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Observe, Target, Engage, Respond(OTER©):
High-stake behaviour analysis using an integrated, scientific approach within an airport context.

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A B S T R A C T

In this paper, we explore the impact of combining three key components of behavioural analysis into a training course for those responsible for observing, targeting, engaging and responding to those who may pose a terrorist or other serious threat to airport safety and security. First, the challenge of primary detection; identifying and targeting those with potential malintent from a crowd of genuine passengers and airport users from behaviour alone, without racial or other discriminatory profiling practices. Secondly, testing the prediction through real-time capturing of behavioural data across multiple communication channels (Face, Body/Gestures, Voice, Linguistic Content, Interactive (verbal) Style and Psychophysiology) that aid veracity judgments. It is about noticing what we see and hear. We adopt a truth bias to enable a manageable methodology for real-time lie/truth detection using a holistic approach with concurrent attention to multiple channels of a subject's behaviour. Thirdly, we highlight the key to detecting malintent is in the questions you ask. Undercover personnel, using elicitation techniques via casual conversations and/or formal interviews by armed and unarmed staff, using unpredictable questions that are no trouble for a truthful person, yet are a major challenge for the malfeasant, creating verbal and non-verbal leakage across six channels that are probably impossible to manage simultaneously. We highlight the impact of training processes that are fit for purpose for the field and the need to devise innovative approaches for those working in high-stakes, real-time contexts, maybe working alone, maybe in interactions that last only three minutes. We will outline how this unique combination was tested and resulted in increased true negatives by 400% and reduced false positives by 60% in a high-stake experiment, with benchmark controls, conducted over six days in a busy airport by an integrated team of behaviour detection officers from civil, police and military agencies.

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1. Introduction

Air Marshals(AMs) were introduced into the security layers within airports in the 1960s following an increase in airliner hijacking (Ravich 2007), though Behavioural Detection Officers (BDOs) were not introduced until a half-century later following the events of 9/11 (Price and Forrest 2012). A BDO's remit is that of airport surveillance using behavioural detection techniques to supplement the technological and other security layers in an airport context. The use of behaviour detection techniques in airport settings has been criticized recently, not least because of fears that BDOs were effectively undertaking a form of ethnic and racial profiling (see, e.g., Bangert, 2003; Hawk, 2003). This should not be taken to mean that there are no behavioural indicators which can be helpful in such settings. A recent report from USA Homeland Security (2015) supported this argument with its report to Congress[1]. There is also some evidence to suggest that individuals with mal-intent (e.g., suicide bombers) will generally feel high levels of stress and thus show visible signs of anxiety (Silke, 2010). What must be avoided, nonetheless, are theories such as someone with mal-intent will always be anxious, or conversely, signs of stress and

[1] Department of Homeland Security. 2015. *Scientific Substantiation of Behavioural Indicators* . [ONLINE] Available at: https://www.dhs.gov/sites/default/files/publications/Transportation%20Security%20Administration%20(TSA)%20-%20Scientific%20Substantiation%20of%20Behavioural%20Indicators.pdf. [Accessed 14 March 2017].

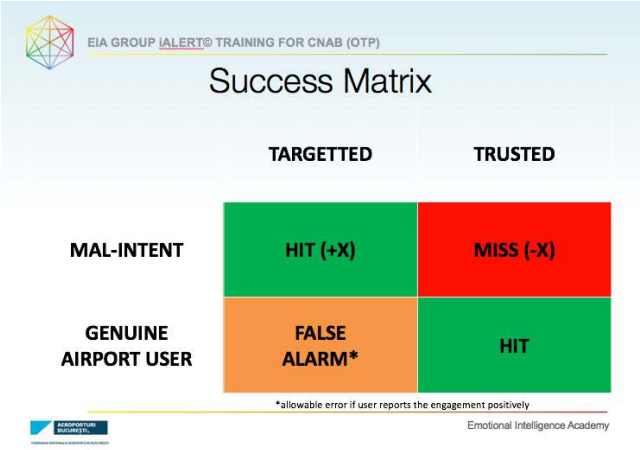
anxiety automatically equate to mal-intent on the part of that nervous individual.

From analysis of over 300 historical post-engagement reports, from operational BDOs in Bucharest Airports[2], the authors found that these states (not behaviours) of 'anxious' and 'nervous' were often used as descriptors when BDOs reported what triggered their decision to engage a particular passenger and resulted in many false positives – innocent passengers suffering unnecessary interviews and/or delays. Reliance on anxiety related triggers is particular problematic in an airport setting given that,

> Major airports are stressful environments at the best of times. Missed connections, flight delays and cancellations, fear of flying, missing luggage, tiredness, sleep deprivation, crowded environments, long queues and so on all have impacts. Indeed, for many (if not most) being stressed and anxious is an entirely routine experience at a busy airport (Silke, 2010: 9).

All stakeholders in this initiative were keen to ensure that a zero-tolerance principle towards racial profiling[3] and to respect basic human rights and freedoms. This included the desire to optimise safety and security and minimise false-positives[4] to ensure this security initiative had limited or positive effects on customer service. There was also a will to avoid unnecessary delays or queues that interfere with smooth operations for airport users, and increase effective and efficient use of security personnel.

The following matrix summarises these general success indicators:



The Emotional Intelligence Academy (EIAGroup) were engaged under contract by Compania Naţională Aeroporturi Bucureşti (CNAB) in September 2016 to develop and deploy a highly tailored programme for BDOs, based on EIAGroup's behavioural analysis and primary detection research[5]. This was achieved in close cooperation with senior operational staff from across the Serviciul Român de Informaţii (SRI) and CNAB under the support and scrutiny of the Civil Aviation Authority and the Ministry of Transport.

The purpose of the programme was to train BDOs, and other airport personnel based in Romania's Otopeni Airport, to better identify and investigate those airport users who exhibit behaviour that is consistent with those who may have malintent[6], i.e., a Person of Interest (henceforth PoI).

This pilot programme ran from November 2016 to March 2017. It began with a three-day workshop, involving twenty-four BDOs (in November) followed by a further three days of training (in January 2017). All BDOs were then brought together in March, for the final, three-day "application and testing" exercise at Otopeni Airport, preceded by a three-day control exercise that didn't involve the trained group. This paper reports on the training received, by the BDOs, the design of the exercise

[2] Classified internal documents reporting triggers, engagement process and outcomes when airport users were identified to be a potential security/safety threat to the airport and other passengers.

[3] Racial profiling defined here as suspicion of malintent based on the individual's race, ethnicity, religion or national origin.

[4] Mis-judging genuine passengers as having malintent.

[5] Controlled and classified as Secret within the initiative.

[6] Focused primarily on imminent terrorist attacks or those carrying out surveillance that may lead to one. A range of other threats were included including those transporting weapons, IEDs or other dangerous or illegal objects/substances through the airport; those with fake or invalid IDs, all the way down to pickpockets.

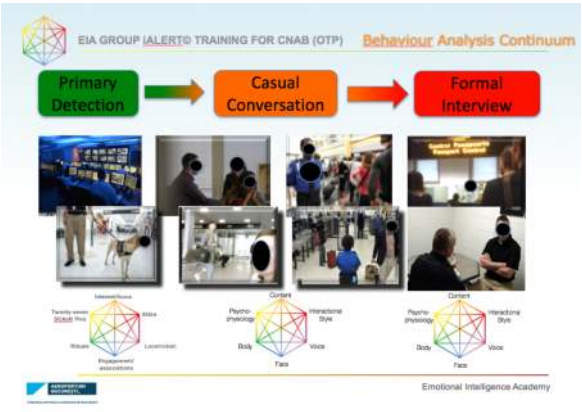
undertaken in the Airport, and the results generated by the testing exercise. Our objective is to evaluate the usefulness of implementing such a systematic, integrated method, based on 179 sources of relevant research (Appendix 1) for determining when BDOs should report instances of suspicious behaviour upwards to airport security personnel, albeit in one specific context: landside departures, Otopeni, Bucharest. The report then goes on to discuss the implications of these findings for behavioural detection in an airport context.

2. Otopeni BDO Training Programme

A mixture of secure online modules and workshops were deployed over 5 months to train 24 BDOs using a four stage '**OTER**©' process:

1. **O**bserve multiple airport users from a distance
2. **T**arget individuals who exhibit clusters of behavioural indicators of potential malintent
3. **E**ngage those targeted in casual conversations and/or formal interviews by uniformed and non-uniformed BDOs
4. **R**espond appropriately following the engagement (e.g. release, refer, arrest, report, etc).

The Observe and Target phases are centred on forty-nine primary detection behaviour indicators, with twenty-seven of those behaviour indicators being the focus once the target has been Engaged in casual conversation and/or semi-/formal interview processes. This process is outlined in the following diagram:



2.1 Observe/Target (Primary Detection)

The primary detection criteria from EIAGroup were adapted and tailored through four levels so as to be context specific (general malintent > airport > OTP airport > landside departures). They are grouped into 6 dimensions, captured by the acronym, iALERT©.

- **i** relates to what a PoI is showing interest in, when in the airport.
- **A** relates to a PoI's Attire, which includes but is not specific to their clothing.
- **L** relates to Locomotion, including a PoI's gait and trajectory through the airport.
- **E** relates to Engagement, that is, how a PoI is reacting to/interacting with their surroundings.
- **R** relates to a PoI's use of Ritual behaviour.
- **T** relates to Twenty-seven criteria that the BDO can use from a distance, when scanning the PoI's six communication channels (facial expressions, body movements, plus their psychophysiology, and/or, if they are close enough to the PoI, their voice, interactive(verbal) style and verbal content.

2.2 Engage (casual/formal)

The behavioural analysis focus transitions totally to these 27 indicators (the **T** of iALERT©) once a person is engaged in casual/formal interaction with the BDO. These are sub-divided into six channels outlined in '**T**' above. These are derived from peer reviewed research where they are framed as the Six Channel Analysis - Real-time (SCAnR©) method (Archer and Lansley 2015; Lansley 2017).

As Silke (2010: 9) notes, we cannot assume to understand *why* an individual may be exhibiting a particular behaviour or behaviours in an airport context using observation techniques alone: whether those observations have been made from a distance or close up. The i-ALERT© training is therefore combined with additional training in a variety of cognitive and emotion based elicitation and interview techniques (covert, formal and semi-formal), so that BDOs have the ability/interactional tools to engage a PoI and

(in)validate any hypotheses they may have (Hargie, 2011; Lansley 2017; Archer et al. forthcoming; Hadnagy, 2011). The iALERT© and SCAnR methods are both reliant, in turn, upon different sensitivity algorithms. These are designed to ensure that BDOs do not act upon single or limited behavioural cues. This is in line with deception research, which indicates that multiple cues occurring across the communication channels can be taken to be more indicative of potential deception than a single cue can (Porter and ten Brinke 2010; Lansley et al 2016). The iALERT© method necessitates that BDOs pay attention to behavioural cues only when they notice three cues representative of two or more dimensions within a three-minute observational window (prior to engaging the PoI). Once a BDO engages a PoI, the SCAnR method necessitates that BDOs need only be concerned with three or more indicators across two or more of the six communication channels (face, body, voice, verbal content, interactive style, psychophysiology) within a seven-second observational window following a stimulus. This is especially the case following a prompt, probe or question from the BDO or another (Archer and Lansley 2015: 232), in line with the belief that the PoI's behaviour is likely to be "directly associated with th[is] stimulus" (Houston et al., 2012: 30).

Another means of ensuring BDOs do not jump to conclusions based on inadequate data – such as a single criterion – is that of training them to maximize their observational capabilities by:

a. Ignoring any behaviours that seem consistent with *ABC*, that is, the *Account* being given by a PoI and that PoI's apparent/emerging *Baseline* in this particular *Context* (micro and macro). BDOs are trained to assume truth[7] in real-time contexts.

b. Paying attention, instead, to indicators which represent an inconsistency in respect to the *ABC* at which point they are escalated to Points of Interest (PIns); especially where PIns cluster across the communication channels or across the Primary Detection dimensions (as noted above).

Point 'a' is in line with the belief that, generally speaking, people are better at detecting truths than they are lies: see, for example, Vrij's (2008) assessment that 67 percent of people can correctly evaluate truths (whilst only 44 percent can correctly evaluate lies). Point 2 is an attempt to *free up* BDOs' time, as well as mental faculties, so that they can "prioritise those occasions when an individual demonstrates inconsistencies across [the] communication channels" (Archer and Lansley 2015: 236) or primary detection dimensions (iALERT©). A focus upon multiple cues from words, body, face, etc., in combination with the baseline method (see Point 'a'), is believed in turn to boost a trainee's confidence respecting the PIns identified (see also Porter and ten Brinke 2010). Points 'a' and 'b' are based, further, on the concept that *when people tell lies, they often leak the truth* from one or more channels. That is to say, they experience and thus potentially leak more indicators of cognitive load and/or felt emotions (e.g., fear, duping delight, guilt/shame) when lying than they do when telling the truth (Ekman 2004).

As PIns based upon behavioural observation are *points of interest* relating to inconsistencies only, at this point, BDOs are advised of the need to engage a PoI in further "probing", when possible, using a mixture of elicitation and challenging, yet non-oppressive, cognitive and emotion based interview techniques taught and practiced within the course. It can often be advantageous for BDOs to undertake this probing themselves – or engage a BDO team member in that stage where appropriate - given that, to most passengers, they will appear to be engaging in "simple, light, airy conversation" (Hadnagy 2011: 58).[8]

[7] Controversial, and may be judged as bias, though see rationale in Archer & Lansley (2015).

[8] Where it is not possible for AMs or BDOs to engage in small talk, the PIns would remain *points of interest* to be referred upwards (for further consideration/ investigation by others).

In the remainder of this paper, we therefore report on an airport exercise we have undertaken, which primarily tested BDOs' ability to use iALERT© to identify inconsistencies in a PoI's behaviour. As a secondary focus, we also paid attention to the BDO's engagement with the PoI, as a means of:

- Eliminating noted inconsistencies (because more targeted information relating to the *ABC* was explained to them), or
- Validating PIns to be referred upwards, so that the PoI might be questioned around them by an airport official.

The report concludes with a discussion around the implications of the findings for behavioural detection in an airport context.

3. Participants

The airport exercise involved thirty-two participants:

- BDOs, deployed in eight-person shifts, trained in the system outlined later.
- BDOs, deployed in eight-person shifts, who have not received iALERT© training, to act as a control group.

Both groups were informed that BDO practice was being monitored and all were requested to complete standard reporting forms for consistent data capture. They were blind to the presence of any blue/red-team activity and asked to perform their role as normal, though both groups may have suspected some form of testing processes due to the increased data capture requests (Hawthorne Effect). This constant across the control and trained groups can therefore be eliminated as a contaminant.

The sixteen trained BDOs and sixteen controls were expected to operate as usual as a xx%/xx%[9] mix of uniformed BDOs or undercover BDOs (as passengers - a BDO's normal working role), and the latter were asked to stay in role (i.e., not break their rehearsed cover) throughout the exercise. The trained delegates consisted of 24 professionals (19 male; five female - aged between 24 and 49 years old – drawn from across major civil airport security and military/government agencies/groups (included staff from Border Police, Immigration, Passenger Screening, Transport Police, BDOs, Air Marshalls, Aviation Security officials, Gendarmerie, Intelligence Service, etc.). The control group were of a similar profile.

4. Exercise Design

The design of the airport exercise deliberately allows for a comparison of the performances of the BDOs trained in iALERT© with controls, across two days. Two groups of eight controls were tested in their ability to detect (and verify) inconsistences in a PoI's behaviour in Otopeni airport on a Sunday afternoon and Tuesday morning respectively (their inclusion was based upon their normal shift patterns). The group of sixteen, trained in iALERT©, were tested in their ability to detect (and verify) a PoI's behavioural inconsistencies related to iALERT© on a Wednesday afternoon and Friday morning in the airport. The BDOs were organised such that eight only were in Departures at any one time. Passenger numbers in departures was fairly consistent across the exercise periods and averaged around 2627 giving a 328:1 ratio of passengers to BDO.

Both groups were instructed to refer a PoI upwards to the Common Point of Referral (CPR)[10] when they believed they had found a cluster of diverse PIns within the requisite time period: three minutes in the case of iALERT© and seven seconds in the case of SCAnR©. However, this was *only* when the noted behaviours could not be accounted for and thus explained by the *ABC* (*Account*, *Baseline*, *Context*). They were authorised to engage the PoI in a casual conversation prior to doing so, which some did. Others, however, seemed to prefer referring direct to (uniformed) formal interview, prior to any casual

[9] Classified proportions

[10] A multi-agency hub within the airport, kitted with monitors/communications, closely allied to the central (CCTV) control room

(undercover) engagement with the PoI, and only engaged with them when approved to do so by CPR staff.

We used a *red-team*[11] to test both groups of BDOs (trained and controls – we named the team assigned to the control as 'blue-team' - on all four days of the exercise. Two trainee security personnel from a national agency were engaged as blue-team members on 1pm-4pm Sunday and 10.30am-1.30pm Tuesday (when the controls were active), and then different security personnel as red-team at 1pm-4pm Wednesday (when the BDOs trained in iALERT© were active) and on Friday, 9.45-12.45, though in the latter session the two red-team were fully trained security professionals (with over 10 years undercover experience in the field), in place of trainee security personnel. This was designed to ensure that both controls and trained BDOs had the same amount of exposure to red-team representatives and our trained group were subjected to the more experienced red-team members.

We recognise that there is a slight difference in times on the Tuesday/Friday, and that the controls and trained BDOs were active on different days (Sunday/Tuesday versus Wednesday/Friday). Based upon a review of the number of passengers taking off from Departures during these periods we know that 3,548 passengers went through Departures between 1pm and 4pm Sunday; 2,000 passengers went through between 11am and 2pm Tuesday; 2,607 passengers went through between 1pm and 4pm Wednesday; and 2,352 passengers went through between 10am and 1pm Friday. This suggests an average of 2627 giving a 328:1 ratio of passengers to BDO. Non-travellers[12] can also be present in Departures (the Airport senior management team suggests that they probably increase the above figures by a further 12.5%) though these aren't included in the figures.

The blue/red-team brief[13] was (1) to build a cover story and gather information about security procedures in Departures (= Mission 1), on the Sunday/Wednesday, and (2) to get themselves and unauthorized objects (fake weapons, contraband, fake IEDs, etc.) through security (= Mission 2), on the Tuesday/Friday. As a means of incentivising the trainee security personnel, in particular, they were told that their career grading/success relied on them succeeding (after the exercise they were told this would not be the case).

5. Results and Discussion

In the Sections that follow, we discuss the referrals made by the controls and the BDOs trained in iALERT©, during what we will refer to as Mission 1 and Mission 2. We then go on explore the extent to which both groups engaged with PoIs, and how successful their engagements were.

5.1 Mission 1 (intelligence surveillance for Mission 2)

The eight controls made ten referrals between 1pm and 4pm Sunday. However, six were deemed to be invalid, by the authors, because we discovered that the referrer had previously received some training, within another Agency, in SCAnR© (the T dimension within iALERT©). As Table 1 reveals, one of the two red-team members undertaking Mission 1 (surveillance) was identified by the controls, and ultimately found to have mal-intent when referred upwards. As a group, the controls also identified three PoIs who were later confirmed to be genuine passengers.

TABLE 1: RESULTS FOR CONTROLS (MISSION 1)

	Freq.	%
True Negative	1	20.0
False Positive	3	60.0
Unknown	1	20.0
Total	5	100.0

The number of justifications (or cues) per referral was found to be 1.6 on average for the control group. This is

[11] The remit of a "red-team" is to challenge an organization as a means of improving its effectiveness.

[12] Family, taxi drivers, staff, enthusiasts, business meetings, etc.

[13] The red-team were briefed 24 hours before the exercise commenced, and were allowed to be connected, via private *Whatsapp* links, during the exercise. They were told that they were not to pass through security until authorised by us (as part of the Tuesday/Friday tests). We did not authorize them to pass through security on the days of the relevant exercise, however, even though they were equipped with travel documents, including Boarding Cards.

lower than we recommend when using the iALERT© method (see below). It also points to a lack of understanding that, in deception-detection related-work, co-occurring multiple inconsistencies tend to provide a confident (and accurate) rationale more so than a single inconsistency (Vrij 2008; Porter and ten Brinke 2010; Lansley et al 2016). Surprisingly, one referral was made without providing any cues, and a second was made based on one cue: *isolated.* The absence of cues in the case of the former is further problematized by the fact that the PoI was referred, but then "lost" by the control group (i.e., probably left the airport) prior to further engagement.

The BDO whose referrals were excluded, because of their previous SCAnR© training, identified the second member of the red-team undertaking Mission 1 (surveillance). The red-team member was confirmed to have mal-intent, on being referred upwards. This particular BDO averaged two cues per referral (across the five referrals). This is lower than recommended, when using the SCAnR© approach, but nonetheless suggests that such training alerts BDOs to the importance of identifying multiple cues (rather than relying upon one only). The use of the twenty-seven SCAnR© criteria, without effective elicitation techniques, is also problematic. This particular BDO concluded behavioural inconsistencies were worthy of referral, but they were later accounted for by passengers' explanations during their formal interviews, for example. If he had engaged the passenger more effectively in line with the training, he may have been able to eradicate him/her as a PoI, prior to referral upwards.

Two (different) red-team members undertook Mission 1 during the early Wednesday 1pm-4pm slot, when BDOs trained in iALERT© were active in Otopeni Airport. As Table 2 reveals, both were identified by the BDOs, thereby verifying the validity of the iALERT© process itself. However, they were subsequently released after the formal interview stage. A review of the referrals in conjunction with the engagement protocols has shown that the engagement process equated to a standard document check rather than a behavioural investigation (framed as either a casual conversation or a formal interview). This is something we sought to rectify on the Thursday (of the March workshop): by reviewing the training on engagement, developing rapport, elicitation techniques, etc. We will return to the issue of effective elicitation later.

TABLE 2: RESULTS FOR BDOS TRAINED IN iALERT (MISSION 1)

	Freq.	%
True Negative	2	25.0
False Positive	5	62.5
Unknown	1	12.5
Total	8	100.0

Other indicators that the iALERT© process has been successfully integrated into the (trained) BDOs' role was their referring a PoI upwards only when three PIns (or more) were evident. In fact, they averaged 3.88 PIns across the eight referrals.

The referrals identified* in Table 3, which were based upon five and seven PIns, relate to the two red-team members.

TABLE 3: FREQUENCY OF CUES USED BY TRAINED, WHEN REFERRING UPWARDS (MISSION 1)

No. of cues which prompted referrals	Freq.	%
3	5	62.5
4	1	12.5
5	1*	12.5
7	1*	12.5

For security reasons, we cannot provide a detailed analysis of the PIns used to refer a PoI upwards. We are able to confirm that all but one of the dimensions (**R**itual) were drawn upon, and that the **A**ttire, **E**ngagement and **L**ocomotion dimensions were included as part of six referrals each. **I**nterest was the next most occurring dimension (having been included in four referrals). Two BDOs also made use of two of the criteria drawn from

SCAnR, which are captured by **T** of the iALERT© acronym.

5.2 Mission 2 (get illegal items through Departures)

The second group of eight controls referred nine PoIs between 10.30am and 1.30pm Tuesday. All were ultimately found to be genuine passengers, following either an interview process or because of entering – and safely completing – the screening process prior to engagement (see Table 4).

TABLE 4: RESULTS FOR CONTROLS (MISSION 2)

	Freq.	%
True Negative	0	0.0
False Positive	8	88.9
Unknown	1	11.1
Total	9	100.0

This group of eight controls used 1.78 cues per referral on average. They referred three of the nine PoIs based upon one cue only (see Table 5). This said, four referrals were based on at least two cues.

TABLE 5: FREQUENCY OF CUES USED BY CONTROLS, WHEN REFERRING UPWARDS (MISSION 2)

No. of cues which prompted referrals	Freq.	%
1	3	33.3
2	5	55.6
3	1	11.1

The BDOs trained in iALERT© referred only five PoIs to CPR between 9.45am and 12.45pm. The *red-team* (whose Mission [2] was to get themselves and unauthorized objects through security) made up two of the referrals (see Table 6).

TABLE 6: RESULTS FOR BDOS TRAINED IN i-ALERT (MISSION 2)

	Freq.	%
True Negative	2	40.0
False Positive	2	40.0
Unknown	1	20.0
Total	5	100.0

They were initially identified through PIns and then engaged casually. Following the activation of CPR, a formal interview took place, and this prompted the screening procedure, a body search, and a security interview. They were found to have mal-intent, and tagged (at which point they confirmed, using a codeword, that they were red-team).

In addition to identifying the *red-team*, the BDOs identified two genuine passengers[14] incorrectly as a PoI. A fifth referral was characterised as unknown (as the PoI was "lost" before they could be engaged).

All referrals were based upon three PIns. Attire was the most frequent domain identified (with four referrals including such PIns). Locomotion, Engagement and SCAnR© PIns were present in two referrals, and an interest PIn was present in one referral. No Ritual PIns were recorded by the referring BDOs.

The exercise as a whole reveals an increase in primary detection from identification of one from four *red-team* members by the controls, and four from four identifications of *red-team* members by the BDOs trained in iALERT©. However, in one case, a *red-team* member was subsequently released. This was found to be due to a failure to effectively engage (rather than a failure of the iALERT© method).

[14] Validated beyond reasonable doubt from behaviour and document/ID checks.

5.3 Importance of BDOs' engagement with PoIs

Controls on both missions seemed to prefer a formal interview to casual conversation (with two formal interviews and one casual interaction occurring as part of the five referrals).

TABLE 7: ENGAGEMENT

	MISSION 1 REFERRALS			MISSION 2 REFERRALS			
CONTROL GROUP	CASUAL X 1	FORMAL X 2	LOST X 2	CASUAL X 4	FORMAL X 3	LOST X 1	SYSTEM CLEARANCE X 1
TRAINED GROUP	CASUAL X 4	FORMAL X 3	LOST X 1	CASUAL X 4	FORMAL X 3	LOST X 1	-

The trained group engaged the PoIs in casual conversation x 4 in Mission 1, and/or referred to CPR for a formal interview x 3. Many of these interactions were more akin to document checking than a behavioural interview (in spite of using casual conversations x 4 and formal interviews x 3). This prompted a coaching session (on the Thursday) prior to Mission 2. The BDOs' engagement with PoIs improved during Mission 2, but this improvement did not completely eradicate false positives. They engaged four PoIs using a casual conversation format. Three of the four were then engaged again, but using a formal interviewing format (see Table 7).

6. Implications for behavioural detection in airports

This study has demonstrated that the iALERT© method provides BDOs with a systematic means of coding behavioural inconsistencies they have noticed from afar and/or close up. The ability to notice behavioural inconsistencies from afar, and label them systematically for referral purposes, has been found to be especially useful, not least because they enable a BDO to act covertly. The two missions, where PIns were drawn upon by the trained BDOs, suggest that a clustering of at least three PIns is a good way of categorising a passenger as a PoI. However, effective elicitation/interview strategies are then needed to ensure any of the behavioural inconsistencies, which have been noted, are confirmed as PIns – and thus require referral upwards – or can be disregarded – because the new (elicited) information has proven them to be consistent with a genuine passenger's *ABC*. The latter is one means of limiting the number of false positives. We do not believe that they can – or, indeed, should be – completely eradicated. In fact, our view of false positives is that they are "bad" only when a passenger reports any related interaction in a negative way. We are aware that false positives have time implications for BDOs, but would contend that it is still more effective for BDOs to engage in more casual conversations than an airport to be solely (or unduly) reliant upon the more resource intensive formal interviews.

Keeping formal interviews to a minimum, such that a BDO relies primarily upon observation and, where relevant, casual engagements, would have the added benefit of keeping the BDOs' work as invisible as possible. This is supported by recent work (also involving Otopeni Airport), in which we demonstrate how techniques other than questions can be used effectively to elicit useful information. (Lansley et al 2016). This study found a high correlation (0.89[15]), in particular, between the quantity and quality of data gathered during an undercover AMs' fifteen minutes of engagement with passengers and the quality of the elicitation probes used. Passengers shared such information with AMs in ways that suggested they were not considering the sensitivity of such information, moreover (were it to fall into the wrong hands). Any personal data gathered during these sessions is destroyed following immediate review.

7. Future Developments and Research

The project team have identified the need to maintain the momentum gathered and collaborate and progress this development and research in **ten** distinct yet complimentary projects over 2017:

[15] Using Spearman's Coefficient of Rank Order Correlation. See Appendix 1 of that paper.

7.1 Repeating the studies with new groups and retesting the approach, comparing results with the successes realised here. Such testing might also be undertaken at lighter and heavier passenger throughput times in Otopeni Airport's Departures terminal.

7.2 Extending this from Otopeni Airport's Departures terminal to Arrivals and to airside. This will require further tailoring of the iALERT PIns as the context has an effect on the zonal *baselines* with regards to behaviour, attire, locomotion, interactions, focus, etc.. This will not negate the fact that the model has individual, context-specific baselines built into its *ABC* elements.

7.3 Researching the degree to which the iALERT PIns transfer to three other international airports on the principle that no context and culture is the same and the global scope of this model needs to be further tested.

7.4 We will develop a suspicious activity report (akin to those used by police and national security globally), but based upon a 'lighter' (non-classified) version of the iALERT© process (and the PIns within). This part of our work would relate to personnel in the airport whose primary roles may not be security but who can play a valuable role in the behavioural analysis security layer, and complement iALERT© (as used by security personnel).

7.5 We see value in formally polling post-engagement passenger perceptions, as a means of further testing our argument that passengers generally respond positively to BDOs when these security personnel engage them covertly, or uniformed, as "fellow passengers" (Lansley et al 2017; Archer et al forthcoming). The customer service-related work has been prompted by the client's need to increase security effectiveness in a way that has a positive (as opposed to detrimental) effect on the customer's experience.

7.6 To enable a strategic approach to the above five projects will also develop a layered[16], competency-based framework with role profile(s) for BDOs. These will be disaggregated into essential knowledge, understanding, skills and mindsets/aptitudes, so this can be used to recruit, train and assess whether a person meets the requirements of a competent BDO.

7.7 Design an assessment centre (online diagnostics and reality scenario based) to effectively and efficiently assess potential BDOs against this framework prior to recruitment.

7.8 Measure skill attrition and performance deterioration over the short-term (daily/weekly shifts) and long term (months/years in role) via random red-team testing and development of a retraining/upskilling/ refresher model that sustains optimal performance.

7.9 EIA and CNAB tested a ALPHA version of an app developed by EIA that enables standardised logging and reporting of engagements to enable appropriate recording, monitoring and evaluation. This will be developed to a BETA version this year.

7.10 Extend the BD capability and develop a strategy to apply it to supplement other approaches to counter the 'insider threat'.

[16] 'Layered' – maybe organised to allow for Observers/Targeters(+refer) only such as those in CCTV/Observer roles only, as well as the higher-level skill needed by those who also Engage(casual and/or formal) and Respond. Also a light version for extended BD assets (check-in/customer-services/screeners/immigration/customs/ retail/transport… even the public [suspicious signs alert system).

The project team partners are keen to continue to develop, learn, research and share results with other airport companies and Appropriate Authorities to help contribute towards a global gold standard for BDOs. The hope is that this will help ensure global safety and security in airports, and for air travel. Classified content has been removed and therefore, with the permission of the relevant agencies, we are therefore please to make this report available for critique, citing and reference.

(The core and context-specific primary detection indicators of the iALERT© model will remain secure and classified with a central (and local) register of system users to prevent use as security counter-measures).

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APPENDIX 1 – 27 SCAnR© PInS overview* and index to research
N.B. (iALERT© indicators not included as they have been protected and Classified as Secret).

The psychophysiological/ANS channel (P) accounts for seven of the twenty-seven PIns, five of which capture physiological signals that users can sometimes see and hear without technical aids: that is, changes in skin colour, perspiration (P3), blood pressure on visible veins (P4), breath (P5), dryness of the mouth (P6) and pupil size (P7). P1 and P2 relate to changes which usually require technology to be detected (e.g., heart rate and galvonomic monitoring).

Similar to ten Brinke and Porter (2012), the EIA Group model draw on insights from FACS-related research for the first of the five Face codes (F1). Specifically, our (FACS-certified) SCAnR© coders catalogue FACS anomalies with seventeen key FACS codes. F2 marks a durational misfit (Ekman and Frank, 1993), F3 marks evidence of asymmetry (unless indicative of contempt), and F4, evidence of asynchrony between muscle movement across the face for 'felt' emotion(s unless subtle). Finally, F5 marks onset/offset profiles which do not display the smooth onset/offset patterns characteristic of felt emotions (Ekman and Frank, 1993). As with all features, we required inter-annotator agreement between three of the four coders for an individual inconsistency to be verified as a PIn in the SCAnR analysis proper.

The Body channel (B) captures features shown to be of value in emotion and veracity judgments (Vrij *et al*., 1996): specifically, micro- gestures or gestural slips indicative of 'leakage' (B1); evidence of change(s) in illustrator behaviour (B2) and/or manipulators (B3); evidence of (muscle) tension in the body (B4); and changes in eye behaviour (blinks, eye gaze/movement/closure, *etc*.). Codes B1 to B5 are based on a more detailed system of Action Descriptors (ADs) developed by the team at EIA[*****] (cf. ten Brinke and Porter, who simplified FACS Action Units/Descriptors or AUs to aid realtime annotation and multi-rater coding comparisons).

The SCAnR© coding adopted for the Voice (V) enables realtime analysis of changes to pitch (V1), volume (V2) and tone (V3), but coders can also note sound lengthening, backchannels, stressed syllables, utterance trail offs, *etc*. (Rockwell *et al*., 1997).

Interactional Style (IS) is our label for phenomena such as fillers, parroting, evasion strategies (including equivocation markers), response latency, emphatic statements, repetition, qualifiers, pronoun usage (e.g., use of third person/avoidance of first person, or *vice versa*), (de)personalisation, distancing devices, *etc*. (following Jurafsky *et al*., 2009). More specifically, I1 marks changes to the rhythm (or 'flow') of the interaction because of features such as (filled) pauses, stutters, disfluencies, response latency, and so on. I2 marks evidence of evasiveness/ambiguity/equivocation (Wright Whelan et al., 2013). I3 encompasses influencing or impression management strategies. For example, the use of religious belief/values/character references, credibility labels, or a proof/evidence frame (Houston *et al*., 2012), representational frames relating to the subject, inappropriate politeness, repetition, *etc*.

The Content channel (C) contains four PIns. C1 captures changes in tense or inappropriate tense usage (such as when someone pleads for the return of a loved one, but refers to them in the past tense). C2 captures distancing language, following DePaulo *et al*.'s (2003) observation that deceivers will sometimes use linguistic constructions (e.g., fewer self-references, more tentative words) which serve to distance them from the subject(s) of their speech (see also Hancock and Woodworth, 2013). Here, SCAnR© users might consider pronouns, tentativeness features, subject/noun changes, emotional terms/affective language, inappropriate concern, qualifiers, minimisers and other epistemic modality markers, *etc*. (Bond and Lee, 2005; ten Brinke and Porter, 2012; and Newman *et al*., 2003).

The third Content criteria, C3, makes use of an adapted version of Criteria-Based Content Analysis (CBCA)[†††††]. Although CBCA is primarily used to assist (European) courts in evaluating the credibility of children's (transcribed) narratives of sexual abuse, it has been used to evaluate adult accounts relating to issues other than sexual abuse (Porter and Yuille 1996; and Vrij *et al*., 2000). When drawing on CBCA criteria, Vrij *et al*. (2000) used a restricted set in combination with Reality Monitoring criteria. The SCAnR© method, in contrast, has been to amend CBCA criteria[‡‡‡‡‡] so that users might record, as a PIn, occasions when the content of the story that S conveys: (*i*) lacks coherence, (*ii*) lacks unstructured, spontaneous reproduction, (*iii*) includes inappropriate detail, especially relative to the core of the story and what we know about memory (the account may also be void of related associations and unusual/superfluous details), (*iv*) exhibits contextual vagueness (as opposed to being characterised by contextual embedding), (*v*) is devoid of descriptions of interactions (including [recalled] verbatim conversations), (*vi*) is devoid of admissions of poor memory recall/spontaneous correction of memory errors (without prompting) and self-deprecation, and (*vii*) is devoid of accounts of mental states (self and other). The final Content criteria, C4, is used when the SCAnR© user recognises a verbal slip as a PIn (Ekman, 2004: 40).

**27 SCAnR© PInS element of iALERT© were not Classified as they are not deemed useful as a counter-measure as many of these multi-channel cues are leaked sub-consciously and virtually impossible to control simultaneously. (see Archer, D. and C.A.Lansley (2015). 'Public appeals, news interviews and crocodile tears: an argument for multi-channel analysis'. Corpora 10(2): 231-258)*

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The EIA www.emotional-intelligence-academy.com team have catalogued/illustrated each action/signal with a still photograph or video, and assigned it a specific AD reference number. The photographs and videos are not to be taken too literally, as they are designed to exemplify, not typify. There will be slight variations from person to person due to their anatomy and flexibility.

†††††
CBCA assumes that 'a statement derived from memory of an actual experience differs in content and quality from a statement based on invention or fantasy' (Vrij, 2008: 209).

‡‡‡‡‡
This aspect of SCAnR© may prove to be the most contentious, given that CBCA was developed to assess witness credibility, not whether a person was telling the truth or being deceptive, and has previously struggled to distinguish short lies (non-experienced elements) within otherwise truthful stories (i.e., experienced events; see Vrij and Mann, 2001). In our defense, we point to the fact that we are not the only researchers to use CBCA in deception detection research (see, for example, Colwell, 2007; and Vrij *et al*., 2004, 2007), and the fact that our adapted version of CBCA is but one component of the SCAnR method.

Appendix 2 - Index to samples of 179 research sources relevant to the PIns:

PIns defined: Data from one or more of 6 channels that is inconsistent with the Account, Baseline and/or Context

SCAnR©

PIn ref		Descriptor	PIns related Academic Publications - References and Bibliography
F Face	1	Facial expression anomoly	BULLER, D.B. and BURGOON, J.K., 1996. Interpersonal deception theory. Communication theory, 6(3), pp. 203-242. EKMAN, P., 2009. Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage (Revised Edition). WW Norton & Company. EKMAN, P., 2007. Emotions revealed: Recognizing faces and feelings to improve communication and emotional life. Macmillan.
	2	Duration	EKMAN, P., 2003. Darwin, deception, and facial expression. Annals of the New York Academy of Sciences, 1000(1), pp. 205-221. EKMAN, P. and FRIESEN, W.V., 1974. Detecting deception from the body or face. Journal of personality and social psychology, 29(3), pp. 288. EKMAN, P. and FRIESEN, W.V., 1969. Nonverbal leakage and clues to deception, .
	3	Symmetry	EKMAN, P. and FRIESEN, W.V., 1969. Nonverbal leakage and clues to deception, . EKMAN, P., FRIESEN, W.V., O'SULLIVAN, M. and SCHERER, K., 1980. Relative importance of face, body, and speech in judgments of personality and affect. Journal of personality and social psychology, 38(2), pp. 270. FRANK, M.G. and EKMAN, P., 2004. Appearing truthful generalizes across different deception situations. Journal of personality and social psychology, 86(3), pp. 486.
	4	Synchronisation	FRANK, M.G. and EKMAN, P., 1993. Not all smiles are created equal: The differences between enjoyment and nonenjoyment smiles. Humor: International Journal of Humor Research, . HWANG, I.S. and SKINNER, L., Evaluating Truthfulness and Detecting Deception. MATSUMOTO, D., HWANG, H.S., SKINNER, L. and FRANK, M., 2011. Evaluating truthfulness and detecting deception. FBI Law Enforcement Bulletin, 80, pp. 1-25. PORTER, S. and BRINKE, L., 2010. The truth about lies: What works in detecting high-stakes deception? Legal and Criminological Psychology, 15(1), pp. 57-75.
	5	Profile	TEN BRINKE, L., MACDONALD, S., PORTER, S. and O'CONNOR, B., 2012. Crocodile tears: Facial, verbal and body language behaviours associated with genuine and fabricated remorse. Law and human behaviour, 36(1), pp. 51. VRIJ, A., EDWARD, K., ROBERTS, K.P. and BULL, R., 2000. Detecting deceit via analysis of verbal and nonverbal behaviour. Journal of Nonverbal Behaviour, 24(4), pp. 239-263. WOJCIECHOWSKI, J., STOLARSKI, M. and MATTHEWS, G., 2014. Emotional Intelligence and Mismatching Expressive and Verbal Messages: A Contribution to Detection of Deception. PloS one, 9(3), pp. e92570. YAP, M.H., RAJOUB, B., UGAIL, H. and ZWIGGELAAR, R., 2011. Visual cues of facial behaviour in deception detection, Computer Applications and Industrial Electronics (ICCAIE), 2011 IEEE International Conference on 2011, IEEE, pp. 294-299. ZUCKERMAN, M., AMIDON, M.D., BISHOP, S.E. and POMERANTZ, S.D., 1982. Face and tone of voice in the communication of deception. Journal of personality and social psychology, 43(2), pp. 347. ZUCKERMAN, M., DEFRANK, R.S., HALL, J.A., LARRANCE, D.T. and ROSENTHAL, R., 1979. Facial and vocal cues of deception and honesty. Journal of experimental social psychology, 15(4), pp. 378-396.
B Body	1	Gestural slip	BULLER, D.B. and BURGOON, J.K., 1996. Interpersonal deception theory. Communication theory, 6(3), pp. 203-242. BURGOON, J.K. and BULLER, D.B., 1994. Interpersonal deception: III. Effects of deceit on perceived communication and nonverbal behaviour dynamics. Journal of Nonverbal Behaviour, 18(2), pp. 155-184. DEPAULO, B.M., LINDSAY, J.J., MALONE, B.E., MUHLENBRUCK, L., CHARLTON, K. and COOPER, H., 2003. Cues to deception. Psychological bulletin, 129(1), pp. 74.
	2	Illustrators	EKMAN, P., 2009. Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage (Revised Edition). WW Norton & Company. EKMAN, P., 2007. Emotions revealed: Recognizing faces and feelings to improve communication and emotional life. Macmillan. EKMAN, P. and FRIESEN, W.V., 1974. Detecting deception from the body or face. Journal of personality and social psychology, 29(3), pp. 288. EKMAN, P. and FRIESEN, W.V., 1972. Hand movements. Journal of communication, 22(4), pp. 353-374. EKMAN, P. and FRIESEN, W.V., 1969. Nonverbal leakage and clues to deception, .
	3	Manipulators	EKMAN, P., FRIESEN, W.V., O'SULLIVAN, M. and SCHERER, K., 1980. Relative importance of face, body, and speech in judgments of personality and affect. Journal of personality and social psychology, 38(2), pp. 270. EKMAN, P., FRIESEN, W.V. and SCHERER, K.R., 1976. Body movement and voice pitch in deceptive interaction. Semiotica, 16(1), pp. 23-28. HWANG, I.S. and SKINNER, L., Evaluating Truthfulness and Detecting Deception. KENDON, A., 1983. Gesture and speech: How they interact. Nonverbal interaction, 11, pp. 13-45. LEAL, S. and VRIJ, A., 2008. Blinking during and after lying. Journal of Nonverbal Behaviour, 32(4), pp. 187-194.
	4	Tension (muscle/body)	MANN, S., VRIJ, A. and BULL, R., 2002. Suspects, lies, and videotape: An analysis of authentic high-stake liars. Law and human behaviour, 26(3), pp. 365-376. MATSUMOTO, D., HWANG, H.S., SKINNER, L. and FRANK, M., 2011. Evaluating truthfulness and detecting deception. FBI Law Enforcement Bulletin, 80, pp. 1-25. PERELMAN, B.S., 2014. Detecting deception via eyeblink frequency modulation. PeerJ, 2, pp. e260.
	5	Eyes	PORTER, S. and BRINKE, L., 2010. The truth about lies: What works in detecting high-stakes deception? Legal and Criminological Psychology, 15(1), pp. 57-75. TEN BRINKE, L., MACDONALD, S., PORTER, S. and O'CONNOR, B., 2012. Crocodile tears: Facial, verbal and body language behaviours associated with genuine and fabricated remorse. Law and human behaviour, 36(1), pp. 51. VRIJ, A., 1995. Behavioural correlates of deception in a simulated police interview. The Journal of psychology, 129(1), pp. 15-28. VRIJ, A., EDWARD, K., ROBERTS, K.P. and BULL, R., 2000. Detecting deceit via analysis of verbal and nonverbal behaviour. Journal of Nonverbal Behaviour, 24(4), pp. 239-263. VRIJ, A., SEMIN, G.R. and BULL, R., 1996. Insight into behaviour displayed during deception. Human Communication Research, 22(4), pp. 544-562. WHITE, C.H. and BURGOON, J.K., 2001. Adaptation and communicative design. Human Communication Research, 27(1), pp. 9-37. ZUCKERMAN, M., DEPAULO, B.M. and ROSENTHAL, R., 1981. Verbal and nonverbal communication of deception. Advances in experimental social psychology, 14, pp. 1-59. ZURLONI, V., DIANA, B., CAVALERA, C., ARGENTON, L., ELIA, M. and MANTOVANI, F., 2014. Deceptive behaviour in doping related interviews: The case of Lance Armstrong. Psychology of Sport and Exercise, .
V (Voice)	1	Pitch	ANOLLI, L. and CICERI, R., 1997. The voice of deception: Vocal strategies of naive and able liars. Journal of Nonverbal Behaviour, 21(4), pp. 259-284. BACHOROWSKI, J. and OWREN, M.J., 1995. Vocal expression of emotion: Acoustic properties of speech are associated with emotional intensity and context. Psychological Science, 6(4), pp. 219-224. BULLER, D.B. and BURGOON, J.K., 1996. Interpersonal deception theory. Communication theory, 6(3), pp. 203-242. DEPAULO, B.M., LINDSAY, J.J., MALONE, B.E., MUHLENBRUCK, L., CHARLTON, K. and COOPER, H., 2003. Cues to deception. Psychological bulletin, 129(1), pp. 74.
	2	Volume	DEPAULO, B.M., STONE, J.I. and LASSITER, G.D., 1985. Deceiving and detecting deceit. The self and social life, 323. EKMAN, P., 2009. Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage (Revised Edition). WW Norton & Company. EKMAN, P., 2007. Emotions revealed: Recognizing faces and feelings to improve communication and emotional life. Macmillan. EKMAN, P., FRIESEN, W.V. and SCHERER, K.R., 1976. Body movement and voice pitch in deceptive interaction. Semiotica, 16(1), pp. 23-28. ELFENBEIN, H.A. and AMBADY, N., 2002. On the universality and cultural specificity of emotion recognition: a meta-analysis. Psychological bulletin, 128(2), pp. 203. FRICK, R.W., 1985. Communicating emotion: The role of prosodic features. Psychological bulletin, 97(3), pp. 412. HOCKING, J.E. and LEATHERS, D.G., 1980. Nonverbal indicators of deception: A new theoretical perspective. Communications Monographs, 47(2), pp. 119-131. HOLLIEN, H.F., 1990. The acoustics of crime. Springer Science & Business Media.
	3	Voice quality	JUSLIN, P.N. and LAUKKA, P., 2003. Communication of emotions in vocal expression and music performance: Different channels, same code? Psychological bulletin, 129(5), pp. 770. LAUKKA, P., JUSLIN, P. and BRESIN, R., 2005. A dimensional approach to vocal expression of emotion. Cognition & Emotion, 19(5), pp. 633-653. PORTER, S. and BRINKE, L., 2010. The truth about lies: What works in detecting high-stakes deception? Legal and Criminological Psychology, 15(1), pp. 57-75. ROCKWELL, P., BULLER, D.B. and BURGOON, J.K., 1997. The voice of deceit: Refining and expanding vocal cues to deception. Communication Research Reports, 14(4), pp. 451-459. SCHERER, K.R., 1986. Voice, stress, and emotion. Dynamics of stress. Springer, pp. 157-179. STREETER, L.A., KRAUSS, R.M., GELLER, V., OLSON, C. and APPLE, W., 1977. Pitch changes during attempted deception. Journal of personality and social psychology, 35(5), pp. 345. VERVERIDIS, D. and KOTROPOULOS, C., 2006. Emotional speech recognition: Resources, features, and methods. Speech Communication, 48(9), pp. 1162-1181. YILDIRIM, S., BULUT, M., LEE, C.M., KAZEMZADEH, A., DENG, Z., LEE, S., NARAYANAN, S. and BUSSO, C., 2004. An acoustic study of emotions expressed in speech. INTERSPEECH 2004. ZUCKERMAN, M., DEFRANK, R.S., HALL, J.A., LARRANCE, D.T. and ROSENTHAL, R., 1979. Facial and vocal cues of deception and honesty. Journal of experimental social psychology, 15(4), pp. 378-396.
S Interaction Style	1	Flow	ARCULI, J., MALLARD, D. and VILLAR, G., 2010. "Um, I can tell you're lying": linguistic markers of deception versus truth-telling in speech. Applied Psycholinguistics, 31(03), pp. 397-411. BULLER, D.B. and BURGOON, J.K., 1996. Interpersonal deception theory. Communication theory, 6(3), pp. 203-242. CARPENTER, R.H., 1981. Stylistic analysis for law enforcement purposes: A case study of a language variable as an index of a suspect's caution in phrasing answers. Communication Quarterly, 29(1), pp. 32-39. CHOUDHURY, F., 2014. CAN LANGUAGE BE USEFUL IN DETECTING DECEPTION? THE LINGUISTIC MARKERS OF DECEPTION IN THE JODI ARIAS INTERVIEW. Diffusion-The UCLan Journal of Undergraduate Research, 7(2),.
	2	Evasiveness	COLWELL, K., HISCOCK, C.K. and MEMON, A., 2002. Interviewing techniques and the assessment of statement credibility. Applied Cognitive Psychology, 16(3), pp. 287-300. COLWELL, K., HISCOCK-ANISMAN, C.K., MEMON, A., TAYLOR, L. and PREWETT, J., 2007. Assessment Criteria Indicative of Deception (ACID): An integrated system of investigative interviewing and detecting deception. Journal of Investigative Psychology and Offender Profiling, 4(3), pp. 167-180. DEPAULO, B.M., LINDSAY, J.J., MALONE, B.E., MUHLENBRUCK, L., CHARLTON, K. and COOPER, H., 2003. Cues to deception. Psychological bulletin, 129(1), pp. 74. DRISKELL, J.E., SALAS, E. and DRISKELL, T., 2012. Social indicators of deception. Human factors, 54(4), pp. 577-588. EKMAN, P., 2009. Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage (Revised Edition). WW Norton & Company. HIRSCHBERG, J.B., BENUS, S., ENOS, F. and SHRIBERG, E., 2006. Pauses in Deceptive Speech, 2006, Proc. ISCA 3rd International Conference on Speech Prosody.
	3	Impression management	HUMPHERYS, S.L., 2010. A system of deception and fraud detection using reliable linguistic cues including hedging, disfluencies, and repeated phrases. HWANG, I.S. and SKINNER, L., Evaluating Truthfulness and Detecting Deception. MANN, S., VRIJ, A. and BULL, R., 2002. Suspects, lies, and videotape: An analysis of authentic high-stake liars. Law and human behaviour, 26(3), pp. 365-376. PORTER, S. and BRINKE, L., 2010. The truth about lies: What works in detecting high-stakes deception? Legal and Criminological Psychology, 15(1), pp. 57-75. ROCKWELL, P., BULLER, D.B. and BURGOON, J.K., 1997. The voice of deceit: Refining and expanding vocal cues to deception. Communication Research Reports, 14(4), pp. 451-459. VERNHAM, Z., VRIJ, A., LEAL, S., MANN, S. and HILLMAN, J., 2014. Collective intelligence: A field-dependency approach towards identifying signs of truthfulness. Journal of Applied Research in Memory and Cognition, 3(1), pp. 12-20. VRIJ, A., EDWARD, K., ROBERTS, K.P. and BULL, R., 2000. Detecting deceit via analysis of verbal and nonverbal behaviour. Journal of Nonverbal Behaviour, 24(4), pp. 239-263. WHITE, C.H. and BURGOON, J.K., 2001. Adaptation and communicative design. Human Communication Research, 27(1), pp. 9-37. ZUCKERMAN, M., DEPAULO, B.M. and ROSENTHAL, R., 1981. Verbal and nonverbal communication of deception. Advances in experimental social psychology, 14, pp. 1-59.
C Content	1	Tense	AKEHURST, L., KÖHNKEN, G. and HÖFER, E., 2001. Content credibility of accounts derived from live and video presentations. Legal and Criminological Psychology, 6(1), pp. 65-83. BULLER, D.B. and BURGOON, J.K., 1996. Interpersonal deception theory. Communication theory, 6(3), pp. 203-242. BURGOON, J.K. and QIN, T., 2006. The dynamic nature of deception: Verbal communication in duration. Journal of Language and Social Psychology, 25(1), pp. 76-96. CARPENTER, R.H., 1981. Stylistic analysis for law enforcement purposes: A case study of a language variable as an index of a suspect's caution in phrasing answers. Communication Quarterly, 29(1), pp. 32-39.
	2	Distancing language	COLWELL, K., HISCOCK, C.K. and MEMON, A., 2002. Interviewing techniques and the assessment of statement credibility. Applied Cognitive Psychology, 16(3), pp. 287-300. COLWELL, K., HISCOCK-ANISMAN, C.K., MEMON, A., TAYLOR, L. and PREWETT, J., 2007. Assessment Criteria Indicative of Deception (ACID): An integrated system of investigative interviewing and detecting deception. Journal of Investigative Psychology and Offender Profiling, 4(3), pp. 167-180. DEPAULO, B.M., LINDSAY, J.J., MALONE, B.E., MUHLENBRUCK, L., CHARLTON, K. and COOPER, H., 2003. Cues to deception. Psychological bulletin, 129(1), pp. 74. EKMAN, P., 2009. Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage (Revised Edition). WW Norton & Company.
	3	CBCA (adapted criteria)	HWANG, I.S. and SKINNER, L., Evaluating Truthfulness and Detecting Deception. IRELAND, M.E., SLATCHER, R.B., EASTWICK, P.W., SCISSORS, L.E., FINKEL, E.J. and PENNEBAKER, J.W., 2011. Language style matching predicts relationship initiation and stability. Psychological science, 22(1), pp. 39-44. KNIEPS, M., GRANHAG, P. and VRIJ, A., 2013. Repeated visits to the future: Asking about mental images to discriminate between true and false intentions. International Journal of Advances in Psychology, 2(2), pp. 93. MATSUMOTO, D., HWANG, H.S., SKINNER, L. and FRANK, M., 2011. Evaluating truthfulness and detecting deception. FBI Law Enforcement Bulletin, 80, pp. 1-25. MCDOUGALL, A.J. and BULL, R., 2014. Detecting truth in suspect interviews: The effect of use of evidence (early and gradual) and time delay on Criteria-Based Content Analysis, Reality monitoring and inconsistency within suspect
	4	Verbal slip	statements. Psychology, Crime & Law, (just-accepted), pp. 1-26. PEACE, K.A., SHUDRA, R.D., FORRESTER, D.L., KASPER, R., HARDER, J. and PORTER, S., 2014. Tall Tales Across Time: Narrative Analysis of True and False Allegations. Journal of Investigative Psychology and Offender Profiling, . PENNEBAKER, J.W., 2011. The secret life of pronouns. New Scientist, 211(2828), pp. 42-45. PORTER, S. and BRINKE, L., 2010. The truth about lies: What works in detecting high-stakes deception? Legal and Criminological Psychology, 15(1), pp. 57-75. PORTER, S. and YUILLE, J.C., 1994. Credibility assessment of criminal suspects through statement analysis. Psychology, Crime and Law, 1(4), pp. 319-331. TEN BRINKE, L., MACDONALD, S., PORTER, S. and O'CONNOR, B., 2012. Crocodile tears: Facial, verbal and body language behaviours associated with genuine and fabricated remorse. Law and human behaviour, 36(1), pp. 51. UNDEUTSCH, U., 1989. The development of statement reality analysis. Credibility assessment. Springer, pp. 101-119. VRIJ, A., EDWARD, K., ROBERTS, K.P. and BULL, R., 2000. Detecting deceit via analysis of verbal and nonverbal behaviour. Journal of Nonverbal Behaviour, 24(4), pp. 239-263. YUILLE, J.C. and CUTSHALL, J., 1989. Analysis of the statements of victims, witnesses and suspects. Credibility assessment. Springer, pp. 175-191. ZUCKERMAN, M., DEPAULO, B.M. and ROSENTHAL, R., 1981. Verbal and nonverbal communication of deception. Advances in experimental social psychology, 14, pp. 1-59.
P Psycho-physiology	1	Heart Rate	CRITCHLEY, H.D., ECCLES, J. and GARFINKEL, S.N., 2013. Interaction between cognition, emotion, and the autonomic nervous system. Handb Clin Neurol, 117, pp. 59-77.
	2	Galvonomic	EKMAN, P., LEVENSON, R.W. and FRIESEN, W.V., 1983. Autonomic nervous system activity distinguishes among emotions. Science (New York, N.Y.), 221(4616), pp. 1208-1210.
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Appendix 3 - Index to samples of sources of research relevant to the remaining iALERT© PIns:

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