Hidden covariation detection produces faster, not slower, social judgments

BARKER, Lynne <http://orcid.org/0000-0002-5526-4148> and ANDRADE, Jackie

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Hidden Co-variation Detection produces faster, not slower, social judgements? *Lynne A. Barker & *Jackie Andrade

* University of Sheffield

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Corresponding Author:

Dr L. A. Barker

Department of Psychology

University of Sheffield

Western Bank

S10 2TP

Email: l.a.barker@Sheffield.ac.uk, Tel: +44 114 222 6520

From the 1st of February Lynne Barker can be contacted at:

Psychology group

School of Social Science and Law

Sheffield Hallam University

Collegiate Crescent Campus

S10 2BP, Tel: +44 114 225 2543

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ABSTRACT

In Lewicki's (1986a) demonstration of Hidden Co-variation Detection (HCD), responses were slower to faces that corresponded with a co-variation encountered previously than to faces with novel co-variations. This slowing contrasts with the typical finding that priming leads to faster responding, and might suggest that HCD is a unique type of implicit process. We extended Lewicki's (1986a) methodology and showed that participants exposed to non-salient co-variations between hair length and personality were subsequently faster to respond to faces with those co-variations than to faces without, despite lack of awareness of the critical co-variations. This result confirms that people can detect subtle relationships between features of stimuli and that, as with other types of implicit cognition, this detection facilitates responding.

Co-variation, implicit, non-conscious, social judgement.

INTRODUCTION

In a series of studies, Lewicki demonstrated that individuals detect subtle relationships between features of stimuli without concurrent awareness of what is being learned, even when those features are not overtly relevant to the task in hand (1986a, 1986b; Hill, Lewicki, Czyzewska & Schuller, 1990; Lewicki, Hill & Czyzewska, 1994; Lewicki, Hill and Czyzewska, 1997). Lewicki (1986a) argued that this Hidden Co-variation Detection (HCD) plays a central role in social cognition and may be thought of as a non-verbalisable algorithm that biases social judgements. There is, however, debate about whether HCD represents a unique cognitive process, as Lewicki implied, or whether it is simply another example of implicit learning (Hendrickx, De Houwer, Baeyens, Eelen & Van Avermaet, 1997; Hoffmann & Sebald, 2005); the present study addresses this.

In the Lewicki (1986a) HCD study, the hair length of stimulus faces co-varied with a particular personality trait, kindness or capability. At test participants were slower to decide whether for instance, someone with short hair was kind, if people with short hair had been previously associated with kindness. Lewicki (1986a) interpreted this result on the basis of a 'question-answering' model (Glucksberg & McCloskey, 1981), whereby responses are slower when people have relevant information in memory to search rather than when there is no information relevant to the question.

This interpretation distinguishes HCD from other priming effects, for example Serial Reaction Time learning (Nissen & Bullemer, 1987; Nissen, Willingham, & Hartman, 1989) or artificial grammar learning (Reber, 1967; 1969), where priming is associated with preferential processing and results in faster or more accurate responses. Moreover this interpretation also differentiates the hair/trait HCD task from other HCD tasks where faster responses to crucial stimuli are an index of learning (Lewicki, Czyzewska and Hoffman, 1987). The 'question-answering' model (Glucksberg & McCloskey, 1981) adopted by Lewicki (1986a) deals with memory search for declarative knowledge, so we question its applicability to implicit processing. The current study improved upon Lewicki's (1986a) original stimuli and methods to investigate whether HCD with social stimuli is a distinct process or an example of 'normal' priming.

Some studies have found it difficult to capture HCD effects (Hendrickx et al, 1997) whilst others suggest that co-variation learning makes demands upon attentional processes (Hoffmann & Sebald, 2005). Stamov-Roßnagel (2001) found evidence for the implicit nature of HCD by showing that HCD effects were seen only after short presentation times and not with presentations long enough to produce explicit knowledge of the co-variation. Stamov-Roßnagel's (2001) study also supported Lewicki et al's (1997) argument that HCD results from a naturalistic, 'global' processing style by varying participant instructions; HCD only occurred in the 'global' and not the 'analytical' condition. In contrast, Hoffmann and Sebald (2005) found that with the exception of one experiment, co-variation learning only occurred when participants were consciously aware of the relevant co-variation. However, their task instructions may have encouraged analytic processing, as they required participants to perform a visual search and identify a particular type of card (colour or suit) and a particular location. What emerges from the literature is that type of method, mode of instruction and the nature of experimental stimuli are critical variables in any attempt to capture co-variation learning in a laboratory setting. It seems likely that when global processing is encouraged, HCD facilitates responses in the same way as implicit learning of other types of information. The critical question is whether, in contrast to Lewicki's (1986a) findings, HCD also facilitates responding when naturalistic, social stimuli are used. We tested this possibility by replicating Lewicki's (1986a) hair/trait co-variation study following the original methodology as closely as possible but improving the stimuli and counterbalancing at acquisition and test stage.

METHOD

Thirty-two male and female undergraduate students completed the HCD task as part of their psychology course requirements. The task was completed in a quiet testing room in the Psychology department.

The task was programmed in Psyscope (Cohen, MacWhinney, Flatt & Provost, 1993) and presented on a Macintosh Powerbook 5300. The critical co-variations were counterbalanced across participants, as were stimulus orders at acquisition and test (Table 1). Ten black and white female faces were chosen from an old photograph yearbook that students had consented to being used for psychological research. Faces were piloted and rated on dimensions of attractiveness, capability and kindness by undergraduates on a five-point Likert scale. The faces rated as most attractive were adjusted in Adobe Photoshop to equate for attractiveness, expression, hair tone and facial symmetry. Further piloting with different participants confirmed that the adjusted faces were matched for attractiveness, capability and kindness.

Lewicki (1986a) used different faces for short and longhaired stimuli. To improve stimulus control and counterbalancing, we graphically manipulated hair length so that each stimulus face had both long and shorthaired presentations (Figure 1). Short hair was defined as not reaching the shoulders. Hair length varied in degree of long or shortness so that the co-variation between hair length and trait remained non-salient at an explicit level.

Task instructions were replicated exactly from Lewicki’s (1986a) original study: participants were told that the stimulus persons were real and were chosen as remarkable, and especially positive in some way. Participants were instructed merely to look at the faces and listen to the personality descriptions.

Six faces were presented in the acquisition phase, three with long and three with short hair. Hair length alternated. Each face was presented for 15 seconds, with 2.5 seconds interval between presentations when the screen was blank. Auditory files describing the personality of the stimulus person accompanied the face presentations; the content of auditory files was the same as in the original Lewicki (1986a) experiment. Three descriptions implied that the stimulus person was kind and three described the person as capable, for example, ‘she does a great deal for others’ (kind) or ‘she is intelligent and effective’ (capable). In condition one, the three longhaired stimulus persons were described as kind, and the three shorthaired faces as capable; this was reversed for condition two. The acquisition stage was followed by a simple visual distractor task.

At test, participants were presented with four photographs of previously unseen stimulus persons, two short and two longhaired. Each stimulus face was exposed twice, accompanied once by the question ‘Kind?’ and once by the question ‘Capable?’, giving a total of eight trials in this phase of the task. The two exposures of the same slide were separated by 2-4 other exposures. Measurement of response latency ended when participants pressed either ‘Y’ or ‘N’ on the keypad.

Table 1: Counterbalancing of faces and personality traits in acquisition and test phases of hidden co-variation detection task

Key: L= Long hair, S = Short hair, C = Capable, K = Kind

Group	Stimulus order at acquisition and test: Position in presentation sequence								Condition
	1	2	3	4	5	6	7	8	
Group 1									Condition 1
Face number and hair length	8L	9S	7L	10S	4L	3S			Long hair kind
Soundfile order	K1	C1	K2	C 2	K3	C3			Short hair capable
Position of target stimuli at test			T	T		T	T		
Test order of stimuli	2L	1S	5L	6S	5L	6S	2L	1S	
Personality question	C	K	K	C	C	K	K	C	
Group 2									Condition 2
Face number and hair length	7S	10L	2S	6L	5S	1L			Short hair kind
Soundfile order	K2	C2	K1	C1	K3	C3			Long hair capable
Position of target stimuli at test	T	T		T	T				
Test order of stimuli	4S	9L	8S	3L	8S	3L	4S	9L	
Personality question	K	C	C	K	K	C	C	K	
Group 3									Condition I
Face number and hair length	2S	6L	5S	1L	4S	9L			Long hair kind
Soundfile order	C3	K3	C2	K1	C1	K2			Short hair capable
Position of target stimuli at test	T			T	T			T	
Test order of stimuli	7S	3L	8S	10L	8S	10L	7S	3L	

Personality question	C	C	K	K	C	C	K	K	
Group 4									Condition 2
Face number and hair length	4L	10S	2L	3S	8L	1S			Short hair kind
Soundfile order	C2	K1	C3	K3	C1	K2			Long hair capable
Test order of stimuli	5L	9S	7L	6S	7L	9S	5L	6S	
Position of target stimuli at test			T		T		T	T	
Personality question	K	C	C	C	K	K	C	K	

We used Lewicki’s (1986a) explicit measure: participants were given a question sheet asking whether they based their judgements at test stage on a visual aspect of the person, and if ‘yes’ what aspect of the person?

RESULTS

The four target and four foil reaction times at test for each participant were collapsed to provide a single mean for primed hair/trait co-variances and a single mean for non-target co-variances per participant (Table 2).

Table 2: Reaction time means and standard errors for primed and non-primed co-variances at test for each condition

Condition	Target mean (*SE*)	Foil mean (*SE)*	Difference (*SE*)
Condition I Long hair kind, short hair capable (*n* = 16)	2811.2 (381.3)	2962.2 (362.5)	151.0 (163.8)
Condition II Short hair kind, long hair capable (*n* = 16)	2586.9 (223.9)	2885.6 (188.5)	288.7 (134.8)
Overall mean score Condition I and II combined	2699.0 (218.4)	2923.9 (201.1)	224.9 (105.2)

A repeated-measures ANOVA tested whether the co-variances at acquisition affected response times at test. This analysis showed a main effect of stimulus type (primed co-variance compared to non-primed co-variance), *F* (1,30) = 4.50, $p < .05$, with responses to primed co-variances being faster than responses to unprimed co-variances. There was no interaction for stimulus type and condition, *F* (1,30) = .48, *p* = *ns*, and no main effect of condition *F* (1,30) = .13, *p* = *ns*.

HCD appeared to improve performance accuracy as well as speed. Overall, there were fewer correct responses for foils (42/128) compared to targets (106/128). Mean reaction times were faster for correct responses to targets than for incorrect responses (*M* = 2606.2, *SE* 228.2 compared with *M* = 3913.3, *SE* 1222.2). Half the sample had no incorrect responses to target faces so these data were not analysed further.

If co-variation learning directly influenced judgment to trait questions, we would expect a greater frequency of ‘yes’ responses to ‘kind?’ questions for longhaired faces and ‘capable?’ questions for shorthaired faces compared to responses for ‘kind’ shorthaired faces and capable longhaired faces in condition I. In condition II we expected to find the reverse pattern. These data are presented below in Table 3.

Table 3. Means and standard deviations of yes-response frequencies for crucial and non-crucial co-variations in each condition at test stage. Target hair/trait values indicated in bold for each condition.

Question		Condition	
		I	II
KIND?			
Long hair			
	Mean	**1.69**	1.56
	SE	**0.48**	0.63
Short hair			
	Mean	1.13	**1.75**
	SE	0.15	**0.11**
CAPABLE?			
Long hair			
	Mean	1.50	**1.69**
	SE	0.18	**0.15**
Short hair			
	Mean	**1.56**	1.25
	SE	**0.16**	0.17

Frequency data for 'yes' responses followed the predicted direction indicating that HCD influenced judgement ratings. Results of a repeated-measures ANOVA showed a main effect of stimulus type (primed co-variance compared to non-primed co-variance) on frequency of affirmative responses at test $F\ (1,30) = 6.52, p < .05$. There was no interaction for stimulus type and condition and no effect of condition $F\ (1,30) = .82$, p = *ns*.

For the explicit measure all participants responded 'yes' they used some aspect of the person on which to base their trait ratings. Typical responses were either 'eyes' or 'smile' or a combination of both, and this finding corresponds with the results of the original task where participants made no explicit reference to the hair/trait co-variation.

DISCUSSION

This study replicated Lewicki's (1986a) original hair/trait co-variation task. Task stimuli included real faces and the same trait descriptions, explicit measure and participant instructions as the original task. Our study differed by counterbalancing the hair length and appearance of each face at acquisition and test. In contrast to Lewicki (1986a), we found faster responses and greater frequency of 'yes' responses at test to novel faces sharing the crucial co-variations with the previously studied faces, compared to novel test faces without those co-variations. Our findings of faster RT responses to the relevant stimuli on a HCD task concord with current assumptions that priming facilitates performance at test, either through faster RT responses or more accurate or preferential responses to crucial stimuli at test (Stamov-Roßnagel, 2001; Lewicki, Czyzewska and Hoffmann, 1987). This phenomenon appears to be an intrinsic and ubiquitous effect of prior stimulus processing and has been shown across a range of implicit tasks including artificial grammar learning (Reber, 1967, 1969; Gomez & Schvaneveldt, 1994), Serial Reaction Time learning (Nissen & Bullemer, 1987; 1989; Cohen, Ivry & Keele, 1990; Seger, 1997), dynamic systems learning (Berry & Broadbent, 1988) hidden co-variation detection (Lewicki, Czyzewska and Hoffmann, 1987; Lewicki, Hill & Sasaki, 1989; Lewicki, Hill, & Czyzewska, 1994; Roßnagel, 2001), probabilistic sequence learning (Jiménéz, & Méndez, 2001 ; Jiménéz, Méndez, & Cleeremans, 1996), mere exposure effect tasks (Zajonc 1968; Moreland & Zajonc, 1979; Kunst-Wilson & Zajonc, 1980; Elliott & Dolan, 1998; Whittlesea & Price, 2001), learning of perceptual categories (Jacoby & Brooks, 1984), and visual search tasks (Lewicki, 1986b, Hoffmann & Sebald, 2005). The effects of processing fluency are represented at a neural level whereby neuronal firing decreases on the second presentation of a stimulus independent of attention and awareness (Posner, DiGiralmo & Fernandez-Duque, 1997), supporting the assumption that such processes are facilitative. Indeed the facilitative nature of prior processing is so widely reported that Jiménéz and Méndez (2001) suggested a defining feature of implicit processing effects is that they always function in a uniformly facilitative way whereas explicit processing effects may be either facilitative or inhibitory. Hoffmann and Sebald (2005) recently surmised that organisms respond faster to predicted than unpredicted events and that evolution may have afforded mechanisms that enable automatic adaptation to environmental co-variations. HCD learning may draw on such adaptive mechanisms, when adaptation is construed as a facilitative process that produces faster/more accurate responses when previously co-varying environmental features are re-encountered.

Although our finding of faster and more accurate responses to relevant co-variances at test fits well with the literature on implicit effects, our results contrast with Lewicki's (1986a) results of slower responses to crucial co-variations at test. Slower responses to crucial test stimuli are consistent with the explanatory framework adopted by Lewicki (1986a), although the Glucksberg and McCloskey model (1981) seems better suited to deliberative cognitive processes than implicit processing effects. The basic tenet of this model is that a memory search is initiated in response to a question and if nothing is known then a rapid “don’t know” response is given. The model follows a two-stage process and if relevant information is found it is further analysed for features that correspond to the question. Response time is therefore longer when information relevant to a question is available. This model provides a spatial memory metaphor for information stored in memory that can be verbalised and retrieved via a deliberative search. However, core features of implicit learning are that the knowledge acquired is unverbalisable, and that the individual is unaware of both the process (information acquisition) and the product (subsequent behaviour) of implicit learning. The ‘memory search’ pattern of responding should only be seen when the participant holds some declarative knowledge relevant to the question. At the test stage of the hair/trait HCD task, participants are required to respond to the one word question ‘kind?’ or ‘capable?’ presented below a previously unseen stimulus face. The participants have no information about the kindness or otherwise of the new faces, they merely hold information that certain beneficent acts are associated with a certain hair length *in some faces seen earlier* and that organised and efficient behaviours are associated with the alternate hair length. It seems unlikely that they might initiate a two-stage memory retrieval process since they know nothing of the ‘kindness’ or ‘capability’ of the newly seen faces at test.

As it stands the Glucksberg and McCloskey (1981) model seems an unlikely candidate to explain the results shown by Lewicki (1986a) in the original hair/trait HCD task. An alternative explanation is Hendrickx et al’s (1996) suggestion that slower responses were an artefact of poor counterbalancing of test items. We have no information to help evaluate this criticism. However, with careful counterbalancing in the present study we found that responses to primed traits were faster not slower.

On a more general level, several researchers have proposed that certain boundary conditions must be met before co-variation effects can be captured experimentally. Lewicki et al (1997) suggested that a global holistic processing style, rather than an analytic investigative style, must be adopted for the occurrence of HCD. They drew on this argument to explain Hendrickx et al's (1997) failure to replicate HCD effects across a range of tasks. They proposed that this boundary condition is only met by the use of 'real' and meaningful stimuli that induce the automatic adoption of a processing style. According to Lewicki et al (1997) this holistic processing 'style' is the automatic and ubiquitous modus operandi when processing social information in naturalistic settings. However matrix scanning tasks and brain scan HCD tasks do not use naturalistic stimuli, and HCD effects have been shown with these stimuli, so the need for 'real life' stimuli to produce co-variation learning seems questionable. Type of stimuli may be neither the fundamental or only factor in the adoption of a particular processing style and processing 'style' may be initiated by other factors. Stamov-Roßnagel's (2001) recent study comprehensively investigated the boundary conditions that constrain HCD effects. His findings showed that when participants are explicitly instructed to adopt an analytical style in a brain scan HCD task, by specifically focussing on separate quadrants of the 'scan' rather than the overall scan, HCD effects were not seen. Interestingly the crucial role of type of instruction in the adoption of a particular processing style may not only apply to HCD tasks. Whittlesea and Price (2001) recently showed similar results in a mere exposure effect task.

Considered together these findings suggest that instructive tasks induce an analytical processing style that prevents priming across a range of implicit tasks. These findings are also suggestive of some general-purpose mechanism not specific to a particular subgenus of implicit learning that can be overridden if instructions/context encourage a deliberative approach. Consequently methodological variables may be as crucial as the ‘realistic’ nature of stimuli used to initiate a global processing style and to capture implicit learning effects.

In the present study, the acquisition of co-varying information led to faster judgements about the personality traits of stimulus persons who corresponded to the learned co-variation, compared to stimulus persons who did not. The question remains as to what purpose the mechanism underlying this performance might serve in naturalistic settings? Implicit information processing has been traditionally perceived as a ‘lab-based’ phenomenon, with most, if not all, researchers remaining mute as to the function of these processes (but see Barker, Andrade; & Romanowski, 2004). This predicament led Cleeremans and Jiménéz (2002; pg.1) to speculate, “What is implicit learning for?” Lieberman (2000) recently provided a partial answer by arguing that implicit tasks used in the laboratory might employ the same mechanisms recruited during nonverbal encoding and decoding of social information in normal social functioning. Other researchers have suggested that implicit processes are crucial to social cognition by mediating language acquisition, affective judgements, socialisation and the development of a sense of aesthetics (Reber, 2002; Zajonc, 1968; 1980).

The common strand that unites these proposed ‘real-world’ analogues of implicit effects is the notion that contextual regularities are detected and automatically processed and that this function might depend upon a common mechanism that is recruited across disparate implicit tasks and is fast, uniformly facilitative, non-verbal and able to concurrently encode several variables. In natural settings this sub-symbolic or implicit mechanism may function to ‘catch’ regular co-variances or constancies in the environment and modulate behaviour accordingly without recourse to conscious deliberative processes. Such a proposed mechanism seems entirely suited to the realm of non-verbal social cognition. A new departure for implicit research might involve investigations of the contribution of sub-symbolic processes to other aspects of cognition and the putative contribution that implicit cognition makes to social behaviour. In conclusion, the mechanism underlying co-variation detection may function to detect and preferentially attend to repeated presentations of subtle co-occurring regularities amongst a stream of inchoate stimuli, of which the most salient might be social stimuli.

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