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ORIGINAL PAPER

The Information–Motivation–Behavioral Skills Model of ART Adherence in a Deep South HIV+ Clinic Sample

K. Rivet Amico · William Barta · Deborah J. Konkle-Parker · Jeffrey D. Fisher · Deborah H. Cornman · Paul A. Shuper · William A. Fisher

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Abstract High levels of adherence to antiretroviral therapy (ART) are critical to the management of HIV, yet many people living with HIV do not achieve these levels. There is a substantial body of literature regarding correlates of adherence to ART, and theory-based multivariate models of ART adherence are emerging. The current study assessed the determinants of adherence behavior postulated by the Information–Motivation–Behavioral Skills model of ART adherence in a sample of 149 HIV-positive patients in Mississippi. Structural equation modeling indicated that ART-related information correlated with personal and social motivation, and the two sub-areas of motivation were not intercorrelated. In this Deep South sample, being better informed, socially supported, and perceiving fewer negative consequences of adherence were independently related to stronger behavioral skills for taking medications, which in turn associated with self-reported adherence. The IMB model of ART adherence appeared to well characterize the complexities of adherence for this sample.

K. R. Amico (✉) · W. Barta · J. D. Fisher · D. H. Cornman · P. A. Shuper · W. A. Fisher
Center for Health, Intervention, and Prevention, University of Connecticut, 2006 Hillside Rd., Unit 1248, Storrs, CT 06269-1248, USA
e-mail: rivetamico@comcast.net

D. J. Konkle-Parker
University of Mississippi Medical Center, Jackson, MS, USA

W. A. Fisher
Department of Psychology, University of Western Ontario, London, ON, Canada

W. A. Fisher
Department of Obstetrics and Gynecology, University of Western Ontario, London, ON, Canada

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Introduction

People living with HIV/AIDS (PLWHA) are able to lead longer, healthier lives by closely adhering to antiretroviral therapy (ART; Lucas 2005). Although optimal adherence rates may vary by particular regimens (Bangsberg et al. 2006; Bangsberg and Deeks 2002), most patients can achieve optimal viral suppression and immune function and reduce their risk of developing drug resistance by taking 90–95% of all ART medication doses as prescribed (Bartlett 2002; Paterson et al. 2000). ART regimens, however, may be extremely demanding and side effect laden, and despite the serious consequences of suboptimal adherence, a substantial proportion of PLWHA do not adhere sufficiently to therapy. Based on a number of studies using diverse measures of adherence, and granting wide dispersion in adherence rates from one population to the next, the average level of ART medication adherence is approximately 70% (Bangsberg and Deeks 2002).

Exploration of adherence barriers and facilitators has become a critical line of inquiry. Numerous studies identifying discrete correlates of ART adherence have been published in the 10 years since this therapy became available and, more recently, theory-based models of adherence to ART have been developed and evaluated (e.g., Amico et al. 2005; De Bruin et al. 2005; Fisher et al. 2006; Simoni et al. 2006a; Starace et al. 2006). Such models integrate discrete correlates of ART adherence within a comprehensive multivariate framework and guide efforts to understand, predict, and promote adherence to therapy.

The Information–Motivation–Behavioral Skills (IMB) model of ART adherence (Fisher et al. 2006) consolidates much of the literature regarding discrete factors that influence ART adherence in an evidence-based, theory-driven approach to understanding adherence to this therapy. The IMB model of ART adherence posits that adherence-related information and motivation are associated with adherence-related behavioral skills and these skills then directly predict adherence to ART. Adherence-related information is comprised of one's fund of accurate information concerning one's specific ART regimen in terms of how and when doses should be taken, potential side-effects, and decision rules concerning adherence that may be inaccurate (e.g., believing that medication can be skipped if one is feeling physically well) or accurate (e.g., understanding that poor adherence levels may jeopardize viral suppression). Adherence motivation is comprised of components of personal and social motivation. Personal motivation rests upon an individual's attitudes and beliefs about adherence and non-adherence, whereas social motivation reflects the extent to which one feels that his or her adherence is supported by significant others. Finally, adherence behavioral skills involve the specific skills individuals must apply to facilitate consistent medication taking across conditions and circumstances, and one's sense of efficacy for enacting these skills.

The interrelations among the core constructs of the IMB model of ART adherence specify that adherence information and adherence motivation will likely work through adherence behavioral skills to affect adherence to ART. The IMB model also specifies that adherence information and adherence motivation may be directly related to ART adherence in cases where medication-taking behaviors are not complex or demanding (Fisher et al. 2006). However, in the context of most ART regimens available to date, which are both complex and demanding in many regards, one would anticipate that behavioral skills would mediate information and motivation's relations to ART adherence. Essentially, the IMB model asserts that to the extent that one is well-informed and well-motivated, he or she will acquire behavioral skills and apply these skills to the challenge of adherence to therapy. Alternatively, patients may be well-informed and well-motivated, but in the absence of critical behavioral skills, such as how to hide one's medications or keep them available during dose times, they will be less likely to achieve or sustain high levels of adherence. In addition, patients may have inaccurate adherence information or have low levels of motivation, which may result in failure to acquire and apply adherence behavioral skills and poor adherence to therapy. While it is predicted that these inter-relations apply to ART adherence for most individuals under most conditions, the model also predicts that certain moderating factors, such as acute depression or homelessness, may alter the magnitude of the proposed relations between information, motivation, and behavioral skills.

The IMB model of ART adherence (Fisher et al. 2006) has been evaluated with a number of populations. Starace et al. (2006) explored the IMB model of ART adherence via a measured-variable approach with a dichotomously defined adherence outcome (optimal versus sub-optimal adherence) in a sample of 100 HIV-positive patients in clinical care in Italy. Amico et al. (2005) conducted a similar exploration, extending the results of Starace et al. (2006) with a sample of 200 HIV-positive patients in clinical care in Puerto Rico. In each of these studies support was found for the core relations posited by the IMB model of in terms of model fit and magnitude and direction of paths. Additionally, each study found support for the IMB model's mediational hypothesis. Kalichman et al.'s (2001) exploration of the general tenets of the IMB model (Fisher and Fisher 1992, 2000, 1993; Fisher et al. 2003) in a study of HIV-positive women's ART adherence found support for the relation between motivation (intentions) and behavioral skills, and self-reported adherence, but information was not related to other model constructs. It is important to further evaluate the IMB model of ART adherence in terms of the utility of its core constructs and the structural hypotheses posed by the model. Although the IMB model further distinguishes certain conditions (e.g., acute depression) and circumstances (e.g., homelessness) that may moderate the proposed relations in the model's core constructs, this aspect of the model has not yet been explored, nor does the current study extend research in this area. Of primary importance to the current study is the utility and efficacy of major tenets of the IMB model in a 'typical' clinical care sample from the Deep South.

Investigations of the IMB model of adherence to date (e.g., Amico et al. 2005; Starace et al. 2006) have been carried out via measured variable approaches. As such, details regarding the specific relationship of the personal and social motivation components within the model's motivation construct, such as how each may relate to behavioral skills, adherence behavior, and one another, would advance our nuanced understanding of adherence to ART. In addition, exploration of the subcomponents of the motivation construct and their structural relations within the model could provide refined direction for applications of the model to theory-based intervention development.

While gaining a better understanding of the constellation of factors that influence adherence in any population of PLWHA may provide valuable information for theory and intervention development, advancing our understanding of adherence to ART is particularly critical for PLWHA in the Deep South of the United States. The HIV crisis in the Deep South (Copello 2004; Pfizer 2005) has led to

increasingly large numbers of PLWHA in this region. To date, Mississippi, which ranks 17th among 50 US states in terms of cumulative HIV cases (CDC 2004), has been under-represented in this area of inquiry. Exploring the factors that influence adherence behavior within this population is fundamental to preparing for the provision of effective ART adherence support, which is currently needed and likely to continue in demand.

As one of the first applications of the full IMB model of adherence (Fisher et al. 2006) to a Deep South US population, we explored the IMB model of ART adherence to determine the extent to which the model provided a good explanation of adherence for HIV-positive clinical care patients in Mississippi. We utilized assessments of core IMB model constructs (adherence information, motivation, and behavioral skills; LifeWindows Project Team 2006), and evaluated the relations among these constructs and self-reported rates of adherence. Consistent with the IMB model of ART adherence, we represented the motivation construct as two component parts (see Fig. 1); personal motivation and social motivation. Personal motivation was defined as one's attitudes and beliefs regarding the consequences of taking one's medications (e.g., potential negative effects of the medications themselves), and regarding the negative lifestyle consequences of adhering to one's regimen (e.g., perceived negative impact and inconveniences associated with working one's regimen into one's daily routine). Social motivation was defined by one's perceived social support for adherence. As indicated in Fig. 1, we hypothesized that information would be related to behavioral skills; that personal and social motivation would each be related to behavioral skills, but not necessarily to each other; and that behavioral skills would be related to rates of self-reported adherence. Further, in accord with previous research (Amico et al. 2005; Starace et al. 2006) and the IMB model of ART adherence (Fisher et al. 2006), we expected that a mediated model would provide a good fit to the sample data.

Methods

Procedures

A convenience sample of 150 participants was recruited in a large public infectious disease clinic located in Jackson, Mississippi. Eligibility requirements included being currently prescribed ART, being at least 18 years of age, and having the time to complete the survey at the time of consent. Recruitment and enrollment procedures were configured to protect patient confidentiality. The third author approached participants while they waited for an HIV care appointment in the clinic, asked if they were prescribed ART, and, if so, would they be willing to complete a computer delivered survey of ART adherence. Two hundred and forty patients of the 298 approached who were prescribed ART expressed interest in learning more about the project. Of these, 194 (81%) agreed to participate, and 151 of the 194 interested patients were able to complete the full survey on the same day as consent. Participants received $15.00 for completing the audio-supported, anonymous, computer-

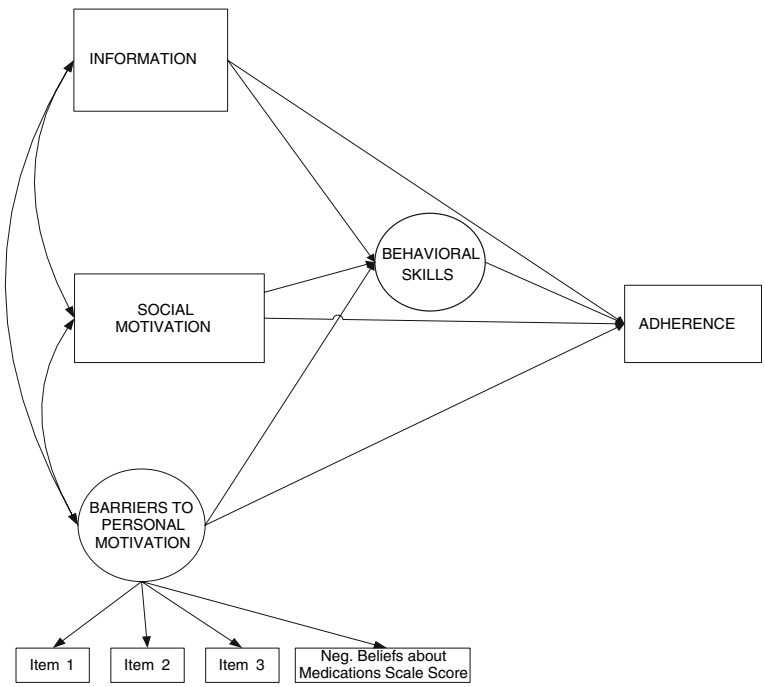

Fig. 1 Measured and latent variable representation of the IMB model of ART adherence. *Notes:* Social motivation: Most people who are important to me who know I'm HIV positive support me in taking my HIV medications; Item 1: It frustrates me to think that I will have to take these HIV medications every day for the rest of my life; Item 2: I don't like taking my HIV medications because they remind me that I am HIV+; Item 3: I get frustrated taking my HIV medications because I have to plan my life around them

delivered survey, which took approximately 45 min to complete.

Measures

A computer-delivered audio-supported survey, designed to accommodate participants with limited literacy, was used to assess demographic characteristics, mental and physical health functioning, adherence over the last 3 days (a modified version of the 3-day ACTG measure: Chesney et al. 2000), and ART related information, motivation, and behavioral skills (the LifeWindows ART Adherence Questionnaire; LW-IMB-AAQ; LifeWindows Project Team 2006).

ART Adherence

A modified version of the 3-day Adult AIDS Clinical Trials Group self-report measure (ACTG, Chesney et al. 2000) was used to assess levels of adherence. Self-report (SR) measures such as the ACTG have been validated against biological indicators of adherence (e.g., Haubrich et al. 1999; Kleeberger et al. 2001; Knobel et al. 2001; Moatti and Spire 2000; Murri et al. 2000; Nieuwkerk et al. 2001). More recently, SR measures of adherence have received additional consistent support in terms of concurrent validity with a number of indices of disease progression and in relation to other more 'objective' measures of adherence (cf. Nieuwkerk and Oort's 2005; Pearson et al. 2007; Simoni et al. 2006b). The ACTG was modified in the following ways: (1) translation from a paper questionnaire format to delivery via a computer software program with text, pictorial, and audio support features, and (2) changes to the response options provided for medication-taking behavior over the preceding 3 days (instead of asking for number of doses missed, participants were instructed to select if he or she 'took the full dose,' 'more than the dose,' or 'missed some or all of the medications in the dose'). Modification of response options was implemented to assist in ease of computer-delivery of the measure by providing easily understood point-and-click options and to provide patients the opportunity to report on the full range of dose-event outcomes.

The first step in the adherence assessment consisted of prompting the participant to select the ART medication(s) that he or she was prescribed by clicking on its picture from an on-screen pill chart. The participant then selected the exact times of day he or she was prescribed to take the medication and the number of pills or liquid doses prescribed for each dose. For each medication, participants were then asked to report whether he or she took the full dose, more than the dose, or missed some or all of the medications in the dose, for each of the preceding 3 days. The same procedure was repeated for each medication in the regimen until adherence to all medications in the participant's regimen had been assessed.

Adherence was calculated as the total number of doses taken in full as prescribed for all prescribed ART medications over the total number of doses prescribed for all ART medications in the patient's regimen. The distribution of levels of adherence in the current sample is skewed toward higher levels of adherence, with a sample mean of .81 (or 81% adherent) and the median 1.0 (or 100% adherent). The distribution was somewhat kurtotic (2.10), however, adherence values were not transformed to normalize, as kurtosis indices of less than 3 are generally considered to pose insignificant threat to the assumptions of latent variable models (Kline 2005).

ART Adherence-Related Information, Motivation, and Behavioral Skills

Items from the LW-IMB-AAQ (LifeWindows Project Team 2006) were used to assess levels of ART-related information, motivation, and behavioral skills. This 35-item survey was originally developed for use in a software package that assesses adherence barriers and provides targeted intervention activities. For purposes of the current study, items from the LW-IMB-AAQ that were developed to assess the IMB model constructs (adherence-related information, motivation, or behavioral skills), including the motivation construct's components of personal and social motivation, were evaluated. Because the LW-IMB-AAQ is a relatively new measure, item selection to create scales representing constructs in the current study was determined substantively and in terms of interitem consistency/covariation when appropriate. We also performed an initial exploration of each construct's measurement model within the current sample's dataset to further inform our item selection decisions.

ART Adherence Information

Seven LW-IMB-AAQ's information items were used to define ART adherence-related information. Five items assessed perceived knowledge concerning one's regimen (I know how each of the HIV medications are supposed to be taken; I know what I do if I miss a dose; I know the possible side effects of my medications; I know how each medication works in my body; I know how my HIV medications interact with alcohol or street drugs), one item assessed faulty heuristics (If I feel healthy, it's OK to skip a

dose), and one assessed misinformation (Skipping doses from time to time won't hurt my health). For each item, a response on the extreme end of a 5-point "strongly disagree" to "strongly agree" scale in the direction of 'correct' was assigned a value of 1, while other response options were scored zero, producing a total range of 0–5. While this strategy may produce conservative estimates of adherence-related information, it is important to note that the distribution of scores demonstrated adequate variability between participants (with a mean of 2.72, standard deviation of 1.65,) and did not appear positively skewed (–.135) or overly kurtotic (–1.143). Inter-item consistency between the 5 information items was moderate ($\alpha = .70$), which was expected given that these items assess diverse aspects of ART information. This construct was represented in our subsequent analyses as a summed scale measured variable reflecting total number of items 'correct.'

ART Adherence Motivation

Items from the LW-IMB-AAQ developed to assess personal and social motivation to adhere to one's ART regimen were used. Initial inspection of the measurement model in the current sample suggested that personal and social motivation were best represented as independent constructs, as opposed to each loading into a single, higher-order 'motivation' latent variable. Personal motivation was assessed by 6 items reflecting one's beliefs about the adverse physical consequences of one's medications, including side effects, and items concerning the negative lifestyle consequences of adhering to the medication regimen on a daily basis with response options ranging on a 5-point scale from "strongly disagree" to "strongly agree." Preliminary review suggested a poor fit of the measurement to the current sample's data when using the all 6 items as separate measured variables for the personal motivation construct. An alternative approach was adopted that produced an improved measurement model where the personal motivation construct was comprised of a total of 4 measured variables: one representing a summed scale score and the other three representing responses to single items. The summed scale score for personal motivation summed 3 items that were highly correlated and all appeared to represent negative beliefs about ART medications themselves ('I am worried that the HIV medications I have been prescribed will hurt my health;' 'It upsets me that the HIV medications I have been prescribed can affect the way I look;' 'It upsets me that the HIV medications I have been prescribed can cause side effects'). This 'negative beliefs about medications' scale demonstrated adequate internal consistency ($\alpha = .74$), with a range of 3–15 and higher scores reflected greater negative beliefs about one's ART medications.

The other 3 measured variables used in defining the personal motivation construct in the current research included responses to each of the following items; 'It frustrates me that I have to plan my life around my medications;' 'It frustrates me that I have to take these medications for the rest of my life;' and 'I don't like taking my HIV medications because they remind me that I am HIV positive.' While these items also shared variability ($\alpha = .76$), they maintained an adequate amount of independence from each other and the negative consequences of medication scale scores to allow the inclusion of each individual item as a separate measured variable in defining personal motivation. Thus, in full, personal motivation for each participant was defined by their 'negative beliefs about medications' scale score and separate responses to each of the three additional LW-IMB-AAQ items noted above. This approach produced an acceptable measurement model for the current sample.

Social motivation is measured by a single item on the LW-IMB-AAQ (Most people who are important to me who know I'm HIV positive support me in taking my HIV medications). Other items in the LW-IMB-AAQ, such as items assessing perceived support from one's medical provider, were not included in the current analyses as they did not appear to covary consistently across participants with the 'social support from significant others' item. Moreover, because our primary interest was to represent the social motivation construct as detailed in the IMB model of ART adherence (Fisher et al. 2006), which emphasizes perceived social support from significant others regardless as to who those significant others may be, we preferred the more generically worded item over those items that designate a specific referent other. Inquiring about a 'significant other' would allow for greater ideographic identification of exactly who those 'others' may be, thus allowing participants to include or not to include support from one's medical provider depending on their particular view of who constitutes an important and influential 'other.'

ART Adherence Behavioral Skills

The LW-IMB-AAQ includes a total of 14 items targeting adherence-related behavioral skills, which were highly intercorrelated in the current sample ($\alpha = .88$). The set of items was trimmed to 5 items that had good internal consistency ($\alpha = .88$) and was well correlated with the original 14-item scale ($r = .899$, $P < .001$). The items ask participants "How hard or easy is it for you to..." (1) 'remember to take your medications,' (2) 'take pills that are hard to

swallow or taste bad,' (3) 'take medications when your usual routine changes,' (4) 'take medications when you are feeling bad emotionally,' and (5) 'take medications when feeling bad physically.' Participants used a 5 point response scale ranging from "very hard" to "very easy." Each item's responses were anchored between 1 and 5 with higher values reflecting higher levels of behavioral skills.

Data Analyses

Several strategies were employed to evaluate the IMB model of ART adherence in relation to rates of self-reported adherence. The first involved evaluation of the *full* IMB model, depicted in Fig. 1, which was assessed in terms of inspection of standardized path estimates and with standard model fit indices (e.g., χ^2, CFI, RMSEA). A second, nested model was analyzed to evaluate the mediation hypothesis where the full IMB model was compared to a restricted IMB model where the non-mediated paths from information and all motivation constructs were set to zero. The restricted model fit was evaluated with standard fit indices and a χ^2 difference test. Initial inspection of the measurement model was conducted prior to running the structural analyses. As mentioned previously, ART information was represented as a scale score measured variable. The two components of motivation (social and personal) were represented as the single social motivation item and the personal motivation latent variable represented a total of 4 measured variables: the negative beliefs about medications scale score and the three single-item indicators regarding the negative lifestyle consequences of ART adherence. Behavioral skills was represented as a latent variable with 5 measured single-item indicators. Adherence was represented as a single measured continuous variable. The same measurement model was used for each of the analyses. It is important to note that we chose to maintain the original directionality of personal motivation items, such that the construct reflects what may be considered barriers to personal motivation (negative beliefs about the medications and lifestyle consequences of adherence), as opposed to reverse scoring the measured items to produce a 'lack of barriers in personal motivation.' Maintaining the negative direction of the construct was more consistent with the item content, straightforward in interpretation, and maintained the valuation implied in the content of the items.

Results

Of the 151 participants who used the compute delivered assessment software, 149 provided complete data. Participants resided in both urban and rural locations; 42% of those taking part were female (consistent with the 60/40 ratio of males to females in the clinic population); 85% identified as African-American, 9% as White, and the remainder reported other racial/ethnic backgrounds. Sixty percent of participants identified themselves as heterosexual, 27% as gay or lesbian, and the remainder as either bisexual or unsure. Median income was approximately $10,000 per year.

Structural Model Tests

The core constructs of the IMB model of ART adherence were evaluated first as a full model, where direct and indirect effects of information, motivation (social and personal), and behavioral skills on adherence were assessed. As indicated in Fig. 2, the information construct was significantly related to behavioral skills, and was not significantly related directly to adherence. There was significant covariation between information and the personal and social motivation constructs. Greater accurate information scores were related to greater positive social motivation (specifically, one's perceptions of social support). Greater accurate information scores were related to lower barriers to personal motivation (negative beliefs about medications and lifestyle consequences of adherence). The social motivation measured item was significantly related to adherence behavioral skills in the direction anticipated, and was not significantly directly related to adherence behavior. Similarly, personal motivation was significantly related to behavioral skills in the anticipated direction, but was not directly related to adherence behavior. The two motivation sub-constructs (personal motivation and social motivation) were not significantly correlated with each other. Thus, their influence on behavioral skills, and subsequently on adherence, appeared to be fairly independent. Finally, behavioral skills demonstrated a significant relation to adherence behavior, such that the greater the behavioral skills, the higher the rates of self-reported adherence. As indicated in Fig. 2, the model in full accounted for 20% of the variability in rates of adherence, and demonstrated good fit to the sample data.

In order to evaluate the structural propositions of the IMB model, each direct (non-mediated) path from information and motivation to rates of adherence were set to zero, thus restricting the model to an entirely mediated model. As indicated in Fig. 3, this model produced only a slight decrease in variance accounted for in rates adherence (from 20% to 19%), although model comparison overall suggested that the mediated model was a viable alternative. The fit indices generated compared favorably to those generated by the full model. Thus, the mediated model was

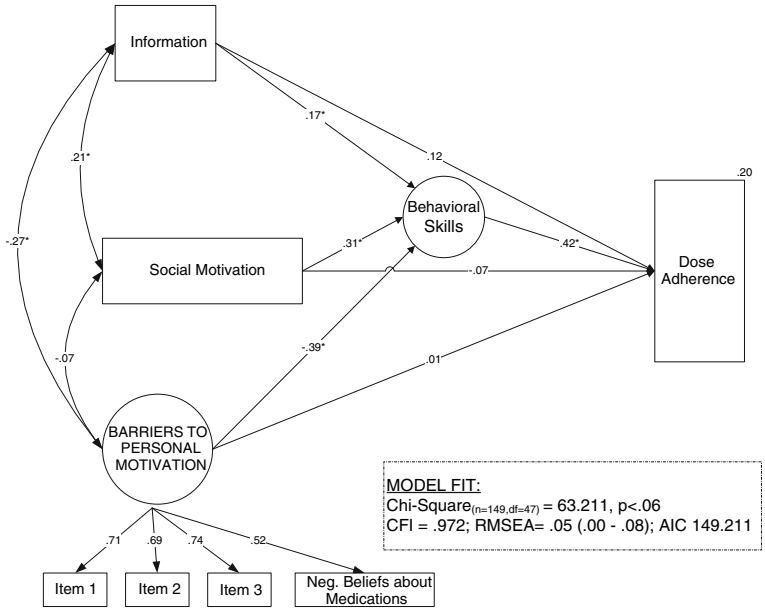

Fig. 2 Full IMB model. *Notes:* *$P < .05$

supported as providing a comparable fit to the sample data that is more parsimonious.

Discussion

The current research explored the IMB model of ART adherence (Fisher et al. 2006) in a sample of HIV-positive patients in clinical care in the Deep South (Mississippi). The model's core constructs and the relationships between them were examined. Specifically, adherence-related information, motivation (personal and social), and behavioral skills were evaluated in terms of their association with self-reported dose adherence over a preceding 3-day period. We hypothesized that adherence-related information and adherence-related motivation would be associated with levels of adherence-related behavioral skills, which in turn would be related to adherence behavior. Further, we hypothesized that, in accord with the structural propositions of the IMB model of ART adherence (Fisher et al. 2006), the relation between information and adherence and between motivation and adherence would be primarily mediated by behavioral skills. These hypotheses were evaluated via a computer-delivered survey and structural model tests with a final sample of 149 HIV-positive patients in clinical care in Mississippi.

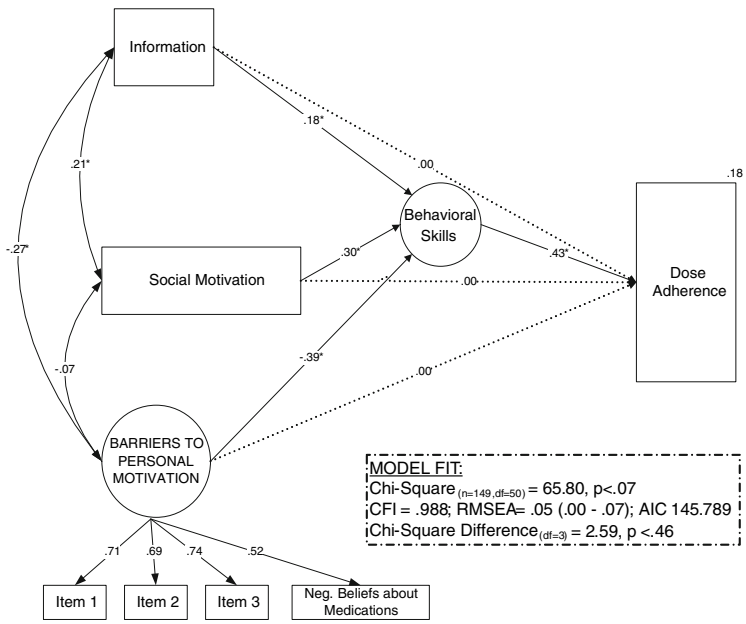

Fig. 3 Restricted (fully mediated) IMB model. *Notes:* *$P < .05$

Using structural measured and latent variable modeling techniques, we found support for each of the propositions of the IMB model of ART adherence (Fisher et al. 2006). Within the current sample, adherence-related information about one's regimen was related to adherence behavioral skills and was not significantly directly associated with 3-day self-reports of dose adherence. Thus, it appears that being well-informed did not necessarily imply high levels of adherence, but did relate to one's fund of behavioral skills, which was directly related to levels of ART adherence. Similarly, social motivation, or the extent to which one believed that important others supported them in taking their medications, and personal motivation, or one's negative beliefs about ART medications and lifestyle consequences of adherence, were also related to behavioral skills. The behavioral skills construct, in turn, was directly related to self-reported adherence. In full, the model results suggest that better adherence is associated with more accurate information about one's regimen, stronger social motivation for taking medications, fewer barriers to personal motivation, and stronger adherence behavioral skills.

While previous research concerning the IMB model of adherence (Fisher et al. 2006) has found support for the model with samples from Puerto Rico (Amico et al. 2005) and Italy (Starace et al. 2006), and research applying an IMB model (Fisher and Fisher 1992) to adherence behavior in a sample of HIV-positive women in the US has supported the importance of the motivation and behavioral skills constructs (Kalichman et al. 2001), the current study is unique in its representation of the motivation construct. Whereas other studies have represented the motivation construct as a measured summed variable where aspects of social and personal motivation are combined/summed (e.g., Amico et al. 2005; Starace et al. 2006) or as summed behavioral intentions (e.g., Kalichman et al. 2001), the current research separated the personal and social components of motivation to adhere to therapy. In doing so, we found that these constructs are related to adherence information and adherence behavioral skills, and that these components are relatively independent of each other. These findings suggest that each type of motivation helps influence adherence to ART and that each should receive attention in adherence promotion interventions. On both empirical and rational bases, it appears that one can have positive or negative beliefs about adherence and HIV medications that are independent of the perceptions of support for adherence from significant others. Similarly, lacking social support may limit social motivation, but individuals may nonetheless develop strong positive beliefs about adherence and HIV medications. These results, while novel, are quite consistent with the IMB model's descriptions of ART adherence motivation, in that each component of motivation was independently important to ART adherence behavior.

An important objective in the current research was to apply results to the development of theory-grounded ART adherence interventions for this Deep South population. Our findings, based on the IMB model in this sample of HIV-positive patients in care in Mississippi, suggest that adherence interventions may be most effective if intervention components target (1) adherence-related information, (2) the minimization of negative beliefs about HIV medications and perceived negative lifestyle consequences of ART adherence, (3) the development of adherence-related social support, and (4) the development of practical skills in adhering to medications across various situations and contexts as well as the confidence to implement them.

Future research with the IMB model could expand upon the relative contributions of social and personal motivation to behavioral skills and adherence behavior by representing social motivation with a greater number of measured variables and by evaluating the model for various subgroups of patients (e.g., depressed patients, injection drug users, women and men, rural versus urban, and so on). The relative independence of the motivation sub-constructs should be replicated with other clinic-based samples in diverse geographic locations. It is possible that the current sample of PLWHA in the Deep South US, where a substantial amount of HIV related stigma and shame persists (Lichtenstein et al. 2002), may uniquely experience social and personal motivation as quite separate experiences. In areas where HIV is less stigmatized and issues of disclosure may be less acute, it may be that social and personal motivation would influence one another in a positive direction. However, the rational appeal and theoretical rationale for the independent influence of each aspect of motivation suggests that the current results may generalize across US populations.

Among the limitations in the current research, issues surrounding cross-sectional self-report are noteworthy. While there continues to be substantial debate regarding the validity of self-reported adherence, a number of recent publications lend ongoing support for this type of strategy (cf. Nieuwkerk and Oort's 2005; Pearson et al. 2007; Simoni et al. 2006b). Nonetheless, the potential for overestimation of rates of adherence via self-report (versus other more objective measures: Arnsten et al. 2001; Wagner and Miller 2004) may have contributed to the high rates of adherence reported by the current sample. Future research should assess the IMB model using multiple measures of ART adherence and, when possible, a longitudinal approach. As a cross-sectional study, the current modeling results cannot speak to issues of causality, only of association between the constructs at a single point in

time. Evaluation of the causal relations among the IMB model constructs requires a longitudinal, multiple assessment approach. Thus, the current research is applicable to understanding adherence at a given point in time and not over time. An attractive feature of the IMB-model is its applicability to understanding adherence over time, in that changes in the core constructs over time are predicted to relate to changes in levels of ART adherence. Whether changes in the core constructs are a result of naturally occurring events (e.g., changes in regimen, adherence fatigue) or targeted intervention, the magnitude of change should be reflected in similar changes in adherence. While not addressed in the current research, exploration of the longitudinal predictions of the model is an exciting area for future research. Another important aspect of the IMB model is its assumption that certain moderators (e.g., depression; homelessness) are likely to attenuate the IMB relations with adherence. We were unable to assess these hypotheses in the current research; however, assessing moderating variables over time would offer a unique and powerful assessment of the potential impact of these kinds of personal and structural challenges. It is also important to note that we used items from the LW-IMB-AAQ (Life-Windows Project Team 2006) to represent the individual IMB constructs. Development and use of a measure specifically designed to assess separate IMB constructs within the context of adherence would allow for more sophisticated latent variable modeling, as would a larger sample size. Additionally, targeted elicitation work within clinic-based populations in the Deep South could advise the development of a unique measure of IMB-model based adherence strengths and weaknesses articulated specifically to the adherence-related needs and challenges in this region of the United States. Finally, because of the convenience sampling strategy used in the current research, the potential for sampling bias must be noted. While the current sample appeared demographically similar to overall clinic demographics, it may over-represent those who were more motivated and willing to invest time and effort into completing the measures and these individuals may be unique. Thus, when generalizing the current results, it should be kept in mind that the results are most appropriately applied to those patients in clinical care who engage in clinic-based research.

The current results provide consistent empirical support for the IMB model of ART adherence (Fisher et al. 2006) in this sample of HIV-positive patients in Mississippi. Recognizing, modeling, and exploring the complexities of ART adherence is best captured by multifaceted, theory-based approaches. Clearly, difficulties with ART adherence are not unidimensional or easily addressed by targeting only one aspect of adherence. Barriers to adherence most likely change over time within a given individual and can span across multiple areas at any given point in time. Intervening to improve or support adherence will likely be most effective with theory-based interventions that offer a full compendium of intervention strategies targeting potential barriers within each of the information, motivation, and behavioral skills dimensions.

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References

Amico, K. R., Toro-Alfonso, J., & Fisher, J. D. (2005). An empirical test of the information, motivation, behavioral skills model of antiretroviral therapy adherence. *AIDS Care, 17*(6), 661–673.

Arnsten, J. H., Demas, P. A., Farzadegan, H., Grant, R. W., Gourevitch, M. N., Chang, C. J., et al. (2001). Antiretroviral therapy adherence and viral suppression in HIV-infected drug users: Comparison of self-report and electronic monitoring. *Clinical Infectious Diseases*, *33*, 1417–1423.

Bangsberg, D. R., Acosta, E. P., Gupta, R., Guzman, D., Riley, E. D., Harrogan, P. R., Parkin, N., & Deeks, S. G. (2006). Adherence-resistance relationships for protease and non-nucleoside reverse transcriptase inhibitors explained by virological fitness. *AIDS, 20*(2), 223–231.

Bangsberg, D. R., & Deeks, S. G. (2002). Is average adherence to HIV antiretroviral therapy enough? *Journal of General Internal Medicine, 17*(10), 812–813.

Bartlett, J. A. (2002). Addressing the challenges of adherence. *Journal of Acquired Immune Deficiency Syndromes, 29*, s2–s10.

Centers for Disease Control and Prevention. (2004). HIV/AIDS Surveillance Report, 2004, vol. 16. Atlanta: US Department of Health and Human Services, Centers for Disease Control and Prevention. Retrieved June 1, 2006, from http://www.cdc.gov/hiv/stats/hasrlink.htm

Chesney, M. A., Ickovics, J. R., Chambers, D. B., Gifford, A. L., Neidig, J., Zwickl, B., et al. (2000). Self-reported adherence to antiretroviral medications among participants in HIV clinical trials: The ACTG Adherence Instruments. *AIDS Care, 12*, 255–266.

Copello, G. (2004). Congressional public policy forum: *Fighting HIV/AIDS in the Southern United States*. Retrieved November 7, 2006, from http://www.theaidsinstitute.org/downloads/fightaidsouth.doc

De Bruin, M., Hospers, H. J., Van Den Borne, H. W., Kok, G., & Prins, J. M. (2005). Theory- and evidence-based intervention to improve adherence to antiretroviral therapy among HIV-infected patients in the Netherlands: A pilot study. *AIDS Patient Care and STDs, 19*, 284–294.

Fisher, J. D., & Fisher, W. A. (1992). Changing AIDS risk behavior. *Psychological Bulletin, 111*, 455–474.

Fisher, W. A., & Fisher, J. D. (1993). A general psychological model for changing AIDS risk behavior. In J. Pryor & G. Reeder (Eds.), *The social psychology of HIV infection* (pp. 127–153). Hillsdale, NJ: Erlbaum.

Fisher, J. D., & Fisher, W. A. (2000). Theoretical approaches to individual-level change. In J. Peterson & R. DiClemente (Eds.), *HIV prevention handbook* (pp. 3–55). New York: Kluwer Academic/Plenum Press.

Fisher, W. A., Fisher, J. D., & Harman, J. (2003). The Information–Motivation–Behavioral skills model as a general model of health behavior change: Theoretical approaches to individual-level change. In J. Suls & K. Wallston (Eds.), *Social psychological foundations of health* (pp. 127–153). London: Blackwell Publishers.

Fisher, J. D., Fisher, W. A., Amico, K. R., & Harman, J. J. (2006). An information–motivation–behavioral skills model of adherence to antiretroviral therapy. *Health Psychology, 25*, 462–473.

Haubrich, R. H., Little, S. J., Currier, J. S., Forthal, D. N., Kemper, C. A., Beall, G. N., et al. (1999). The value of patient-reported adherence to antiretroviral therapy in predicting virologic and immunologic response. *AIDS, 13*, 1099–1107.

Kalichman, S. C., Rompa, D., DiFonzo, K., Simpson, D., Austin, J., Luke, W., Kyomugisha, F., & Buckles, J. (2001). HIV treatment adherence in women living with HIV/AIDS: Research based on the Information–Motivation–Behavioral Skills model of health behavior. *Journal of the Association of Nurses in AIDS Care, 12*(4), 58–67.

Kleeberger, C. A., Phair, J. P., Strathdee, S. A., Detels, R., Kingsley, L., & Jacobson, L. P. (2001). Determinants of heterogeneous adherence to HIV-antiretroviral therapies in the Miluticenter AIDS Cohort Study. *Journal of Acquired Immune Deficiency Syndromes, 26*(1), 82–92.

Kline, R. B. (2005). *Principles and practice of structural equation modeling*, 2nd ed. NY: Guilford.

Knobel, H., Guelar, A., Carmona, A., Espona, M., Gonzalez, A., Lopez-Colimes, J. L., et al. (2001). Virologic outcome and predictors of virologic failure of highly active antiretroviral therapy containing protease inhibitors. *AIDS Patient Care and STDs, 15*(4), 193–199.

Lichtenstein, B., Laska, M. K., & Clair, J. M. (2002). Chronic sorrow in the HIV-positive patient: Issues of race, gender, and social support. *AIDS Patient Care and STDs, 16*(1), 27–38.

LifeWindows Project Team (2006). *The LifeWindows Information Motivation Behavioral Skills ART Adherence Questionnaire (LW-IMB-AAQ)*. Retrieved December 20, 2006, from http://www.chip.uconn.edu/int/F_LWIMBARTQuestionnaire.pdf

Lucas, G. M. (2005). Antiretroviral adherence, drug resistance, viral fitness, and HIV disease progression: A triangle web is woven. *Journal of Antimicrobial Chemotherapy, 55*, 413–416.

Moatti, J. P., & Spire, B. (2000). Living with HIV/AIDS and adherence to antiretroviral treatments. In J.-P. Moatti, Y. Souteyrand, A. Prieur, T. Sandfort, & P. Aggleton (Eds.), *AIDS in Europe: New challenges for the social sciences* (pp. 57–73). New York: Routledge.

Murri, R., Ammassari, A., Gallicano, K., De Luca, A., Cingolani, A., Jacobson, D., et al. (2000). Patient-reported non-adherence to HAART is related to protease inhibitor levels. *Journal of Acquired Immune Deficiency Syndrome, 24*(2), 123–128.

Nieuwkerk, P. T., & Oort, F. J. (2005). Self-reported adherence to antiretroviral therapy for HIV-1 infection and virologic treatment response: A meta-analysis. *Journal of Acquired Immune Deficiency Syndromes, 38*(4), 445–448.

Nieuwkerk, P. T., Sprangers, M. A., Burger, D. M., Hoetelmans, R. M., Hugan, P. W., Danner, S. A., et al. (2001). Limited patient adherence to highly active antiretroviral therapy for HIV-1 infection in an observational cohort study. *Archives of Internal Medicine, 161*(16), 1962–1968.

Paterson, D. L., Swindells, S., Mohr, J., Brester, M., Vergis, E. N., Aquier, C., Wagener, M. M., & Singh, N. (2000). Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. *Annals of Internal Medicine, 133*, 21–30.

Pearson, C. R., Simoni, J. M., Hoff, P., Kurth, A. E., & Martin, D. P. (2007). Assessing antiretroviral adherence via electronic drug monitoring and self-report: An examination of key methodological issues. *AIDS and Behavior, 11*(2), 161–173.

Pfizer (2005). *Global HIV/AIDS partnerships: Southern HIV/AIDS prevention initiative*. Retrieved November 7, 2006, from http://www.pfizer.com/pfizer/subsites/philanthropy/caring/global.health.hiv.southern.jsp

Simoni, J. M., Frick, P. A., & Huang, B. (2006a). A longitudinal evaluation of a social support model of medication adherence among HIV-positive men and women on antiretroviral therapy. *Health Psychology, 25*, 74–81.

Simoni, J. M., Kurth, A. E., Pearson, C. R., Pantaline, D. W., Merrill, J. O., & Frick, P. A. (2006b). Self-report measures of antiretroviral therapy adherence: A review with recommendations for HIV research and clinical management. *AIDS and Behavior, 10*(3), 227–245.

Starace, F., Massa, A., Amico, R., & Fisher, J. D. (2006). Adherence to antiretroviral therapy: An empirical test of the information–motivation–behavioral skills model. *Health Psychology, 25*(2), 153–162.

Wagner, G., & Miller, L. G. (2004). Is the influence of social desirability on patients' self-reported adherence overrated? *Journal of Acquired Immune Deficiency Syndromes, 35*(2), 203–204.