist (e.g., facial affect dot probe task; Mogg and Bradley, 1998). Second, the variables of interest were operationalized using single measures (i.e., perseverative errors, emotion misperceptions, and paranoid factor scores). Future studies should include multiple measures to assess cognitive rigidity, symptoms and social cognitive bias. Third, the results are interpreted based on hypotheses about attribution biases associated with paranoid symptoms; these biases were not actually measured and thus their contribution to the observed relationships can only be inferred. The predictions about emotion were partially informed by the construct of hostility. Hostility was not directly measured in this study, although the paranoid factor score did include a hostility item. Future studies should include measures to directly assess the relationship between these constructs and emotion misperception bias.

The current study is one of the few studies to date to evaluate the contribution of both neurocognitive deficits and social cognitive biases to paranoid symptoms and how they vary over time. It demonstrates that there is a robust relationship between perseveration and paranoid symptoms and that social cognitive biases can interact with neurocognitive deficits in the manifestation of paranoid symptoms. This interaction was unique to paranoid symptoms and is consistent with predictions from both experimental psychopathology and social cognitive research paradigms.

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