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Science Theatre: Changing South African Students' Intended Behaviour Towards HIV AIDS

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Science centres and other informal learning environments are increasingly becoming venues in which socioscientific issues are presented, sometimes with the aim of influencing attitudes and behaviour. This study investigated the effects of an HIV AIDS science theatre presentation on the behavioural intentions of 697 South African students, a population facing extreme HIV risk. Surveys measured 15 HIV-related intentions before and after the presentation. Significant changes occurred in 9 of 15 intentions including resisting peer-pressure, HIV learning, discussing HIV with family and sexual abstinence. Changes typically involved strengthening of already positive intentions. Regression modelling showed prior intention was the greatest single predictor of intention change, with poor prior intentions associated with greater change. Audience emotional responses of interest and enjoyment, prior knowledge and knowledge change regarding HIV risk, and self-reported learning also predicted intention change; higher scores were associated with greater change. These variables predicted more variation in intention change than prior intentions, suggesting emotional responses in particular, but also knowledge and learning, play an important role in influencing intentions. Demographic variables had no influence on intention change. These findings provide provisional evidence of the importance of the emotions of interest and enjoyment in informal science learning, especially where the aim is to motivate change. The study underscores the potential that science centres and other informal science learning providers have as advocates for positive societal change, even with difficult and contentious issues such as HIV AIDS.

Keywords: *HIV AIDS; Intention; Emotion; Science centre; Affective domain; Health education*

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Introduction: Dealing with Difficult Issues in Science Centres

Informal science learning (ISL) environments are increasingly becoming places in which societal issues and the science related to them are presented to the public. Rennie (2007), drawing on the work of several authors, describes ISL environments as places where: involvement has a voluntary component; curriculum is more flexible and offers choices; activities are non-evaluative and unassessed; and, mixed age groups participate without a teacher being the central adult involved. Some of these criteria, however, are somewhat compromised in the case of school groups in ISL experiences, as is the case in this study. Nevertheless, ISL is essentially 'learner-led and intrinsically motivated' (Rennie, 2007, p. 127), making it an environment which is likely to foster active engagement with issues. In the context of science centres—a common ISL environment—exhibitions, theatre and other components of the centre experience are moving beyond the staple of interactive phenomenon-based content and beginning to tackle issues-based content (Pedretti, 2002, 2004). Issues-based content focuses on areas of overlap and interaction between science and society, such as climate change, environmental issues and HIV AIDS. The push for issues-based content in science centres appears multifaceted: some authors have levelled criticisms that the presentation of science is decontextualised and ignorant of the processes, nature and societal basis of science (Bradburne, 1998; Pedretti, 2004); science centres themselves have acknowledged they have an important role—arguably an obligation—to engage with social issues (Beetlestone, Johnson, Quin, & White, 1998; Mintz, 1995); and visitors have come to expect science centres to address socioscientific issues pervasive in the media and society at large (Borun cited in Mintz, 1995; Pedretti, 2002).

Science centres have rapidly risen to the challenge of dealing with issues-based content. Pedretti (2002, 2004, 2007) cites numerous examples of 'critical issues-based exhibitions' which tackle socioscientific issues head-on such as Science World's *Mine Games*, which dealt with environmental and social issues around mining, while the last few years have seen dramatic growth of climate change-based content, such as the worldwide International Action on Global Warming project (Association of Science-Technology Centres, 2011). Recently, the science centre movement formalised its commitment to engaging with global socioscientific issues through the Toronto Declaration (Fifth Science Centre World Congress, 2008) and its subsequent presentation to the United Nations Millennium Development Goals conference (Science Center And Museum Leadership Worldwide, 2010). Both the Toronto Declaration and the Millennium Development Goals single out HIV AIDS as an issue of urgent concern. As several authors have pointed out, as science centres communicate socioscientific issues, questions of balance and appropriateness of advocacy or 'taking a side' are inevitable (Mintz, 1995; Pedretti, 2002); however, with efforts to fight the spread of HIV, the appropriate position is unproblematic. Science centre-driven HIV content should aim to promote safe behaviour and change unsafe behaviour to combat the AIDS epidemic.

This paper investigates changes in adolescents' HIV-related behavioural intentions and attitudes (termed 'intention change') associated with a science theatre

presentation dealing with the issue. The research was conducted at a South African science centre, where HIV AIDS is a critical socioscientific issue. The central research questions were:

1. Can a science theatre presentation influence high-school students' intended behaviour across a range of actions related to HIV AIDS?
2. Are emotional responses to the theatre presentation, specifically interest and enjoyment, related to intention change?
3. Are demographic variables (age, gender and rural/urban location) related to intention change?

Compared with gains in knowledge and cognitive learning, the study of affect and emotions in science learning is a relatively understudied but an important area, which is relevant for both motivational outcomes such as intention change and understanding learning in informal environments (Alsop, 2005; Bonney, Kempler, Zusho, Coppola, & Pintrich, 2005; Dierking, 2005). Hence, this research primarily focused on the impact specific emotions have on changes in behavioural intentions due to an ISL experience, an area we know little about. Changes in knowledge, however, and their influence on intention change were also investigated, though were not a central focus of the research.

Science Theatre as a Socioscientific Communication Tool

Numerous researchers and practitioners have drawn particular attention to science theatre as a tool for dealing with socioscientific issues (Arnold, 1996; Beetlestone et al., 1998; Mintz, 1995; Pedretti, 2002; Ucko, 1991). Science theatre can be broadly categorised into three areas: stage plays such as Michael Frayn's *Copenhagen*; demonstration-based science shows or lecture demonstrations; and museum theatre, which often differs from science shows by use of characters, narrative and greater focus on dramatic techniques than use of demonstrations (Bridal, 2004). The boundaries between science shows and museum theatre are blurry and the HIV theatre piece studied here combined elements of both. In this paper, science theatre refers generally to museum theatre, science shows and their various hybrids.

Science theatre is a promising yet largely untapped medium to communicate socioscientific issues where the aim is to change behaviour, such as with HIV AIDS. Science theatre has been shown to facilitate learning and positively influence attitudes (Caleon & Subramaniam, 2005, 2007; Tuah, 2009). It is among the most memorable of the different aspects of a museum or science centre visit, and may be recalled several years later (Anderson, Piscitelli, Weier, Everett, & Tayler, 2002; Farmelo, 1992; Sadler, 2004). Science theatre—importantly for socioscientific issues—has also been shown to be emotionally engaging (Hughes, 2008; McCrory, 2010; Mintz, 1995). Moreover, science theatre, through its use of characters, demonstrations and narrative, can teach skills for positive behaviours, demonstrate how to overcome behavioural barriers, model desirable attitudes and beliefs, and address social norms that either help or hinder target behaviours. These aspects form the central elements

of contemporary behaviour change models, including those applied to HIV (Fishbein, 2000; Fishbein, Triandis, Kanfer, Becker, & Middlestadt, 2001), as discussed below. In addition, traditional drama has been shown to be effective in addressing HIV/AIDS, especially in Africa (Mabala, Allen, with Bagamoyo College of Arts, & Tanzania Theatre Centre, 2002; Mwansa & Bergman, 2003). Taken together, evidence points to science theatre being a good vehicle to change behaviour related to socio-scientific issues, including but not limited to HIV/AIDS, yet a review of the literature suggests it is very rarely applied by science centres in such a way. One exception is the Liberty Science Centre in the USA, which used a laser show *Extreme Choices* and traditional theatre play *Hot Air* to communicate anti-smoking messages to school students (Koster & Baumann, 2005). Evaluation of the programmes showed they communicated the anti-smoking messages effectively, with students understanding the negative health consequences of smoking and the importance of their choices (Koster & Baumann, 2005). While it is likely a participant's understanding of the health risks their decisions relate to could lead to intention and behaviour change, these aspects are, however, not reported on.

Behaviour Change—Informal Learning, Emotions and Models

Behaviour change research in ISL environments is mainly restricted to environmental and health contexts. Within science centres and museums such research is comparatively rare. A small number of investigations, however, have been carried out concerning environmental-based exhibitions (i.e. Sutter, 2008) and, most relevant to this research, health-related initiatives with a behavioural focus. Due to difficulties with measuring actual behaviour, especially around controversial issues, most research focuses on how participants intend to behave. Behavioural intentions describe a person's plan to behave in a certain way (Nieswandt, 2005) and can include both planning to engage in positive behaviours or avoid negative behaviours. Cartmill and Day (1997) found a visit to a museum exhibition on illicit drugs, including an exhibition, film and, notably, a presentation or show, significantly reduced intention of drug use. Effects persisted two weeks following. Other studies on the travelling exhibition *BodyWorlds* have found similar results, with changes in intention being recorded for various health behaviours, including smoking, healthy eating, exercise and dental care (Carney et al., 2009).

Among ISL providers, zoos and other environmental organisations have been most active in advocating directly for behaviour change. In contrast to science centres, zoos and other live-animal experiences have been overt campaigners for behaviour change for many years, some rating it as their highest priority (Patrick, Matthews, & Ayers, 2007; Woollard, 2001). Environmental ISL research has revealed much from which science centres can learn as they move towards influencing behaviour. Three aspects in particular will be discussed here: the role of emotions, application of behaviour change models, and the role of knowledge and learning.

Although a variety of environmental ISL theorists have argued that emotion plays an important role in the ISL experience and that it influences behaviour (Ballantyne

& Packer, 2005; Ballantyne, Packer, Hughes, & Dierking, 2007; Smith, 2008), empirical evidence is limited to a few examples. One such is a study on turtle conservation that showed ‘emotional arousal’ was associated with stating intention and, to a lesser degree, taking action to conserve turtles (Howard, 1999). Emotional arousal was measured with three semantic scales: stimulating–boring, exciting–dull and inspiring–uninspiring. Further environmental ISL studies drawing on qualitative data also suggest changes to attitudes and behaviour were associated with arousing emotions (see Ballantyne & Packer, 2005 for a review). Other apparently contradictory research in zoos, however, suggests limited empirical support for emotional arousal facilitating changes in attitudes, intentions and behaviour, however still argues for the importance of emotions and calls for more research (Smith, 2008). The general conclusion of this body of literature is that while emotions are important and appear to play a role in influencing behaviour, we still have much to learn. More broadly, emotional engagement has been identified as an important part of learning in informal settings such as science centres and museums (Csikszentmihalyi & Hermanson, 1999; Falk & Gillespie, 2009), as a key part of the impact of issues-based exhibitions (Pedretti, 2002, 2004), and, as previously mentioned, as an outcome of science theatre.

In settings aiming to influence intentions and behaviour, such as the one described here, the emotions of interest and enjoyment are worthy of investigation due to their role in intrinsically motivated learning (Deci, 1992; Deci & Ryan, 1985) and learning more broadly. Interest is critical for learning and motivational outcomes and leads to increased attention, cognitive functioning, recall, grades, effort, persistence and deeper information processing (Ainley, 2006; Ainley, Corrigan, & Richardson, 2005; Dewey, 1913; Ellsworth & Smith, 1988; Hidi, 2001, 2006; Hidi & Harackiewicz, 2000; Krapp, 2007; Silvia, 2006, 2008). Enjoyment is less studied in learning environments, however it has been associated with increased focus on the learning task, resistance to distractions and more sophisticated learning strategies such as self-regulated learning, creative problem solving and critical thinking (Goetz, Hall, Frenzel, & Pekrun, 2006; Pekrun, Goetz, Titz, & Perry, 2002).

Recent approaches to emotion research involve measurement of underlying steps or checks that one goes through that determine the emotion generated. These are termed appraisals (Roseman, 2001; Scherer, Schorr, & Johnstone, 2001), however this approach is currently untested in science education research. Two underlying appraisals of the emotion of interest are, first, the novelty and complexity of a stimulus and, second, what emotion researchers term ‘coping potential’—an individual’s ability to understand or make sense of a stimulus (Silvia, 2005, 2006). Thus, a person will feel interested when they experience a novel, complex stimulus that they also feel able to understand. The emotion of enjoyment, however, is less precisely defined than interest, with theorists proposing that its appraisal involves satisfaction of goals or being consistent with one’s motives (Power & Dalglish, 2008; Roseman, 2001). As individuals have a wide range of motives for a science centre visit (Falk & Dierking, 2000; Falk, Moussouri, & Coulson, 1998), which might range from learning about HIV to escaping school lessons, measuring this underlying aspect of enjoyment is

complex. In such cases, researchers often use synonyms and antonyms of emotions in their measurement.

Psychological behaviour change models have been applied in environmental ISL research (Dierking et al., 2004; Ham & Krumpke, 1996), in particular, the Theory of Planned Behaviour (Ajzen, 1991). In conventional HIV interventions and adolescent HIV learning, both the Theory of Planned Behaviour and closely related Theory of Reasoned Action have been applied (Fishbein, 2000; Fishbein et al., 2001; Gebreyesus Hadera, Boer, & Kuiper, 2007). Generally speaking, these models propose that behavioural intentions are a product of (1) behavioural beliefs, knowledge and attitudes, (2) social norms around the behaviour and (3) self-efficacy beliefs in carrying out the behaviour. Intentions are the end point of other influencing factors and meta-analytic reviews have shown intentions to be the best predictors of behaviour (Armitage & Conner, 2001). According to these models, translation of intention into behaviour will also depend on other factors such as environmental barriers/promoters and necessary skills. These other factors have not yet been seriously addressed in the intervention described in this paper, hence are not reported at this stage.

One implication of these models is that to influence intention, we need to influence beliefs and knowledge. Hence prior knowledge, knowledge change and other learning-related factors are of importance. While an individual's learning and resulting knowledge are important, the large gap between knowledge and behaviour documented in numerous areas including environmental and HIV behaviour (James, Reddy, Taylor, & Jinabhai, 2004; Kollmuss & Agyeman, 2002) means knowledge is only one of the factors to consider when trying to influence intentions and behaviour through learning settings. This study focused on the role of providing an interesting and enjoyable experience on intention change. Learning and knowledge were, however, also investigated albeit in less detail.

HIV Behaviour of South African Youth

HIV/AIDS is a critical socioscientific issue in South Africa, with an average HIV prevalence of 18%, or approximately 5.6 million people as of 2009 (UNAIDS, 2010). Approximately 850 people die of the disease each day (UNAIDS, 2010). Most new infections occur in adolescents and young adults, with approximately one-third occurring in 15–24-year-olds (Rehle et al., 2007; UNAIDS, 2008). In the area close to the science centre studied here, prevalence rises from 11% of females and 2% of males in 15–19-year-olds, to 40% of females and 30% of males in 20–29-year-olds (Welz et al., 2007). Welz and colleagues described the area as containing 'some of the highest population-based infection rates yet documented worldwide' (Welz et al., 2007, p. 1471), with 27% of females and 13% of males HIV-positive. It is clear that efficacious interventions targeting high-school youth could have dramatic impacts and are urgently needed in the area near the science centre.

Given that the primary audience of science centres in South Africa is school students and that science centres are able to tackle socioscientific issues, they are ideal

vehicles to deliver HIV interventions. These interventions can address behaviours associated with HIV, explore the biology of HIV transmission, replication and treatment, and explain HIV's effects on the immune system that eventually cause AIDS. In doing so, the science communicated promotes safe behaviour, as is the case with the intervention studied here.

To design effective interventions, a range of behaviours need to be considered and researched. Behaviours associated with HIV include those that directly prevent or risk HIV transmission (such as unprotected sex) or those more generally related to HIV (such as discussing HIV). Unsafe sexual behaviour is the main cause of HIV infections in South African youth (Eaton, Flisher, & Aarb, 2003; Simbayi, Chauveau, & Shisana, 2004), hence promotion of sexual abstinence, condom use and single-partner relationships are common in youth interventions. Our intervention followed a similar avenue, focusing primarily on abstinence, with a secondary focus on condom use and single-partner relationships. This focus shifted depending on age; for example, for senior secondary audiences condom use was stressed more. It is interesting to note that even within the team designing the intervention, disagreement on the balance of these messages existed. This was largely due to diverse cultural, religious and normative beliefs, highlighting issues facing science centres more generally in dealing with issues-based content (Pedretti, 2002). Broader behaviours associated with HIV were also investigated and are important when considering the larger social context surrounding HIV. They include discussing HIV with friends or family, being tested for HIV, being aware of one's HIV status and reducing behaviours that stigmatise HIV.

Demographic differences play a significant role in HIV AIDS in South Africa, with gender, residential location (rural/urban) and age being significant variables. Compared with males, females have much higher prevalence rates, are infected earlier, have lower rates of multiple sexual partnering and poorer HIV knowledge; to a lesser extent they are less sexually active, older at sexual debut (abstinence) and use condoms more, although conflicting data exist on these latter three differences (Akande, 2001; Eaton et al., 2003; Peltzer & Promtussan, 2005; Simbayi et al., 2004; S Pezi The SABSSM III Implementation Team, 2008; Welz et al., 2007). While there are fewer data on rural/urban differences, compared with their urban counterparts, rural students have higher rates of multiple sexual partnering, earlier age of sexual debut, much lower HIV knowledge, greater sexual activity and engage in fewer HIV preventative behaviours (Eaton et al., 2003; Harrison, Cleland, Gouws, & Frohlich, 2005; Kaaya et al., 2002; Kelly, 2000; Peltzer & Promtussan, 2005). As one would expect, sexual behaviour and HIV prevalence increase with age, however less is known about associated behaviour except that multiple partnering increases with age (Kaaya et al., 2002). As the demographic groupings described are substantially different, they require different emphases in any intervention. As the literature concerning South African youth focuses almost exclusively on baseline differences as opposed to differences in response to interventions, this study investigated the influence of these demographic variables on intention change.

Using Science Theatre to Address HIV AIDS

This research investigated the impact of a science theatre show *The Alarming AIDS Adventure* at the University of Zululand Science Centre on the north coast of South Africa's KwaZulu-Natal province. The science centre almost exclusively services urban (township) and rural school groups, as opposed to the general public, with most visitors coming from disadvantaged socioeconomic backgrounds. The centre features hands-on interactive exhibits, science shows, workshops and programmes typical of a contemporary science centre, however it began adding HIV-related initiatives in late 2009. All HIV focused visits involve students and teachers travelling via bus, which is organised by the science centre. During the period of the present investigation the theatre show formed the major HIV intervention component, however other activities such as games and workshops together with a career advice session were also used. A prototype HIV exhibit and poster display are included in the galleries, with a full exhibition planned for the future. Consent was gained from schools and head teachers, and then from individual students

HIV AIDS Theatre Show

The theatre show is presented by two people, one playing the role of a curious student, the other a 'scientist' character. The two roles aim to appeal to students and reinforce the role of science as a way to understand HIV AIDS. Shows are presented in English and isiZulu depending on staff available and the highly variable English proficiency of the audience. Prior to this research, the show was evaluated to ensure it was well received by students. Feedback was gathered from local HIV AIDS workers/scientists and Zulu staff members to ensure the show was scientifically accurate and culturally appropriate.

The show contains a mix of serious messages and light-hearted moments to engage students. Multimedia, props, analogies, narrative and demonstrations are used to explore the topic, using the HIV acronym in reverse as a structure. The first section discusses replication and viruses, the second covers the immune system with reference to HIV, and the third the human aspect focusing on behaviour presented by 'scanning' two people and discussing safe, unsafe and misconceived behaviours. The two characters and audience are then 'shrunk' and travel into the unsafe-behaviour person in a submarine-like ship. Animations are used to show the shrinking process, the life-cycle, genetics and cell biology of HIV, and action of antiretroviral drugs. The theatre then promotes destigmatising HIV, discusses other social issues, encourages testing and reiterates there is no cure for HIV AIDS. It concludes with a large demonstration about sexual behaviours featuring 20 volunteers. Each volunteer has a glass of water, one of which has sodium hydroxide added to it to represent being HIV-positive. Depending on a behavioural instruction on each glass (i.e. abstain from sex—do not share fluids with anyone), volunteers either exchange fluids with everyone, a single partner or nobody. The fact that the fluid mixing is analogous to the exchange of bodily fluids that transmits HIV is stressed. At the end, acid–base indicator is used

as an ‘HIV test’ to show how the virus has spread depending on behaviour, emphasising the show’s primary message.

Method

Pilot Study

Draft survey items were constructed based on the literature review, show content and previous experience with the target audience. An initial pool of 24 behavioural intention items was created and reviewed by five researchers. Additional wording changes and dropping of items due to space considerations left 14 items, which were used on a draft pilot survey and measured with 5-point Likert scales. Likert scales for all studies were labelled ‘strongly disagree’ to ‘strongly agree’, with ‘neutral’ as the midpoint. In addition, Likert scales go some way towards treating intention as a continuous variable by assessing its strength or likelihood (Fishbein et al., 2001). Emotional response was measured using seven semantic difference scales (i.e. boring–exciting), some of which have proven successful in past appraisal-based research on interest (Silvia, 2006). Local Zulu staff were consulted in an attempt to have clear English language surveys for Zulu students. Survey vocabulary was based on terms used in the show and employed more widely when discussing HIV in South Africa (i.e. the ABC acronym for Abstain, Be faithful, Condomise). Additional final changes were made after consultation with science centre staff responsible for translating English into isiZulu.

These surveys were piloted ($n = 453$). Cronbach’s alpha was calculated for the intention items which identified three items with low reliability scores. Inspection of these items revealed possible language interpretation problems, primarily confusion over double negatives (i.e. Strongly disagreeing with ‘not being worried about HIV’ or that HIV-prevention behaviours were *difficult*) and if–then items where it appeared some students interpreted the if–component as a certainty. These items were reworded. Two other intention items previously identified as potentially weak due to a lack of concreteness were also dropped based on extremely high mean scores (ceiling effects) and the desire to instead test new behavioural intentions suggested by the pilot results. The use of semantic difference scales for emotional measurement appeared to cause major interpretation problems, with most participants selecting extreme ends of the scales or circling the actual words.

Main Study

Following item refinement, final pre- and post-show survey instruments were constructed containing 15 HIV behavioural intention items. These items represented a wide range of potential behaviours relevant to HIV derived from the literature and experience with the target audience, with multiple items measuring key facets such as sexual abstinence and condom use, ensuring content validity. Other upstream predictors of intention such as self-efficacy and attitudes were incorporated, however intention was the focus as it is the endpoint in models and best predictor of behaviour, as discussed. These 15 items are henceforth collectively referred to as ‘intentions’.

The same set of intentions was measured immediately before and after the show. Item wordings are reported in the results section. Cronbach's alphas for the pre- and post-intention scales were 0.841 and 0.849, respectively, suggesting excellent reliability given the breadth of intention items.

Given problems with the semantic difference scales used in the pilot, the post-show survey also contained six additional Likert items related to the emotions of interest and enjoyment and their underlying appraisals. Item wordings are reported in Table 3. Issues with semantic difference scales in the pilot stage meant these items could not be tested prior to the main study. Two items directly measured interest and enjoyment. Three additional items were included to deepen the measurement of interest; interest's underlying appraisals of (1) understanding and (2) complexity/complicatedness, along with (3) boredom, a common antonym of interest. As discussed, enjoyment's underlying appraisal of goal consistency varies with individual's motives, so liking of the show was used to measure this underlying appraisal of enjoyment.

To develop a scale that combined these varying aspects of interest and enjoyment, exploratory factor analysis was conducted revealing a two-factor structure (factor loadings are indicated in brackets): (1) enjoyment (0.814), liking (0.744), interest (0.738), and understanding (0.667), and (2) complicatedness (0.912) and boredom (reverse-scored; -0.395). The first factor explained 39% of the variance. After determining that they did not significantly predict intention change, items in the second factor were discarded. Items in the first factor were combined into a summated standardised score (see Table 3) with acceptable reliability (Cronbach's alpha = 0.743), henceforth referred to as 'interest-enjoyment'.

As the role of knowledge was a secondary priority, it was only measured via two items: knowledge of HIV transmission methods (measured pre and post; resulting in a prior knowledge and knowledge change score) and self-reported learning. Item wordings are reported in Table 3.

Sample

A sample of 697 students including approximately equivalent numbers of males and females and about twice as many urban compared with rural students were used in the analysis, as shown in Table 1. Although all attending secondary school, student ages ($M = 14.32$, $SD = 1.36$) were quite broad, ranging from 10 to 21. The data were collected over seven separate shows over a period of three weeks, with rural and urban students attending separately in most cases. Students attended in the context of a free-of-charge school excursion.

Table 1. Demographics

	Unknown	Female	Male	Total
Rural	1	113	127	241
Urban	8	238	210	456
Total	9	351	337	697

Results

Intention Changes

Paired-samples non-parametric tests (Wilcoxon-signed ranks test) and *t*-tests of the pre- and post-survey scores were used to determine significant changes in intention. A non-parametric test was included to verify *t*-test results because the data did not always follow a symmetric normal distribution (an assumption of the *t*-test). All items showed modest positive changes (allowing for a reverse scored item), with significant changes in 9 of 15 intention items including one item of borderline significance (a significant *t*-test, but non-significant non-parametric test). In most cases the change represented a strengthening of an already positive intention (i.e. agree to strongly agree), as opposed to a complete reversal (i.e. disagree to agree), however the latter did occur in some cases. This points to ceiling effects in survey items, however it may also reflect an already well-intentioned sample. Despite surveys being anonymous, the effect of wanting to give the 'correct' intention is also likely to have inflated true intentions. Intentions measured, means and significance of change for each item are reported in Table 2.

Significant changes occurred in intentions measuring resisting peer-pressure, wanting to learn more about HIV, talking to family and two measures each of abstinence and self-efficacy (an upstream influence on intention). Condom use and having an HIV test approached but were not significant at the $p < 0.05$ level. Changes to being worried about HIV (vulnerability; another upstream indicator), talking to friends, thinking unprotected sex was acceptable and seeking more HIV information were non-significant. Scores for non-significant items indicated desirable or 'safe' intentions, however they also indicate areas for refinement of the show and survey instrument. On the whole, the show was able to significantly influence a range of behavioural intentions.

To give an overall indication of change, a measure of total intention change for each individual was calculated. Intention change was first calculated for each item using pre- and post-scores, omitting any pairs with missing items (resulting $n = 437$), and reverse scoring for one item. Total change was then calculated. On average this was small and positive, reflecting a majority of modest positive changes and some negative changes ($M = 2.39$, $SD = 5.85$, $n = 437$). Males ($M = 3.10$, $SD = 6.62$, $n = 212$) had much higher changes than females ($M = 1.53$, $SD = 5.57$, $n = 222$): this gender difference was significant, $t(413) = 2.82$, $p = 0.005$. There were no significant differences in intention change between rural ($M = 2.48$, $SD = 6.00$, $n = 119$) and urban ($M = 2.34$, $SD = 6.21$, $n = 321$) students.

Emotion and Knowledge Variables

Mean scores for interest and enjoyment items demonstrated that the show was well received, which was also supported by informal audience observations. Knowledge items showed that audiences felt the show was an effective learning experience and there was a significant difference in pre to post self-reported knowledge of transmission methods, $t(649) = -3.73$, $p = 0.000$ (Table 3).

Table 2. Intentions and intention change

	Pre mean	Post mean	Mean change	t-Test sig. (2-tailed)	Wilcoxon sig. (2-tailed)	Significant change?
I want to learn more about HIV and AIDS	4.01	4.23	0.22	0.000	0.000	Y
I plan not to have sex until I am older	3.89	4.08	0.19	0.000	0.000	Y
I am worried about catching HIV	3.60	3.62	0.02	0.619	0.682	N
I will be faithful to one partner, If I do have sex	3.81	4.05	0.24	0.000	0.000	Y
I will always use a condom, If I do have sex	4.07	4.17	0.10	0.052	0.073	N
I think I can stay completely safe from HIV AIDS	3.57	3.77	0.20	0.000	0.000	Y
I will talk about HIV AIDS with my friends	3.70	3.75	0.05	0.311	0.340	N
ABC (Abstain, Be faithful, Condomise) is the way I choose to live my life	3.95	4.05	0.10	0.048	0.051	borderline
It is OK to have unprotected sex sometimes	2.26	2.25	-0.01	0.849	0.812	N
At the moment abstinence is the best choice for me	3.57	3.81	0.24	0.000	0.000	Y
I will have an HIV test if I do something unsafe	3.69	3.80	0.11	0.065	0.062	N
I will try hard to find new information on HIV AIDS	3.94	3.96	0.02	0.636	0.726	N
I will talk about HIV AIDS with my family	3.81	3.99	0.18	0.000	0.001	Y
I am sure I can behave in ways that keep me safe from HIV	3.92	4.14	0.22	0.000	0.000	Y
I will do ABC (Abstain, Be faithful, Condomise) even if other learners do not do ABC	3.91	4.08	0.17	0.001	0.001	Y

n = 625–675 due to missing responses.

What Influenced Intention Change?

A hierarchical linear regression model was used to better understand the factors at play in intention change. Using total change as the dependent variable, two hierarchical models were tested. Model one included demographic variables (age, gender and rural/urban) and show language as independent variables, while model two additionally included pre-intention score, interest–enjoyment and the three knowledge-

Table 3. Mean scores for interest, enjoyment and knowledge items

	Item	Mean
Interest items	I was interested in the show ^a	4.02
	I thought the show was complicated	3.12
	I thought the show was boring ^b	2.25
	I could understand the information in the show ^a	3.92
Enjoyment items	I enjoyed seeing the show ^a	4.12
	Overall, I liked the show ^a	4.11
Interest-enjoyment scale score	(Four-item scale)	4.06
Knowledge items	I learnt a lot about HIV AIDS from the show	4.08
	I am sure I know all the ways a person can get HIV (pre)	3.49
	I am sure I know all the ways a person can get HIV (post)	3.69

^aItems in interest–enjoyment scale.

^bItem was reverse-scored.

related items. The aim of the hierarchical model was to test whether gender and rural/urban differences reported in the literature were important when considering intention change in this context. Missing data were excluded on a pairwise basis. Three cases that produced residuals above three standard deviations were also excluded. Inspection of normal probability and residual scatterplots showed that assumptions of the statistical technique had been met.

Variables in model one (demographics) did not predict intention change ($R^2 \text{ Adj.} = 0.016, F(4, 403) = 1.65$, non-significant), which was surprising given the differences in demographic groups reported in the literature. It should be noted, however, that chi-square tests (not reported here) showed that these demographic variables were associated with significant differences in pre- and post-intention levels, knowledge variables and interest–enjoyment, suggesting demographic differences may moderate these variables and have indirect effects. Significant gender differences in mean change score reported earlier are somewhat misleading on closer analysis; modelling shows that gender plays very little role at all, especially when considered along with other variables. Show language was not a significant predictor, however for this finding to be rigorous both show and survey should be presented in the same language.

Model two (all predictors) explained 37% of the variance in intention change ($R^2 \text{ Adj.} = 0.369, F(9, 398) = 27.04, p < 0.001$), a reasonable finding given the relatively simple model (complex intention models predict 39% on average (Armitage & Conner, 2001)). Significant predictors were pre-intention, interest–enjoyment, prior knowledge of transmission methods and self-reported learning at the $p < 0.001$ level, and change in knowledge of transmission methods at the $p < 0.05$ level. Beta coefficients for significant predictors are reported in Table 4, indicating the effects of each predictor if others are held constant. Pre-intention negatively predicted intention change, that is, the higher a student’s pre-intentions, the less those intentions positively changed, and vice versa. This is a logical outcome, but again

Table 4. Regression beta coefficients for total intention change

Model	Standardised beta coefficients	<i>p</i>
1 ^a		
(Constant)		0.624
Age	-0.005	0.930
Gender ^b	0.127	0.013
Show language ^b	0.015	0.808
Rural/urban background ^b	-0.008	0.897
2		
(Constant)		0.165
Age	-0.009	0.847
Gender	0.078	0.056
Show language	0.036	0.461
Rural/urban background	-0.083	0.124
Total prior intention	-0.850	0.000
Interest-enjoyment	0.535	0.000
Transmission methods (prior knowledge)	0.258	0.000
Transmission methods (change in knowledge)	0.124	0.022
Self-reported learning	0.187	0.000

Note: *df* = 4,403 (model 1); 9,398 (model 2).

^aModel *F* value was not significant.

^bCategorical data was coded: males = 1, females = 0; rural = 1, urban = 0; isiZulu language = 1, English language = 0.

highlights ceiling effects. Inspection of standardised beta coefficients showed that pre-intention had the greatest effect on intention change.

Interest–enjoyment and the three knowledge variables had approximately equal effects on intention change, with higher scores associated with greater positive changes in intention. This suggests that providing interesting, enjoyable learning environments is as important as knowledge-related factors for driving intention change, notwithstanding the relation of the two. The finding that interest–enjoyment significantly predicts intention change is important, suggesting that ISL experiences provoking these emotions may have a greater impact on changing behavioural intentions. This point will be taken up further below.

Discussion

The data presented here demonstrate that a science theatre show can create significant changes in behavioural intentions related to HIV. Just over half the intentions studied showed modest yet significant positive changes, while several that did not change remained stable at desirable levels. The vast majority of these changes represented a strengthening of neutral or positive intentions (i.e. moving from 3–4 to 4–5 on a 5-point scale), as opposed to complete reversals from negative to positive

intentions. While encouraging outcomes, these observations raise the problem of ceiling effects in this study, requiring ongoing refinement of survey items measuring intentions. Ceiling effects were also evident in problems detecting change among those with already positive intentions. Further efforts to increase concreteness and specificity of items, which also makes them better predictors of actual behaviour (Ajzen, 1989; Cartmill & Day, 1997), may help address ceiling effects. Tailoring items more specifically to the sample (culture, real-life situations, gender, etc.), employing 7-point scales, and crafting items to minimise the effect of socially acceptable answers are other potential solutions. Nevertheless, the results of this study suggest that science theatre can be a suitable vehicle for behaviour change interventions, especially on HIV. Science theatre and science centres, two common media within ISL environments, are useful tools not only to communicate socioscientific issues, but also to motivate positive change concerning them.

The present results also identify several factors important in changing intentions. Predictably, prior intentions—the attitudes, intentions and motivations with which people arrived—played the most substantial role in determining intention change. Prior intentions are the baseline that the ISL experience works from and the attitudes, beliefs and motivations bound up within them will also colour the learning process (Falk & Dierking, 2000). The model shows that pre-intentions are inversely related to the magnitude of intention change; obviously those with the lowest pre-intentions have more room to improve and this, according to the model, is the greatest factor in determining change.

Of greater note is the finding that the audience's emotional response to the theatre piece, in particular the emotions of interest and enjoyment, was significant in predicting change. Comparison of standardised beta values shows interest–enjoyment predicts almost two-thirds of the variance in intention change as pre-intention scores, and approximately the same amount of variance as knowledge-related factors (as measured in this study). This suggests that interest and enjoyment of the learning experience are almost as critical as the initial starting point, and of equal importance as prior knowledge and learning, when considering intention change. While the model is far from explaining the total picture, with approximately two-thirds of change unexplained (a reasonable remainder given the complexities of change and relative simplicity of the model) it does underscore the importance of the emotional experience in influencing change. Although these emotions, and emotional engagement more broadly, are argued by ISL researchers to be important for influencing attitudes and behaviour, actual evidence for this is limited. This study adds provisional empirical evidence to support the role that emotions, particularly interest and enjoyment, play during ISL experiences such as a science theatre presentation. It reinforces recent studies (i.e. Falk & Gillespie, 2009; McCrory, 2010) that argue for the importance of emotions when understanding the impact of ISL experiences. Moreover, it provides evidence that the emotional experience is associated with critical outcomes such as changing behavioural intentions.

The influence of demographic factors such as age, gender and residential location on HIV-related behaviour is often stressed in the literature, however this study found

very little evidence that these groups responded differently to the intervention. Of these variables, only gender appeared to play any role whatsoever. Although males experienced a significantly higher amount of total intention change, gender was not a significant predictor of change when considered along with other variables. Moreover, when gender was only modelled alongside other demographic variables, it resulted in a model with essentially no predictive power. Despite the widely reported baseline differences between males and females or rural and urban dwellers, these data suggest they all benefit equally from this intervention.

Ceiling effects were a limitation in this study, however several other limitations should also be discussed as they suggest fruitful avenues for future research. Survey length restricted exploration of scale items, and indeed investigation of many other emotions which no doubt play a role in change such as fear and hope. The approach of measuring emotions via appraisals had limited success, however further work in this area may develop scales that provide a functional measure of an emotion and its underlying components, as opposed to using synonyms to create scale items. Although not the focus of this study, knowledge and knowledge change are clearly important to intention change. More rigorous measurement of knowledge variables may well produce better models and provide greater accuracy on the balance and interaction of cognitive and affective factors that influence intentions. While the literature suggests a gap between knowledge and behaviour, according to provisional data presented here, the gap between knowledge and intended behaviour appears smaller. Clarifying these relationships, potentially by applying models such as the Theory of Planned Behaviour, may provide better understanding of how ISL experiences can ultimately affect people's actions. A final limitation of the data presented here is that the focus is solely on short-term intention change. To truly gauge impact, whether intention change was sustained over time, if intention change translated into behaviour change and if so for how long, remain critical questions.

This study provides evidence that ISL experiences can significantly influence behavioural intentions. Tools such as theatre, exhibits, workshops and the like can be tailored not only to communicate science, but also to create positive changes in audiences. As science centres take a more active role in addressing society's most prominent socioscientific issues, from HIV AIDS to climate change, better understanding of the factors that facilitate change in ISL settings is critical. This study suggests that in addition to building knowledge, emotional engagement during the ISL experience, particularly making it interesting and enjoyable, is related to changing behavioural intentions. ISL providers need to consider emotional engagement alongside learning if they are interested in making real differences to people's lives and behaviour.

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