Psycho-information and Credibility Assessment

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Abstract

This paper introduces the principles, procedures, and standards for use of polygraph in China. Some of them are quite different from the conventional polygraph test in the western culture. The goal for using the polygraph is to obtain information, in addition to distinguishing between lies and the truth.

Introduction

Maybe the word "Psycho-information" is a new face to you. However its Chinese name "Xin Li Xin Xi (心理信息, the information in one's mind)" (Chen & Sun et al, 2004; 2005; Chen & Sun, 2005; 2007) is gaining popularity in China in the field of "polygraphy" (Fu & Liu, 2006; Chen & Liu, 2007). Polygraph means detection of deception to a large degree, so the definition of "Psycho-information" is derived from it in Chinese culture.

Mentioning the detection of deception, the most famous ancient philosopher named Confucius (551-479 B.C.) in China had pointed out: "Inspection of Face and Body for Diagnosis" in his *Analects of Confucius* (论语). During the same time almost, another Chinese famous militarist and strategist, Sun Tzu (510 B.C.), said: "Warfare is the Way of Deception. Thus, although you are capable, display incapability to them. When committed to employing your forces, feign inactivity. When your objective is nearby, make it appear as if distant: when far away, create the illusion of being nearby (兵者，诡道也。故能而示之不能，用而示之不用，近而示之远，远而示之近)." There are 36 stratagems in his work *The Art of War* (孙子兵法). Nearly every one of them can teach people how to make a deception. According to a report from "Northern Song Dynasty (960 - 1127) History," a distinguished statesman of the Northern Song Dynasty, Kou Zhun (961~1023), had interrogated a criminal suspect by a wizard stone.

The history of detection of deception in China is long, but modern scientific technology about the detection of deception entered China in 1943 from America (Chen & Sun, 2001). For ideological reasons, the polygraph was rejected by People's Republic of China (PRC) before 1980. During the 1980s, the situation of crime was increasing. The traditional methods of criminal investigation were not enough, so many new techniques were considered including the polygraph.

When polygraph entered China in 1943, it was named "Ce Huang Yi (测谎仪, lie detector)." The "Ce Huang (测谎, lie detection)" became a popular word even after 1949, the year the PRC was founded. In Chinese culture, saying somebody is lying is a serious negative comment on him/her. If somebody is asked to take a lie detection test, they will think they are suspected of being a liar. It means that some unhappy things will happen. So generally speaking, Chinese people, even if they are innocent, are unwilling to volunteer for a lie detection test. After two decades, the use of polygraph has grown from a few cities to many provinces in China. Its influence has become salient and it has acted as a unique role in criminal investigations.

How did we give this new useful technique a proper name in Chinese? A lot of proposals were discussed. The name "Xin Li

Ce Shi (心理测试, Psycho-information Probe, PiP)" was finally adopted by the Ministry of Public Security of PRC and it was formally established in the field of "Xing Shi Ji Shu (刑事技术, forensic science)" in 2004 (Chen & Sun et al, 2005). The "Xin Li Ce Shi (PiP)" association was established in the same year. The association's full name in English was The Professional Psycho-information Probe Committee (PiPC) of Forensic Science Association of China. Now as the name PiP is popular in China, "Take PiP" has become a regular step in criminal investigations for an innocent person to take a polygraph examination voluntarily.

We thought that the term Psycho-information would reflect not only the purpose of polygraph testing, but also other techniques employed such as EEG (including Event-Related Potentials, ERPs), fMRI, and so on in criminal investigations (Fu, 2011; Rosenfeld, 2002; Wolpe, 2005). We know clearly that the polygraph is still a key method and tool in criminal investigations. Other techniques such as EEG, fMRI, and so on cannot be used widely in the field. So the PiPC mainly concentrates its work to use polygraph in criminal investigations. When, as PiPC's General Secretary, the author Chen was appointed to write a training handbook for PiP in 2005, and the handbook was partly published in 2008 (Liu & Wang, 2008). The handbook then became a brief material for a PiP certificate in China. The "Systemic Psycho-information Probe for Investigation (SPiPI)" was introduced in the handbook and now it has become a prevalent (polygraph) technique in China.

Getting a certificate is the first step to become a polygraph examiner in China. The examiners in the government must have a license to administer polygraph examinations in criminal investigations. The license is only issued by the Ministry of Public Security of PRC now. Until now there were no private polygraph examiners in China.

"The Professional Psycho-information Probe Committee (PiPC) of Forensic Science Association of China" received a new English name in 2011: The Professional Committee for Credibility Assessment (PCCA). This name changing is partly from the American DoDPI's name change to the National Center for Credibility Assessment (NCCA). However, most of it is from our understanding about how the examination works. The definition of Credibility Assessment (CA) from DoD Directive (DoD, 2007) is "The multi-disciplinary field of existing as well as potential techniques and procedures to assess truthfulness that relies on physiological reactions and behavioral measures to test the agreement between an individual's memories and statements." Our understanding about "memories" here is the same as the Psycho-information.

A project named "A model of the psycho-information and its application in criminal investigation" won the Science and Technology Award from the Ministry of Public Security of PRC in October, 2011. The author Chen, as the leading researcher of the project group, is the first one to receive the Government Special Allowance granted by the State Council of the PRC for polygraph in forensic science.

SPiPI and SPEI

Systemic Psycho-information Probe for Investigation (SPiPI) is composed of two parts. The first part is called the Basic Examination (BE), and the second part is called the Fine Examination (FE). Both BE and FE are composed of Test Units (TUs). In the polygraph examination, the TUs are the comparison question test (CQT), concealed information test (CIT, also known as the guilty knowledge test, or GKT), the peak of tension (POT), relevant/irrelevant, and so on. If the ERP is used, it is a TU too. Because of the polygraph's key effect in SPiPI, we also call the probe only using the polygraph as the Systemic Polygraph Examination for Investigation (SPEI).

According to the procedure of SPiPI, the BE is implemented first, followed by the FE when necessary. The BE is designed for innocence and the FE is for guilt. When an examinee passes the BE, he/she will be judged to be innocent of a case which is being investigated by the SPiPI. It is unnecessary for him/her to take more tests. It is the end of this probe (examination). The outcome of the probe is described as "pass." If an examinee fails to pass the BE, he/she will generally be asked to take the FE. When an examinee fails

to pass BE but succeeds in passing FE, he/she will be judged to be innocent of the case which was being investigated by SPiPI. It is the end of this probe and the outcome of the probe is described as "pass" too. When the examinee still fails to pass the FE, he/she will be judged to be "guilty" of the case which is being investigated by SPiPI. It is the end of this probe, and the outcome of the probe is described as "fail." When BE's outcome is "inconclusive," the FE must be taken in. The final result is decided by the FE's outcome in this situation. In other words when the BE cannot give a pass outcome for the probe, the FE's outcome will be a determinant in the SPiPI. It is certain that when BE's outcome is "inconclusive" and the FE's outcome is the same, the final result for this probe is "inconclusive." An interview is needed between the BE and the FE. The examiner can conduct an interview of the subjects when they fail the FE, but it is not mandatory. The examiner's duty is only to get valid data. The examiner is not an interrogator. Whether the subjects pass or fail, the subjects will return to the case agent.

It is clear that the TU is the basis of both the BE and the FE in SPiPI (or SPEI). It had been suggested that the BE should be composed by two TUs of multi-issues or multi-facet CQTs and one TU of CIT in SPEI. The TUs in the BE must include seven independent relevant questions at least. The questions such as "Did you steal any of that money?" and "Are you the person who stole any of that money?" are not independent relevant questions. They are not viewed as independent relevant questions. The "seven independent relevant questions" requirement is called "Minimum Measurements Standard (MMS)" (Chen & Liu, 2007; Chen & Sun et al, 2005; Liu & Wang, 2008). MMS can direct the examiner to make a conclusion depending on whether the data collection was sufficient. In general the BE does not encourage the examiner to use more than nine independent relevant questions for efficiency. More questions can be used in FE if needed.

The FE should mainly be composed of one or more TUs of single-issue CQT(s) or CIT(s). The CQT and CIT here are the TUs. We suggest that the FE should use as many TUs as possible. Using a Chinese idiom is "Duo Duo Yi Shan (多多益善, the more the better)."

If the ERPs approach is used, it is still regarded as the TU.

Every TU is made of a series of questions which can be answered with either a Yes or No. With different test purposes different question formats are formed. This is the reason that so many test techniques such as CQT, CIT and so on can exist. Although some scholars like or dislike some test techniques, they do exist and are valid in certain situations. We are not interested in disputing which one is "scientific" or not. To find truth, and to overcome problems that we meet in investigations, are much more important.

The entire outcomes from the BE and the FE can produce a conclusion of the SPiPI (or SPEI). This conclusion is also named "Pass," "Fail," or "Inconclusive." The "Pass" conclusion indicates that the examinee's statements are reliable and there is no more new information concerned with the examinee's statements about the investigation. The "Fail" conclusion means that the examinee's statements are unreliable and there is some new information still in the examinee's mind. The information which the examinee does not express in the statements about the investigation is being detected by the examination. The "Fail" issues (relevant questions) will become guidelines to next step to the investigation. The "Inconclusive" information is fuzzy to the examiner and maybe a further test should be taken after this examination. The "Inconclusive" is still a conclusion of our examination.

It is certain that we need theoretical support and we need to adhere to these principles in practice. We believe that the information theory could provide new illumination and assist in understanding the traditional explanation of detection of deception more completely.

Information Resonance

The definitions of deception are many different types. However the Misleading Information on Purpose (MIP) is a core of all the definition types. In fact the detection of deception means to detect information.

When our body encounters stimuli it can respond instinctively. The response can be analyzed at many different levels, from the complex social interactions within populations to the fine spatial detail of an individual organism's movements. A simple but fundamental point is that the form of measurement used for studying response should reflect the nature of the problem and the questions posed. I think the study of responses from deception should center on information.

A fine-grained analysis is only appropriate for answering some sorts of questions, and a full understanding will not necessarily emerge from describing and analyzing responses at the most detailed level. The information level is a proper level to understand SPiPI and SPEI, even in traditional polygraph examinations. In one hand information is the core of deception and on the other hand it can give an appropriate answer to the question about responses from the probe or examination.

The principle of the Black-Box is known to us. We can analyze the content of a black-box by measuring the difference between its input and output without opening the box. Now let us take a subject as a Black-Box, and take the questions from the TUs as input, then take the responses from the subject as output. This is a complete procedure for the Black-Box.

Almost every examiner has received this question from a layperson, "what are you detecting?" The answer could be "lies" or "physiological responses" etc., but I think the most exact answer should be "information." The difference from its input and output of the Black-Box is from Information Resonance (IR). In other words, the IR is the source of the difference.

In physics, resonance is the tendency of a system (usually a linear system) to oscillate with larger amplitude at some frequencies than at others. These are known as the system's resonant frequencies. At these frequencies, even small periodic driving forces can produce large amplitude oscillations, because the system stores vibrational energy.

Resonance phenomena occur with all types of vibrations or waves: there is mechanical resonance, acoustic resonance, electromagnetic resonance, nuclear magnetic resonance (NMR), electron spin resonance (ESR) and resonance of quantum wave functions. Resonant systems can be used to generate vibrations of a specific frequency (e.g. musical instruments), or pick out specific frequencies from a complex vibration containing many frequencies.

We think that by using resonance phenomena we can easily interpret any change of responses aroused during probe or examination. Any information can be analyzed by a kind of vibration or wave. Resonant systems can be used to pick out specific frequencies from a complex vibration containing many frequencies. It is very similar with our effort to pick out specific information from a brain containing much more complex information than a physics system. A physicist can use a wave with specific frequency to pick specific frequencies out from a complex vibration containing many frequencies. An examiner can use a stimulus (a question or a picture etc.) with specific information to pick specific information out from a subject. It is a natural utility of IR.

The Stim Test in the polygraph examination gives us a good example to explain the utility of IR. Whether the subject writes down a number or reads a poker card, the information of the number or the card will be stored in his/her mind. When the examiner asks or shows the number or card before the subject (input), the subject's many physiological responses will appear (output). Some of them can be detected by polygraph. The reason of the resulting responses can be regarded as the function of IR (Chen & Sun, 2005; Chen & Liu, 2007).

We think whether using probable lie comparison questions or directed lie comparison questions in the CQT, the aim for them is to purify information in the subject's brain. Avital Ginton's RIG (Relevant Issue Gravity) (Ginton, 2009) can help us to understand the usefulness of Information Resonance by other way. We do not test an examinee using a CQT on the same day that the criminal action took place.

Big Control Question Test

During 1998 to 2001 the author organized a series of experiments to test and confirm the utility of the polygraph in China. There were many soldiers as subjects in our experiments. The CQT was a key target to examine for its good or ill repute. The procedures and results of these experiments could not be published. But the main achievement now can be known by several ways. The handbook (Liu & Wang, 2008) for polygraph certificate in China is one of them.

It is an honor for author Chen to be an editor in chief in publishing this book. The SPiPI, SPEI and IR are all from this book as well as the concept of the Big Control Question Test[1] (BCQT). In the BCQT concept, there are three categories of questions which are used as stimuli for the subject. The first category of questions is Big Control Question(s) (BCQ), which includes two types of questions. One is named Control Question(s) (CQ), and the other is named Probe Question(s) (PQ). Both of them are designed for the innocent. CQ can be known as the conventional means in CQT, but PQ may not be very familiar to some examiners. In fact the name of PQ is from the ERP literature for its similarity to its use in ERPs testing. The probe stimulus (including question, picture, and tone etc.) was used as a measure of sensory processing in ERPs. When an apparent irrelevant question is discussed between the examiner and subject during pre-test interview, such as what color the subject likes, if the question "Do you like blue?" is asked in CQT, this question is a PQ.

The second category of questions is the Relevant Question, which is designed for the guilty. The third category of questions is the Irrelevant Question or Neutral Question, which is designed for both innocence and guilt. Based on this thought, the principles about comparison in conventional CQT and CIT can conform to a united name "Big Control Question Test (BCQT)." Their core is the "Big Control Question(s) (BCQ)." By this concept, the CIT's questions from background items all can be assigned as BCQ(s). The key or target question is the Relevant Question. It is undoubted that BCQ(s) is a type of stimulus such as a question or a picture which can elicit responses from an innocent subject and the Relevant Question should elicit responses from a guilty subject in the same way. The question is only one form of stimuli. It can be substituted by a picture or other items in practice.

The BCQ name comes from many questions in SPiPI that can function in the conventional role as "control (or comparison) question(s)." This could be the probe or key question in the CIT. The BCQ is not a single question in the CQT or CIT, but a group of questions within them. A typical group of BCQs are those from CIT questions except the target question and irrelevant questions. The use of "Big" means "many." It is used to distinguish them from a conventional understanding of "control (or comparison) question(s)."

The BCQ concept can give us a great advantage to process data from the examination, especially for computer processing. When the geometric mean of the BCQ is calculated, the criteria of judgment or comparison are established.

A typical CIT format is as follows in SPEI:

1. Are you named XXX?
2. Are you willing to answer the questions concerned with X Case?
3. Do you know where the knife is now?
4. Is in A (background item 1)?
5. Is in B (background item 2)?
6. Is in C (target or background item 3)?
7. Is in D (background item 4)?
8. Is in E (background item 5)?
9. All your above answers are true?

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[1] Editor's note: The APA began substituting the phrase "control question test" with "comparison question test" in 1997 in all of its publications. The former version is used here to retain the direct translation from the original language.

Questions 3 and 6 are relevant questions. Questions 1, 2, and 9 are irrelevant questions. Questions 4, 5, (6), 7, and 8 are buffer questions.

If the knife was found by investigators, the questions 4, 5, 7, and 8 form a BCQ. Their responses are calculated using the Geometric Mean. The Mean is regarded as BCQ's response which can be compared with the target question's response. The Geometric Mean is not the Arithmetic Mean. Based on Stevens' Power Law (Luce, 1990) the physiological response cannot be calculated using the Arithmetic Mean.

If the knife was not found by investigators, they did not know where it was. The buffer questions are questions 4-8. All of them form a BCQ. Their responses are calculated using the Geometric Mean. The mean is compared with each of the items' response. The item producing the biggest difference is the most likely place to find the knife. The conventional CQ can be only used with the CQT. There is no CQ in the CIT (including GKT and POT) by conventional view. The procedure of the calculation is done mainly by computer algorithm. But if necessary the examiner can evaluate the data by hand.

Two Distributions and One Curve

When a response is detected from a subject, the intensity of it should be recorded and analyzed. There are many methods for data processing such as Backster's scoring system (Matte, 1998). Our data processing system is called Sun2000. It is based on two distributions.

If Ic is the intensity of a response of a control question from a subject, Ir is the intensity of a response of a relevant question from the same subject.

The intensity of response is derived from each physiological channel. They are from respiration, electrodermal response, and cardioactivity in a polygraph examination. The Ic and Ir can be a pair of the electrodermal amplitude, a pair of respiratory line length, or a pair of blood pressure from a same subject's response of a pair of control and relevant questions. The details of data processing (including raw data filter and threshold selection) are described in the book (Chen & Liu, 2007) and our training manual. Here is a brief introduction.

Let $Rr=(Ir-Ic)/max(Ir, Ic)$

Then:
When $Rr>0$, the outcome is positive (+), means "fail".
When $Rr<0$, the outcome is negative (-), means "pass".
When $Rr=0$, the outcome is not confirmed, means "inconclusive".

Based on these definitions, we (Chen & Sun, 2004) found two thresholds from subjects who were mainly soldiers had participated in our experiments as examinees. One is $Rr(+)=0.50$, and the other is $Rr(-)=-0.33$, $SD(+)=0.25$, and $SD(-)=0.17$.

When $Rr>Rr(+)=0.50$, the outcome is positive (+), surely means "fail".
When $Rr<Rr(-)=-0.33$, the outcome is negative (-), surely means "pass".
When $-0.33 \leq Rr \leq 0.50$, the outcome will depend on the two normal distributions:

(1) $Rr(+)=0.50\pm0.25$
(2) $Rr(-)=-0.33\pm0.17$

If these two distributions can give our examiners some reasons to judge an examinee, a curve can help us to understand polygraph more. According to these two distributions, we can easily draw a ROC (Receiver Operating Characteristic) curve (Guo, 2004) to evaluate the accuracy of SPEI. This ROC is called one curve.

The ROC curve is as follows:
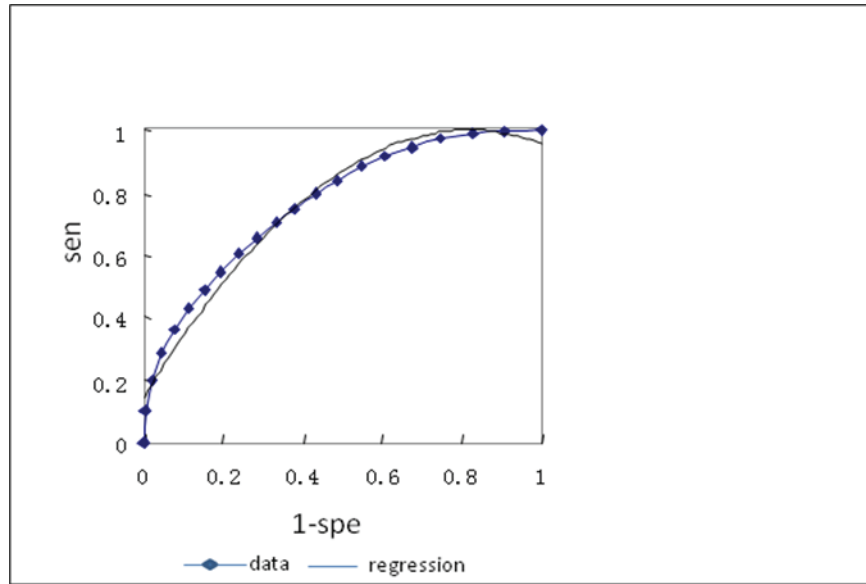
The AUC (area under curve) can be calculated by regression equation (1). The correlation coefficient of this equation is 0.9887 (R^2=0.9776).

$$y=-1.2685x^2+2.0772x+0.1478 \quad (1)$$

Integrate (1), then

$$f(x)=-0.4228x^3+1.0386x^2+0.1478x$$

When x=1, f(x)=0.7636
When x=0, f(x)=0
So the AUC=0.7636-0=0.7636

Based on the standards of ROC (Yang, 2007; Yan, 2010), the accuracy of SPEI is C (fair).

standard	A (excellent)	B (good)	C (fair)	D (poor)	F (fail)
AUC	0.90-1.00	0.80-0.90	0.70-0.80	0.60-0.70	0.50-0.60

This result can be interpreted as proof of the conclusion from the National Academy of Sciences (NAS, 2003):"... we conclude that in populations of examinees such as those represented in the polygraph literature... specific-incident polygraph tests for event-specific investigations can discriminate lying from truth-telling at rates well above chance, though well below perfection." is reasonable.

Conclusions

1. China has its own procedures, systems, and standards about the Psycho-information Probe for Credibility Assessment.
2. The polygraph is a very useful tool for Psycho-information Probe.
3. The Psycho-information Probe can give a way to better understand polygraph.

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