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Face Recognition without Identification

Anne M. Cleary
Colorado State University
USA

1. Introduction

Most people have had the experience of recognizing a person's face as familiar despite failing to identify who the person is or where the person was seen before. Many domains of research have aimed to study this phenomenon; thus, there exist many research paradigms for attempting to tap it in laboratory settings. Among these paradigms are dual-process recognition memory paradigms within the recognition memory literature (e.g., Yonelinas, 2002), feeling-of-knowing paradigms within the metacognition literature (Koriat, 1995), and face identification paradigms within the more general face recognition literature (e.g., Burton, Bruce & Hancock, 1999).

2. Dual process methods of studying recognition memory

2.1 Familiarity-based recognition

Recognition memory is the type of memory that enables people to determine that they have experienced something previously. Dual process theories of recognition memory hold that it can be based on either of two processes: Recollection or familiarity (see Diana et al., 2006, or Yonelinas, 2002, for reviews). Recollection-based recognition occurs when one recognizes having experienced something before based on the retrieval of specifics about the prior occurrence. For example, one might pass someone on the sidewalk and recognize that the person has been seen before by calling to mind the specific instance in which the person was seen before: This person was the receptionist at the dentist the other day. In contrast, familiarity-based recognition occurs when one recognizes having experienced something before based only on a gut feeling or sense about the situation. For example, one might pass someone on the sidewalk and only recognize that the person is familiar without recalling where that person was seen before. The person simply *seems* familiar.

From a dual-process perspective, studying recognition that is familiarity-based requires teasing apart instances of familiarity-based recognition and instances of recollection-based recognition. Over the years, researchers have developed many methods of doing so within list-learning paradigms (see Yonelinas, 2002, or Mandler, 2008, for reviews). Some existing methods are: The process dissociation procedure (e.g., Jacoby, Toth, & Yonelinas, 1993), the tasks procedure (e.g., Cleary & Greene, 2001; Yonelinas, 1997), analyses of receiver operating characteristics (ROCs, Yonelinas, 1994, 1997), the signal-lag procedure (e.g., Hintzman & Curran, 1994) and the remember-know procedure (e.g., Rajaram, 1993).

By separating familiarity from recollection in studies of recognition, presumably the characteristics of familiarity can be studied. Indeed, much has been learned about

familiarity from dual-process methods. Yonelinas (1994) combined the process-dissociation procedure with the analysis of receiver operating characteristics (ROCs) and found that although overall recognition memory tends to lead to a z-ROC slope of significantly less than 1.0, when the contribution of familiarity is isolated, the slope of the z-ROC approximates 1.0, as would be predicted by simple signal detection theory; this suggests that familiarity may be well-described by simple single detection theory when it is isolated. Rajaram (1993) used the remember-know procedure (whereby subjects simply indicate whether the basis for each “yes” response on a recognition test was recollection or familiarity) to show that familiarity, but not recollection, is affected by manipulations of perceptual fluency, such as the rapid presentation of a test stimulus prior to presenting it for the recognition decision. Jacoby, et al. (1993) found similar results using the process-dissociation procedure. Rajaram and Geraci (2000) used the remember-know technique to show that familiarity is affected by manipulations of conceptual fluency, such as the presentation of a semantically related word prior to presenting the recognition test stimulus. Unlike recollection, familiarity is unaffected by divided attention at encoding, as has been shown using the process-dissociation procedure (Jacoby, et al., 1993) and the remember-know paradigm (Gardiner & Parkin, 1990).

Research using the signal-lag procedure, in which subjects are given varying response deadlines across recognition test trials, has shown that familiarity-based old-new discrimination emerges sooner in the processing stream than recollection-based old-new discrimination. This has been shown with such tasks as the plurality task, in which subjects must discriminate between words that remain the same from study to test (e.g., frog) and words that changed plurality from study to test (e.g., frogs). Subjects can discriminate which root words were studied versus unstudied significantly earlier than they can discriminate between correct and incorrect pluralities, suggesting that familiarity becomes available earlier on in processing than recollection (Hintzman & Curran, 1994). This finding is consistent with studies of event-related potentials (ERPs) during recognition testing (e.g., Curran, 2000; Curran & Cleary, 2003), which have suggested that the brain electrophysiological correlate to familiarity occurs earlier (300-500 ms) than that of recollection (e.g., 500-800 ms).

Mathematical models often describe familiarity in terms of features (e.g., Clark & Gronlund, 1996). Memory traces for encoded items each exist as a set of the separable features that composed the item itself. At the time of the recognition test, the features in the test item are matched, on a feature by feature basis, with all of the features that have been stored in memory. From this perspective, features should play a critical role in familiarity-based recognition. Indeed, many studies have shown that there are various features that, when isolated, can produce familiarity-based recognition. Among the features that have been shown to play a role in familiarity are: Letters of words (Cleary & Greene, 2000, 2001), phonemes (Cleary, Winfield & Kostic, 2007), geometric shapes within pictures (Cleary, Langley & Seiler, 2004), song notes (Kostic & Cleary, 2009) and song rhythm (Kostic & Cleary, 2009).

Finally, familiarity appears to be left intact with certain forms of memory impairment and with aging. Many amnesics have been shown to be impaired on recollection with familiarity relatively spared (e.g., Aggleton & Brown, 1999; Vann et al., 2009), suggesting that whereas recollection involves the hippocampus proper, familiarity may involve other regions of the medial temporal lobe (MTL) that are often spared in amnesics. Functional neuroimaging

studies have generally converged on this idea (e.g., Cohn et al., 2009; see Diana et al., 2007 and Eichenbaum et al., 2007, for reviews).

With regard to familiarity and aging, Mantyla (1993) used the remember-know paradigm and showed that “know” responses (indicating familiarity) were unaffected by aging, while “remember” responses (indicating recollection) declined with aging. In another study, Parkin and Walter (1992) found that “know” responses actually increased with age, while “remember” responses decreased. Other more recent studies have converged on the idea that recollection tends to be more impaired by aging than familiarity (e.g., Jacoby, 1999; Jacoby & Rhodes, 2006; McCabe, Roediger, McDaniel, & Balota, 2009; Rhodes, Castel, & Jacoby, 2008).

2.2 Familiarity-based face recognition

In the dual-process recognition literature, the most commonly-used example of familiarity-based recognition is that of recognizing a face as familiar without recollecting any specifics about the person. For example, in their dual-process study of recognition memory, Curran and Cleary (2003, p. 191) state, “We have all had the experience of knowing a face is familiar despite an inability to recollect details such as the person’s name,” and in his review of dual-process theory, Yonelinas (2002, p. 441) states, “The distinction is illustrated by the common experience of recognizing a person as familiar but not being able to recollect who the person is or where they were previously encountered.” Finally, in her dual-process study, Rajaram (1993, p. 90) states, “There are times when we meet someone on the street whom we met at a party a few days ago. Although we know that we met this person at the party, we may not remember actually meeting the person, or his/her name.” Although most dual-process studies use face recognition as an anecdotal example of familiarity-based recognition, most such studies use stimuli other than faces to isolate and study familiarity; in most cases, the stimuli are words. This section examines dual-process studies that have used faces as stimuli in trying to isolate familiarity-based recognition of faces.

Yonelinas, Kroll, Dobbins and Soltani (1999) examined recognition memory for faces. These authors were following up on prior work that had suggested that whereas item recognition (i.e., recognizing a single item as having been studied on an earlier list) can be based on either familiarity or recollection, associative recognition (i.e., recognizing which items were paired together in an earlier studied list and which were re-paired from study to test) appears to require recollection. Specifically, a number of studies have suggested that when subjects study pairs of words (e.g., apple-pond, rock-cat, desk-bottle) and are later tested on their ability to discriminate old from new words, this overall old-new discrimination involves a combination of both familiarity and recollection. However, when participants are instead later tested on their ability to discriminate intact (e.g., apple-pond) from rearranged (e.g., rock-bottle or desk-cat) pairs, recollection is required to make the discrimination (Hintzman, Caulton & Levitin, 1998; Yonelinas, 1997); familiarity alone is thought to lead subjects to false alarm to rearranged pairs.

Yonelinas et al. (1999) examined whether the same principle would apply to faces. To create intact and rearranged faces, these researchers manipulated the features of the faces so as to present some of the faces as rearranged versions of studied faces. Analogously to the rearranged word pairs mentioned above, the rearranged faces were each a combination of two different studied faces’ features. Thus, subjects had to discriminate actually studied (intact) faces from faces that were actually recombined versions of studied faces. In this case,

unlike with rearranged word pairs, familiarity was found to contribute to the ability to discriminate intact from rearranged faces, as suggested by the shape of the ROC curve. Yonelinas et al. suggested that the reason familiarity can contribute to this type of associative recognition with faces is because faces tend to be processed holistically, rather than decomposed into features (e.g., Searcy & Bartlett, 1996).

Prior work has suggested that while faces tend to be processed holistically when presented upright, when presented upside-down, they tend to instead be decomposed into features (e.g., Searcy & Bartlett, 1996). Accordingly, Yonelinas et al. (1999) found that familiarity-based discrimination between intact studied faces and faces comprised of recombined, studied features occurred only when the faces were presented upright. Recollection was required for such discrimination when the faces were presented upside-down. Thus, holistic processing of faces indeed appears to contribute to the ability to use familiarity alone to discriminate actually studied, intact faces from highly familiar, feature-rearranged faces.

Aly, Knight and Yonelinas (2010) investigated whether faces may be more likely to drive familiarity-based recognition than other types of stimuli. These researchers noted that many studies of amnesic patients (i.e., patients with severe memory impairment due to damage to the medial temporal lobe region) demonstrated impaired recognition memory for such stimuli as words or scenes, but relatively spared recognition memory for faces (e.g., Bird & Burgess, 2008; Carlesimo et al., 2001; Taylor, Henson & Graham, 2007). Aly et al. found that, indeed, overall word recognition was more impaired than overall face recognition in their amnesic patients. However, ROC analysis revealed that the amnesics were impaired in recollection for both words and faces. Furthermore, the type of medial temporal lobe damage made a difference; all patients showed intact familiarity for faces, but some of the patients showed impaired familiarity for words. From the full pattern of results, Aly et al. argued that the reason why amnesic patients may often appear less impaired on face recognition may be because 1) face recognition relies more heavily on familiarity than other types of stimuli and 2) face familiarity remains relatively spared in many cases of amnesia.

The research presented thus far suggests that faces may be somewhat unique within recognition memory. First, the evidence suggests that faces tend to be processed holistically rather than decomposed into features, and as such, familiarity can serve as a basis for discriminating similar faces from actually studied faces, or rearranged faces from intact faces. Second, people may rely more heavily on familiarity in face recognition than in the recognition of other types of stimuli. Finally, face familiarity tends to be relatively spared during impairment to other types of familiarity and to recollection.

2.3 Face recognition without identification

A relatively unique laboratory approach to studying familiarity-based recognition within the dual-process framework is that which is used to induce what has been termed *recognition without identification* (e.g., Cleary & Greene, 2000, 2001; Cleary et al., 2004; Peynircioglu, 1990). In this method, one examines recognition memory in situations where participants fail to identify the experimental reason for the feeling of recognition. For example, after listening to a list of words spoken through a set of computer speakers, subjects may receive a recognition test containing fragments of spoken words, such that only certain spliced phonemes of a given word are presented through the speakers (Cleary et al., 2007). Some of these phoneme fragments come from studied words and some come from unstudied words.

For each such fragment presented, subjects attempt to identify the word to which it corresponds. They are also asked to rate the likelihood that the fragment came from a studied word. Recognition without identification is the finding that among unidentified test items (as when the word from which a phoneme fragment came cannot be identified), people give higher recognition ratings to studied than to unstudied items. In short, people can recognize a test item as familiar despite an inability to identify the experimental source of that familiarity; the source in this case is the particular study episode that led to the familiarity (i.e., the particular spoken studied word corresponding to given unidentifiable phoneme fragment).

Cleary and Specker (2007) attempted to apply the recognition without identification paradigm to face recognition. They gave subjects celebrity names at study (e.g., Adrien Brody, Jennifer Connelly). At test, they gave the subjects pictures of celebrity faces, half of which were of celebrities whose names were studied, and half of which were of celebrities whose names were not studied. For each face presented on the test, subjects first attempted to identify the person by typing the person's name. Then, regardless of whether the face could be identified, subjects also rated the likelihood that the person's name was studied. Among celebrity faces that went unidentified on the test, subjects discriminated between those of celebrities whose names were studied and those of celebrities whose names were not. In this case, the unidentifiable experimental source of the familiarity was the person's name. Thus, subjects demonstrated some ability to recognize faces as familiar within the context of the experiment, yet were unable to identify the experimental source of that familiarity. Cleary and Specker termed this finding *recognition without face identification*. The finding suggests that recognition without identification of faces can be based on semantic information, as this effect required a pre-existing link in memory between the celebrity names and their corresponding faces.

Cleary and Specker (2007) also linked their recognition without face identification effect to the tip-of-the-tongue (TOT) phenomenon, which occurs when a person feels as if a word's retrieval is imminent, on the verge of being retrieved, yet remains inaccessible at the moment. Specifically, Cleary and Specker added an additional question to the test phase of a second experiment; after giving a recognition rating to the face, subjects were asked to indicate if they were experiencing a TOT state for the name or not. The results suggested a relationship between the recognition without face identification effect (i.e., higher recognition ratings for unidentified faces of celebrities whose names were studied than for unidentified faces of celebrities whose names were not studied) and the TOT phenomenon. Specifically, when the recognition ratings were broken down into those given during reported TOT states and those given during reported non-TOT states, the recognition without face identification effect was only found when subjects reported being in a TOT state; it was not present when subjects reported not being in a TOT state.

This finding suggests that the feeling of being able to recognize a face without being able to identify who the person is may be related to the more general TOT phenomenon. Indeed, some have used the example of face recognition without identification to illustrate the TOT phenomenon itself. For instance, Yarmey's (1973) article is entitled, "I recognize your face but I cannot remember your name: Further evidence on the tip-of-the-tongue phenomenon," and Schwartz (2002, p. 114) gives the following example in his review of the TOT experience: "You see an acquaintance approaching. Instantly, you are hit with a TOT. You cannot retrieve the person's name, although you are sure that you know it." Cleary and

Specker (2007), Cleary and Reyes (2009), and Cleary, Konkel, Nomi and McCabe (2010) suggest that the feeling of recognizing something as familiar, such as a face, may subjectively resemble the feeling of being in a TOT state. They based this assertion on the additional finding that subjects consistently give higher familiarity ratings overall when in a TOT state than when not in a TOT state (e.g., Cleary et al., 2010; Cleary & Reyes, 2009; Cleary & Specker, 2007).

3. Feelings of knowing

3.1 The feeling of knowing phenomenon

Feelings of knowing (FOKs) are judgments that people make for momentarily unretrievable information about the likelihood that they would recognize that information if presented with it in the future. Koriat (1995, p. 311) used the example of person recognition without identification to illustrate the FOK phenomenon: "The FOK phenomenon is best illustrated by the many everyday situations in which people try to recall the name of a person but fail to find it. These situations are sometimes accompanied by the subjective conviction that one knows the name and that one is likely to recall it given sufficient time and effort." However, as with the dual-process recognition literature, most FOK studies use stimuli other than faces and their corresponding names, even though people's faces and names are often used to illustrate the real-world phenomenon under investigation.

In one of the first FOK studies, Hart (1965) gave subjects general knowledge questions (e.g., What is the largest planet in the solar system?). When subjects failed at retrieving an answer, they rated the likelihood that they would be able to recognize the answer in a future forced-choice recognition test. In comparing subjects' predictions with their actual performance on the later forced-choice test, Hart found that subjects could predict at above-chance levels which of the then-unretrievable answers would be recognized on the later test. Since Hart's study, the FOK phenomenon has been the subject of a fairly large literature (see Koriat, 2007, for a review).

Many theories of the FOK phenomenon have been proposed over the years (e.g., Koriat & Levy-Sadot, 2001; Nelson, Gerler & Narens, 1984; Yaniv & Meyer, 1987). One of the most widely-held theoretical frameworks is that of Koriat and Levy-Sadot. This framework combines two different theoretical accounts of the FOK phenomenon into a single two-stage account. The first of the two stages is cue familiarity. Cue familiarity refers to the familiarity of the test probe or test question itself, and has been shown to be a basis for FOKs (e.g., Metcalfe, Schwartz & Joaquim, 1993). The second of the two stages is accessibility (Koriat, 1993, 1995, 2007). Accessibility refers to the amount of information that is retrievable in response to the cue, and perhaps even the ease with which it is accessed. In the second stage, subjects attribute any retrieved information and the ease with which it was accessed, whether correct or incorrect, to the likelihood that they will recognize the target if presented with it later (Koriat, 1993, 1995; Koriat & Levy-Sadot, 2001).

According to Koriat and Levy-Sadot (2001), subjects first assess the familiarity of the cue itself (i.e., the question or probe). If it seems familiar, this familiarity prompts them to proceed to the accessibility stage, at which point they search memory for any accessible information that can be retrieved in response to the cue. Benjamin (2005) found support for this idea by showing that, when subjects had to make an FOK judgment in a time-constrained manner, cue-familiarity had a larger influence than accessibility. In short,

accessibility played a larger role in subjects' FOK judgments when they had enough time to proceed to that stage.

3.2 Feelings of knowing with faces

Hosey, Peynircioglu, and Rabinovitz (2009) examined subjects' FOKs for pictures of people's faces whose names failed to be retrieved. Hosey et al. also required subjects to indicate the bases of their FOK judgments. These researchers were particularly interested in whether subjects reported relying on cue familiarity or accessibility more often. Though few FOK studies had actually examined FOKs for names in response to faces, at least one study had indicated that cue familiarity with the face itself has an influence on FOKs for faces (Hanley & Cowell, 1988). In line with this idea, Hosey et al. found that subjects indicated relying on cue familiarity as a basis of their FOK judgments more often than they indicated relying on accessibility. These authors assert that this finding is consistent with a claim made by Schwartz, Benjamin and Bjork (1997) that feelings of knowing a person's name in response to a face may actually be driven largely by the familiarity of the face itself. As Schwartz et al. (p. 136) state, "...if you feel that a passerby's name is on the 'tip of your tongue,' it is not because you know the person's name, although it is likely that you do, but because the person's face is familiar."

If indeed such day-to-day feelings of knowing about people are driven largely by familiarity with people's faces themselves, then studying familiarity from the perspective of dual-process theory within recognition memory paradigms may be a complimentary experimental approach toward attempting to understand such day-to-day phenomena, as dual-process paradigms attempt to understand the cue familiarity process itself. Indeed, in Metcalfe et al.'s (1993) demonstration that cue familiarity can drive FOK judgments, cues were familiarized through earlier presentation in the experiment, similarly to how familiarity is manipulated in standard list-learning approaches to dual-process theory in recognition memory.

An interesting future direction for research on feelings of knowing with faces would be to determine how reliance on cue familiarity differs when feelings of knowing with faces are compared to feelings of knowing with other types of stimuli, such as verbal materials. Given the findings by Aly et al. (2010) that faces may tend to elicit a greater reliance on familiarity than other types of stimuli, it may be the case that subjects rely more heavily on cue familiarity when giving FOKs to faces than when giving FOKs to other types of stimuli.

4. Modeling the processes of face recognition

Burton, Bruce and Hancock (1999) developed a model of face recognition that includes mechanisms for explaining instances where face recognition occurs, but the person's name cannot be retrieved. This model stems neither from the dual-process recognition memory literature nor the FOK literature, but rather from a more general literature on identifying faces. This model is called the Interactive Activation and Competition (IAC) model (Burton et al., 1999; Burton, Bruce & Johnston, 1990). The model contains multiple levels of units that contribute to face recognition: Face recognition units (FRUs), person identification nodes (PINs), and semantic information units (SIUs), which carry general semantic information about a person including name information. The model also contains lexical output units for identifying the person's face. In this model, people's names are more difficult to retrieve

than other types of semantic information about a person (e.g., occupation) because names are more distinctive than other types of semantic information, and distinctive information can often be difficult to retrieve.

In the IAC model, different pieces of information become available at different points in time. Face familiarity occurs at the earliest stage, at the level of the PINs. A face is recognized as familiar if a PIN's activation exceeds a determined threshold; this mechanism allows for a face to be recognized as familiar even though no information about the identity of the face may be recalled. Access to semantic information about the person's face becomes available next and occurs at the level of the SIUs. Activation at this level may allow a person to access semantic information associated with the face (e.g., the person's occupation) even though the person's name may still be unretrievable. Again, because they are distinctive, people's names tend to be more difficult to access than general semantic information; thus, semantic information becomes available earlier. At the latest stage of processing, retrieval of the person's name may finally occur.

The stages of processing proposed in the IAC model are supported by a number of empirical studies on general face recognition and identification processes. First, Johnston and Bruce (1990) have shown that subjects are able to determine that a face is familiar earlier than they are able to retrieve semantic information about the person. This type of finding is analogous to the signal-lag and ERP studies of dual-process theory discussed above, which have suggested that familiarity becomes available earlier on in processing than recollection (e.g., Hintzman & Curran, 1994; Curran, 2000; Curran & Cleary, 2003). Second, there is a lot of evidence to suggest that people commonly retrieve semantic information about a person without being able to retrieve the person's name, yet almost no evidence suggests that people can retrieve a person's name in the absence of any semantic information about the person (e.g., Hay, Young & Ellis, 1991; Young, Hay & Ellis, 1985). Third, a substantial literature suggests that people have greater difficulty recalling people's names than recalling general semantic information about people (e.g., Bredart & Valentine, 1998; Cohen, 1990; Stanhope & Cohen, 1993).

5. Summary, conclusions, and future directions

This chapter is concerned with the common experience of recognizing a person's face as familiar, despite an inability to identify who the person is, or very often, anything specific at all about the person. As illustrated here, many different research approaches to this phenomenon have been taken. Many dual-process recognition paradigms aim to study the process of familiarity-based recognition, which is thought to underlie, or at least contribute to, the real-life experience of recognizing without identifying a person. Feeling-of-knowing (FOK) paradigms aim to study the experience of feeling as if one knows something that cannot currently be accessed from memory, and the feeling that one would recognize that information as the sought-after information if later presented with it. Finally, the Interactive Activation and Competition (IAC) model aims to simulate the processes involved in the day-to-day experience of recognizing without identifying a person, as when one looks at a picture of person, recognizes the face as familiar, yet cannot identify the person.

All three of these different approaches aim to tap the same real-world phenomenon, as illustrated by the fact that face recognition without identification is the most common example of the phenomenon under investigation in all of these approaches. However, the extent to which these different approaches all actually tap the same phenomenon remains to

be determined. That said, many commonalities exist between the three approaches. First, the relative timeline for when different types of information become available is very similar across the three paradigms. In dual-process theory, familiarity is thought to become available earlier than recollection (Hintzman & Curran, 1994; Curran, 2000; Curran & Cleary, 2003). In FOK theory, cue familiarity is thought to become available before partial information becomes accessible (Benjamin, 2005). Finally, in the IAC model, face familiarity becomes available before semantic information about the person can be accessed, which in turn becomes available before the name itself can be accessed.

Second, as mentioned, the cue familiarity thought to contribute to FOK judgments (e.g., Metcalfe et al., 1993) may actually be the same type of familiarity that drives familiarity-based recognition in dual-process recognition paradigms. Thus, the findings from different paradigms that 1) subjects in FOK paradigms may rely more heavily on face familiarity than on accessibility of partial information when giving FOK judgments to faces (Hosey et al., 2009) and 2) that faces may elicit a greater reliance on familiarity-based recognition than other types of stimuli in dual-process paradigms (Aly et al., 2010), may indicate a convergence on the idea that face familiarity itself largely drives real-world cases of face recognition without identification. As mentioned, the IAC model contains a mechanism for this: The activation of Person Identification Nodes (PINs) allows a face to be recognized as familiar even when no other information can be accessed. In short, the three methods discussed here may converge on the same general ideas regarding face recognition without identification. Future research should aim to further determine how well they actually do converge.

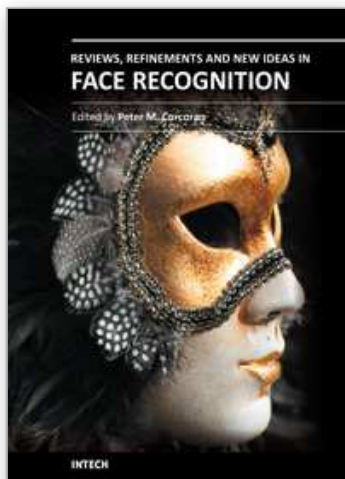
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Reviews, Refinements and New Ideas in Face Recognition

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As a baby one of our earliest stimuli is that of human faces. We rapidly learn to identify, characterize and eventually distinguish those who are near and dear to us. We accept face recognition later as an everyday ability. We realize the complexity of the underlying problem only when we attempt to duplicate this skill in a computer vision system. This book is arranged around a number of clustered themes covering different aspects of face recognition. The first section on Statistical Face Models and Classifiers presents reviews and refinements of some well-known statistical models. The next section presents two articles exploring the use of Infrared imaging techniques and is followed by few articles devoted to refinements of classical methods. New approaches to improve the robustness of face analysis techniques are followed by two articles dealing with real-time challenges in video sequences. A final article explores human perceptual issues of face recognition.

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No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

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