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Optimal Scaling of HIV-Related Sexual Risk Behaviors in Ethnically Diverse Homosexually Active Men

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As HIV-related behavioral research moves increasingly in the direction of seeking to determine predictors of high-risk sexual behavior, more efficient methods of specifying patterns are needed. Two statistical techniques, homogeneity analysis and latent class analysis, useful in scaling binary multivariate data profiles are presented. Both were used to analyze reported sexual behavior patterns in two samples of homosexually active men, one sample of 343 primarily White gay men attending an HIV workshop and one sample of 837 African American gay men recruited nationally. Results support the existence of a single, nonlinear, latent dimension underlying male homosexual behaviors consistent with HIV-related risk taking. Both statistical methods provide an efficient means to optimally scale sexual behavior patterns, a critical outcome variable in HIV-related research.

Much of the initial behavioral research related to the human immunodeficiency virus (HIV) focused on identifying the occurrence of various sexual behaviors among homosexually active men and associated viral transmission (Becker & Joseph, 1988). Overall, researchers found that gay men's sexual behavior patterns reflected diversity in both the types of sexual behaviors and the number and types of sexual partners with whom such behaviors are practiced (Kingsley, Detels, Kaslow, Polk, Rinaldo, Chmiel, Detre, Kelsey, Odaka, Ostrow, VanRaden, & Visscher, 1987; Winkelstein et al., 1987). With recognition of the role of sexual behavior in HIV transmission, public health guidelines recommended adoption of sexual behavior repertoires that eliminate higher risk activities. This has come to be known as the practice of "safer sex." For homosexually active men, safer sex actually represents several possible behavioral patterns involving inhibitory actions, such as reducing frequency of certain higher risk behaviors, or additive ones, such as using condoms during anal intercourse (this latter practice was relatively rare among gay men before the AIDS epidemic; Doll et al., 1990).

As behavioral researchers pose increasingly more complicated questions seeking to predict sexual behavior patterns in relation to other psychological or social factors, methods of indexing the construct of safer sex could prove extremely useful. Two recently emerging quantitative multivariate methodologies for dichotomously measured variables, *homogeneity analysis* (HA; Bartholomew, 1987; McDonald, 1967) and *latent class analysis* (LCA; Bartholomew, 1987; Lazarsfeld & Henry; 1968; McCutcheon, 1990), allow simple approximation of a latent structure model from multiple dichotomous indicators. In the case of sexual behavior, these methods offer an ideal means to translate multivariate patterns of reported sexual behavior into a single, optimally scaled variable, provided that patterns reflect a single underlying latent construct. In the present examination of self-reported sexual behaviors during the prior month from two diverse samples of homosexually active men (343 men recruited from among primarily White men attending an AIDS risk reduction workshop in Southern California and 837 African American men recruited nationally), we hypothesized that this latent construct, if it existed, would reflect sexual risk taking.

A Latent Structure Model Approach

At a general level, a latent structure model specifies that there is an unobserved variable (multidimensional or unidimensional, discrete or continuous) that accounts for any dependency existing among observed variables. The common assumption to this approach is one of local independence: Given the latent variable, values of these observed variables are independent (Langeheine & Rost, 1988). There are many special cases of this general model (for more details, see Bartholomew [1987] or McDonald [1967]).

Approximation of Latent Structure by Homogeneity Analysis

One method of evaluating a latent structure model is homogeneity analysis (HA; also known as multiple correspondence

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analysis). HA is an analysis of interdependence among nominally scaled variables and can be thought of as a nonlinear principal components analysis (Gifi, 1990). In the present study, participants reported the occurrence or nonoccurrence of several, discrete sexual behaviors occurring during the prior month. HA can make use of any redundancy observed in these reported behavioral patterns; the more homogenous the profiles, the more covariance can be captured by the method. Individuals are represented as points in p-dimensional space, where the first dimension extracted represents the largest eigenvalue in the solution and is proportional to the largest eigenvalue in the correlation matrix. Usually either $p = 1$, in the case where a single scale is desired, or $p = 2$, if exploration of clusters of individuals in a scatterplot is sought. Using alternating least squares, the procedure computes the p-dimensional dispersion matrix of individuals in both the occurrence and nonoccurrence categories of each behavior. These are pooled to obtain an estimate of within-category dispersion. Also, comparisons can be made of the centroids, or averages, of the two categories by computing the between-category dispersion, a weighted variance of the two category means. If the between-category dispersion is a large proportion of the total, then points corresponding to individuals in the same category are close together and centroids of the categories are far apart.

HA plots the individuals in p-space such that the between-category dispersion is as large as possible relative to the total dispersion. With a single sexual behavior, this computation is trivial, assigning all individuals who report that the behavior occurred at one point and those who do not at another. The location of points is arbitrary. With multiple categorical behaviors however, HA looks for a compromise in which the average between-category variance across all reported behaviors is as large as possible with respect to the total variance (Gifi, 1990).

The outcome of a typical HA consists of the object scores, which are the projections of the individuals on the p-dimensions, and the category quantifications, which are the projections of the category centroids. For technical details, we refer to Gifi (1990); for a readily available implementation, we refer to to SPSS (1990).

Approximation of Latent Structure by Latent Class Analysis

Another method of estimating a latent structure model is by latent class analysis (LCA; Bartholomew, 1987; Langeheine, 1988; Lazarsfeld & Henry, 1968; McCutcheon, 1990). LCA analyzes multivariate categorical data, in particular binary data, starting with the assumption that individuals belong to s-discrete classes with respect to an underlying dimension. If a latent class model is appropriate, LCA can efficiently disaggregate individuals into discrete classes or groups, with independence of activities within classes. This permits the grouping of individuals who share similar profiles. Evidence for the appropriateness of the s-class model is evaluated first by a likelihood chi square (L^2) test. If the model predicts the observed data well, then the L^2 will be small. Two other procedures provide further support for the specific s-class model being evaluated. The first estimates the percentage of individuals correctly classified ($1 - E$, where E is the probability of misclassification). The second (Goodman and Kruskal's λ) procedure measures association between the latent variable and the joint measured variables (McCutcheon, 1990). Ideally, results of the fit analyses will indicate that nearly all the variance has been captured by the model (nonsignificant L^2), that individuals are, on the whole, classified correctly (generally, $1 - E > .90$), and that the association between the latent variable and the joint measured variables is high (generally, >.80; McCutcheon, 1990). LCA also estimates marginal probabilities of class membership and, within each class, conditional probabilities of reporting a particular behavior. This is analogous to factor contributions and factor loadings in factor analysis. LCA can also be used to test hypotheses concerning possible group differences when two or more samples are available. For technical details, we refer to Lazarsfeld and Henry (1968); for implementation details, we refer to Hagenaars and Luijkx (1991).

The Latent Trait Model

To understand the relationship between the geometric and exploratory technique HA and the probabilistic and confirmatory LCA, a third type of representation is needed. Suppose that reported sexual behavior varies on a single latent continuum, perhaps reflecting risk taking as we hypothesized. The probability of reporting any one of the activities would be a monotonic function of the place on the continuum. For risky activities, the function (or trace line) would increase noticeably over the continuum, whereas for nonrisky activities the trace line would be flat. For some behaviors, there may be a decreasing trace line, because individuals who take risks avoid them. This particular model is called a *latent trait model* and is frequently used in modern test theory, choice theory, and attitude scaling (Everitt, 1984). The model depends quite heavily on the assumption of unidimensionality (one trait, one factor), and in the form discussed here, does not specify the shape of the trace lines. Because specific forms of latent trait analysis (LTA) are quite restrictive (Reiser & Schuessler, 1991), safely imposing their assumptions in a new area of application, such as sexual behavior, requires exploratory work demonstrating that the assumption of unidimensionality is a reasonable one.

Both HA (Gifi, 1990) and LCA (Heinen, 1993) are methods for approximating LTA. For HA, if there is a single trait describing all individuals, with the probability of reporting risky behavior increasing along the trait, then HA will show a "horseshoe" or quadratic pattern in the first two dimensions, because it approximates the nonlinear regression of the behaviors on the trait by orthogonal polynomials (Greenacre, 1984). For LCA, it can also be shown formally to be a particular form of LTA, in which the trace lines are step functions. The number of steps is equal to the number of classes; the height of the step is the conditional probability; the width of the step is the size of the latent class. To show a monotone latent trait model is being estimated, it must be possible to order the classes in the LCA so that the conditional probabilities increase over classes for all activities. In some cases, it is also possible to order activities so that the conditional probabilities increase over activities for all classes. This is double monotonicity, which implies that the trace lines for the various activities do not intersect. If double

monotonicity is obtained, reported sexual behaviors can be unambiguously ordered along a single continuum.

Because the two samples studied here were recruited with distinctly different methods at time points 2 years apart, one can expect that their average location on this latent trait might differ, reflecting differences in sample selection (men specifically interested in AIDS risk reduction education vs. men who were not necessarily interested), naturally occurring community-wide AIDS interventions, and ethnic backgrounds (Cochran & Mays, 1988). Nevertheless, to the extent that sexual patterns of both samples reflect a similar underlying construct then these statistical methods may provide the means to efficiently and accurately scale sexual behavior patterns among disparate groups of homosexually active men.

Method

Sample 1: Homosexually Active Men Attending an AIDS Education Workshop

Participants. Three hundred forty-three men completed questionnaires before participating in an AIDS education workshop. Included were 308 (90%) men who identified themselves as gay, 18 (5%) as bisexual, and 17 (5%) as neither gay nor bisexual but sexually involved with men. The men ranged from 18 to 69 years old (median age = 34 years; M = 35.8 years, SD = 10.2). The majority were White (81%), with the balance reporting Hispanic (5%), African American (2%), Native American (2%) or Asian (4%) ethnic-minority backgrounds. By self-report, 50 men (15%) were HIV infected, 72 (21%) were HIV antibody seronegative, and 209 men (62%) had never been tested. Only 15 men (4%) reported having been diagnosed with symptomatic HIV by a physician.

Questionnaire. Men completed an anonymous questionnaire, including sections assessing sexual behaviors with other men in the previous month. Participants also indicated their number of sexual partners in the past 30 days. In the sample, 29% of the men reported no sexual partners. Forty-one percent had had sexual contact with one man only, 13% with two men, and 17% with more than two (range, 3 to 35 men). Men also indicated whether they had engaged in each of 12 different homosexual behaviors in the past month, including kissing with saliva contact, mutual masturbation, oral and anal intercourse with or without condoms and with or without ejaculation, oral–anal contact, manual–anal intercourse ("fisting"), urinating on a sexual partner, and sharing sex toys.

Procedure. Men (n = 433) who attended a Shanti Foundation, Los Angeles, Special Health Education Program seminar were asked to participate. These free seminars were offered to the public to provide basic AIDS risk reduction education. Men were told in advance that they would be asked to complete questionnaires but could decline to do so without penalty. The cover sheet to the questionnaire provided an informed consent and assurances of confidentiality. Three hundred fifty-five men (82%) agreed to participate. Data from 7 heterosexual participants were excluded as well as those from 5 individuals who did not finish completing their questionnaire.

Sample 2: National Survey of Homosexually Active African American Men

Participants. Eight hundred thirty-seven African American men were recruited nationally. All reported at least one previous same-sex sexual experience, with 672 (80%) self-identifying as gay, 119 (14%) as bisexual, and 46 (6%) as neither gay nor bisexual but currently sexually involved with men. The average participant was 33.4 years old (range, 18 to 70, SD = 8.2). By self-report, 36% did not know their HIV infection status, 35% were HIV-antibody negative at most recent testing, and 28% were infected with HIV, including 118 men (14% of the total sample) who reported being diagnosed by a physician with an HIV-related disease.

Questionnaires. Men completed an anonymous questionnaire. As with the AIDS Workshop sample, participants were asked how many different men they had had sex with in the previous 30 days. Approximately 21% reported no sexual partners in the previous month, 38% reported only one, 15% reported two, and 26% reported more than two (range, 3 to 31). Participants also indicated for each of 26 possible sexual behaviors whether they had engaged in that behavior in the past month. Included were items assessing contact with saliva while kissing, masturbatory behaviors, oral–genital sex, oral–anal contact, anal intercourse, and manual–anal intercourse. In addition, men were questioned about behaviors in conjunction with condom use, as well as relatively rare behaviors such as sharing sex toys and urinating on sexual partners. In Sample 1, we assessed involvement in dyadic sexual behaviors, such as anal intercourse, without concern for whether the individual engaged in only one aspect of the behavior or both. In Sample 2, several behaviors were measured more specifically in terms of the activity in which each member of the dyad engaged. We collapsed the categories to this dyadic level for purposes of comparison across the two samples. This resulted in the indexing of 12 separate sexual behaviors. Three reported behaviors were dropped from analyses because of their rarity and because of sample size limitations of the statistical procedures. Although the HA analyses described later use bivariate marginals to estimate parameters (Gifi, 1990), the LCA analyses depend on cell frequencies (McCutcheon, 1990). The three relatively rare behaviors included fisting (2.7% of participants across both samples), urinating on partners (1.4%), and sharing sex toys (1.4%).

Procedure. Participants were recruited in multiple ways. Several African American gay organizations nationally mailed the questionnaire to their members to complete and return to us in prestamped envelopes. Postcards, included with the packet, but returned separately, gave participants an opportunity to request additional questionnaires for others or flyers to distribute to local social and political groups. These were mailed in bulk to individuals who requested them. In addition, information about the survey was distributed nationally by means of flyers to lesbian, gay, and transvestite bars and organizations listed in homosexual publications; by press releases to gay, bisexual, and transgender newspapers and newsletters; and by announcements in pornography magazines. Potential participants were asked to write or call a telephone number provided if they desired to participate. Because questionnaires were distributed anonymously, for the most part, and returned anonymously, calculation of refusal rates was not possible. Of those questionnaires dispersed, 862 questionnaires were returned completed. Twenty-one were not used because the respondent did not meet inclusion criteria (i.e., was not an African American male participant who has sex with other men). An additional 12 questionnaires were deleted because of missing data.

Results

A Priori Classification by Guidelines for Safer Sex

Sexual behaviors were first categorized hierarchically according to generally accepted HIV risk-related guidelines (Kingsley et al., 1987). This was done to allow later comparison of HA and LCA analyses to a methodologically simple, a priori safer sex classification scheme. Men were assigned to the category of highest sexual risk-rated behaviors in which they had reportedly engaged. Those men who indicated no sexual partners in the previous month were coded as not at risk (29% of Sample 1 and 21% of Sample 2). Men were classified as having engaged

in "very-low-risk" activities if they reported only masturbatory contact with other men (5% and 4% of both samples, respectively). A category of "possible risk" was assigned if men reported, in addition to any lower risk behaviors, kissing with exchange of saliva and oral–genital contact without semen being knowingly present (16% and 8%, respectively). Those who reported using condoms during oral sex or anal intercourse but denied such behaviors without condoms were classified as "condom users" (16% and 17%). Men were assigned to a "definite-risk" category if they reported oral sex with ejaculation, oral–anal contact ("rimming"), or penile insertion into the anus without ejaculation (23% and 33%, respectively). Finally, men who had engaged in anal intercourse without condoms to the point of ejaculation were assigned to an "extreme-risk" category (11% and 18%, respectively). As might be expected, the two samples differed significantly from each other, $\chi^2(5, N = 1180) = 37.19, p < .001$, with the African American men (Sample 2) more likely to be practicing higher risk sexual behaviors than the men (primarily White) attending the AIDS education workshop (Sample 1). Because Samples 1 and 2 differed both in their ethnic backgrounds and methods of participant recruitment, the precise cause for the observed difference is indeterminable and beyond the scope of this article.

Homogeneity Analyses

We first used HA to permit a geometric representation of the covariance structures in the two samples. Although the two samples differed in their level of sexual risk taking, if, as hypothesized, a single, similar latent continuum existed, then this geometric structure should conform to the familiar horseshoe pattern in both samples, with behaviors similarly ordered along the horseshoe. Data from Samples 1 and 2 were submitted separately to HA for the nine self-reported sexual behaviors using the HOMALS computer program (a version of which is available in SPSS, Version 4.0 [SPSS, 1990]). Category quantifications are given in Table 1. Bootstrap sampling with replacement, repeated 100 times, was used to estimate standard errors of the category quantifications.

The first dimension, representing approximately 37% to 39% of the variance, depending on the sample, appeared to index HIV-related sexual risk taking, ranging from reports of unprotected anal intercourse at one extreme to an absence of reported masturbatory behaviors at the other. Ordering of the behaviors generally reflected standard safer sex guidelines. The second dimension, accounting for approximately 13% to 16% of the variance, appeared to index the reporting of safer sex behaviors; that is, reporting highly risky behaviors or not reporting low risk behaviors was at one extreme of the scale, and the reported use of condoms, lower risk behaviors, and absence of high-risk behaviors were at the other extreme. Figures 1 and 2 depict plots of category centroids from the first two HA dimensions for both samples demonstrating the "horseshoe" effect consistent with a single latent trait dimension. For Sample 1, the location of oral sex with condom use appears as an outlier on the curve. Both samples, however, show highly similar patterning of category centroids.

Comparison of HA With A Priori Classification

To tangibly demonstrate this ordering of sexual risk behaviors across both samples, we also calculated composite scores on the HA dimensions for each individual (see Table 2). Comparing these scores to the a priori safer sex classification scheme clearly demonstrates the expected ordering effect for both samples on the first dimension of sexual risk taking. Similarly, for the second dimension scaling enactment of safer sex behaviors, "condom users" scored the highest, whereas both men who reported unprotected anal intercourse and those who were sexually inactive scored at the opposite extreme.

Latent Class Analysis

To specifically test whether the underlying structural relationships among reported sexual behaviors conformed to a similar latent dimension for both samples, we analyzed data using the LCAG (Version 2.12a) computer program (Hagenaars & Luijkx, 1991). Given the large number of tests anticipated, alpha was set at .01. Retaining sample membership through the use of a dummy variable, we evaluated three progressively restrictive sets of hypotheses. First, we tested the plausibility of different *s*-class models in accounting for the associations among the behavioral profiles. In this evaluation, both conditional probabilities for reported sexual behaviors and percentage of cases allocated to each class were unrestricted across the two samples. The unrestricted two-class model (M_1), three-class (M_2), and four class-models (M_5) resulted in nonsignificant L^2 values, indicating model fit (see Table 3).

All three models appeared to divide sexual behavior according to sexual risk taking. The two-class model essentially split both samples into those who reported no sexual behaviors versus those who did. The three-class model divided both samples into those participating in no- or low-risk activities, medium-risk, and high-risk sexual behaviors, as discussed later. The four-class model further subdivided the highest risk class of the three-class model into two separate classes, one with low probability of reporting unprotected anal sex and one with high probability of doing so.

Chi-square difference tests (for example, model comparison M_1–M_2) demonstrate that each *s*-class accounts for significantly more variance than the simpler model. However, the two indices ($1 - E$ and λ) support the adoption of a three-class model over the four-class model in the interests of maximizing accuracy in class membership assignment (McCutcheon, 1990). Because all three models appeared to divide the samples according to sexual risk taking and the three-class model provided the best explanation of the data structure, we chose to explore the three-class model more fully. Fit of the models is consistent with the existence of an underlying latent variable.

In Table 3, we present the conditional probabilities, estimated by the unrestricted model (M_2), for positive responses to each of the nine behaviors by three-class membership. Also presented is the percentage of men reporting behavioral occurrence in the previous month for both samples. In general, Sample 2 reported greater prevalence of most behaviors than Sample 1, as evaluated by univariate tests.

For both samples, the first latent class reflected extremely low

Table 1
Category Quantifications of the Two-Dimensional HOMALS Program Solutions

Behavioral categories	Sample 1		Sample 2	
	First dimension	Second dimension	First dimension	Second dimension
Reported sexual behaviors–positive occurrence				
Ejaculatory anal sex–no condom	1.16 (.19)	−1.90 (.22)	1.12 (.05)	−1.42 (.10)
Anal insertion–no condom	1.33 (.11)	−0.94 (.22)	1.02 (.04)	−0.80 (.07)
Ejaculatory oral sex–no condom	1.18 (.11)	−0.81 (.30)	0.94 (.05)	−0.70 (.12)
Oral–anal contact	1.26 (.10)	−0.56 (.20)	0.92 (.04)	−0.10 (.11)
Oral sex with condom	0.66 (.15)	1.70 (.20)	0.77 (.04)	0.33 (.13)
Anal sex with condom	0.95 (.08)	0.29 (.22)	0.68 (.03)	0.22 (.07)
Kissing with saliva exchange	0.74 (.05)	0.15 (.07)	0.61 (.02)	0.20 (.04)
Oral–genital contact	0.81 (.05)	0.18 (.06)	0.61 (.02)	0.18 (.03)
Masturbatory behaviors	0.53 (.04)	0.28 (.05)	0.44 (.02)	0.23 (.02)
Reported sexual behaviors–nonoccurrence				
Ejaculatory anal sex–no condom	−0.14 (.03)	0.24 (.02)	−0.24 (.02)	0.30 (.02)
Anal insertion–no condom	−0.25 (.03)	0.18 (.04)	−0.38 (.02)	0.30 (.02)
Ejaculatory oral sex–no condom	−0.20 (.03)	0.14 (.04)	−0.25 (.02)	0.18 (.03)
Oral–anal contact	−0.25 (.03)	0.11 (.04)	−0.40 (.02)	0.01 (.05)
Oral sex with condom	−0.10 (.03)	−0.25 (.03)	−0.36 (.02)	−0.16 (.06)
Anal sex with condom	−0.34 (.04)	−0.11 (.08)	−0.54 (.03)	−0.17 (.05)
Kissing with saliva exchange	−0.87 (.05)	−0.17 (.08)	−0.88 (.04)	−0.30 (.06)
Oral–genital contact	−0.84 (.05)	−0.19 (.05)	−0.96 (.04)	−0.28 (.05)
Masturbatory behaviors	−0.97 (.07)	−0.51 (.09)	−1.15 (.05)	−0.60 (.06)
Eigenvalues	.37	.16	.39	.13

Note. Numbers in parentheses are standard errors. Sample 1 was composed of 343 homosexually active men attending an AIDS education workshop; Sample 2 was composed of 837 African American men recruited nationally.

probability of most sexual behaviors occurring. For example, Sample 1 individuals assigned to membership in the first class had an estimated .13 probability of reporting masturbatory behaviors but virtually zero probability of reporting any others. This class was estimated to include approximately 34% of the men attending the AIDS risk reduction workshop and 25% of Sample 2. Membership in the second class for both groups appeared to be associated with reported behaviors consistent, for the most part, with moderate sexual risk taking. For both samples, behaviors most likely to be reported included masturbation (probability of reported occurrence = .96 for Sample 1 and .92 for Sample 2), kissing with saliva exchange, and unprotected oral–genital contact without ejaculation. Whereas condom use showed a moderate probability of being indicated, higher risk behaviors, particularly for Sample 1, were extremely unlikely to be reported. Membership in the third latent class was associated with conditional probabilities indicative of reporting occurrence of most of the nine behaviors, including those of both low and high HIV-related risk. The one exception was the low probability of condom use for oral sex by Sample 1. Patterning of the conditional probabilities in both samples is highly suggestive of double monotonicity (increasing probability of occurrence across classes and across behaviors), or a single latent trait dimension.

To examine whether this underlying dimension was identical in both samples, we then tested a second set of hypotheses restricting the probabilities associated with the nine reported behaviors, conditional on class membership, to be equal in the two samples (M_{3A}–M_{3I} in Table 3). In a series of hierarchical tests imposing, sequentially, restrictions on the conditional probabilities for the behaviors across the two samples, we began with the behavior having the most similar conditional probabilities (kissing with saliva exchange) in both samples, evaluating the difference between this partially constrained model (M_{3A}) where both samples were hypothesized to report equivalent conditional probabilities of the behavior and the unrestricted model (M_2) where the two samples were allowed to differ (McCutcheon, 1990). This did not change the fit of the model significantly. Additional constraints on the conditional probabilities of the next most similar behavior were then added and the fit of the model contrasted to the less constrained model (e.g., M_{3B}–M_{3A}), and so on until all nine behaviors were constrained in hierarchical order. As can be seen in Table 3, a model constraining equivalent conditional probabilities across all behaviors, except the two associated with condom use, was consistent with the data. Thus, although the conditional probabilities were highly similar across most behaviors, there did appear to be some differences between the two samples, particularly with condom use during oral sex as previously seen in the HA analyses.

A final hypothesis evaluated restricting both the conditional probabilities and percentage of latent class membership to be equal across both groups. This most restrictive hypothesis tested essentially whether both samples were drawn from the same population. This set of restrictions could readily be rejected (M_4–M_{3I}).

Comparison of LCA With A Priori Classification

In Table 5, we contrast results of the three-class membership assignment to the a priori safer sex classification scheme described earlier. The three-class LCA model divided men into those engaging in, at most, minimally risky behavior, moder-

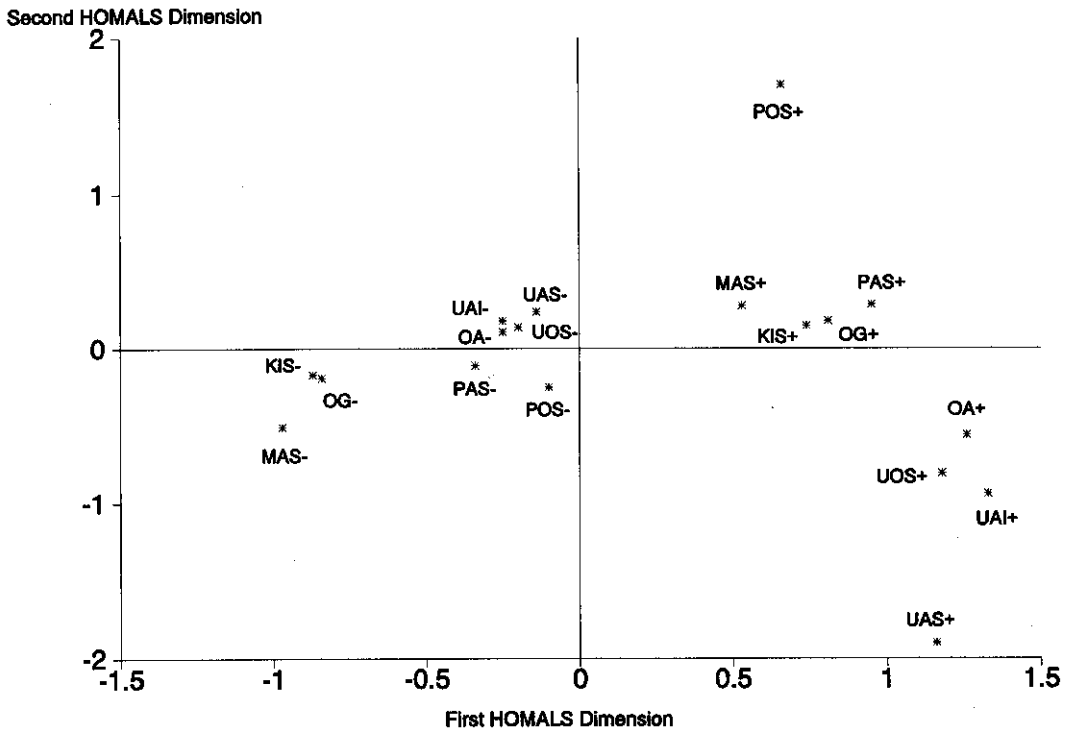

Figure 1. Category quantifications from the HOMALS computer program using data from Sample 1 (AIDS risk reduction workshop participants). Plus signs indicate reported occurrences, and minus signs indicate reported nonoccurrences. UAS = unprotected anal sex; UAI = unprotected anal insertion; UOS = unprotected oral sex; OA = oral–anal contact; OG = oral–genital contact; MAS = masturbation; PAS = anal sex with condom; POS = oral sex with condom.

ately risky behavior, and extremely risky behavior. The first latent class primarily included individuals who had no sexual partners or who had reported behaviors of minimal or no risk; only 7 of the 334 men (2%) assigned to this class reported high-risk behaviors or using condoms during sexual intercourse. The second latent class included men who reported practicing low to highly risky behaviors and appeared to represent more of a middle range of risk taking. Of the 567 men from both samples assigned to this class, 28 (5%) reported having practiced unprotected anal intercourse and an additional 228 (40%) indicated behaviors that clearly fell outside established safer sex guidelines. All men assigned to the third latent class indicated that they had engaged in behaviors involving definite HIV transmission risk. Of the 279 men in the third latent class, 156 (56%) reported practicing unprotected ejaculatory anal intercourse. However, many of these latter men did not report exclusively high-risk behavior; 100 of the 156 men also reported practicing anal sex while using condoms during the same time period.

Discussion

Gay men's sexual behavior has changed profoundly since the onset of the AIDS epidemic (Kelly, St. Lawrence, & Brasfield, 1991). In an effort to reduce their risks of HIV infection, many gay men have added condom use to their behavioral repertoires (Doll et al., 1990). Others have altered their behavioral patterns to minimize the possibility of exposure. Still others, particularly African American gay men (Peterson, Coates, Catania, Middleton, Hilliard, & Hearst, 1991), continue to engage in higher risk sexual behaviors even in the face of possible HIV infection. Despite the complexity of these behavioral choices, our results suggest that gay men's sexual behaviors can be efficiently scaled along a single, nonlinear dimension consistent with sexual risk taking. In this study comparing patterns of sexual behaviors between (primarily) White gay men attending an AIDS risk reduction workshop in Los Angeles and African American gay men recruited nationally without regard to participation in AIDS-related educational interventions although the 1-month prevalence of most reported sexual behaviors differed markedly between the samples, analyses exploring the latent structure of the behavioral profiles suggest a high degree of similarity between these two very disparate groups of gay men. For both groups, sexual behavior patterns, when subjected to homogeneity analysis, demonstrate a nonlinear "horseshoe" pattern reflecting latent unidimensionality. Contrasting results from this analysis with simple a priori coding according to HIV-related risk demonstrated clearly the association between this latent dimension and HIV-related risk taking.

Further analyses using latent class analysis techniques to specifically test for similarities and differences between the two samples suggest a high degree of similarity in structure between the two disparate groups. This latter technique efficiently clas-

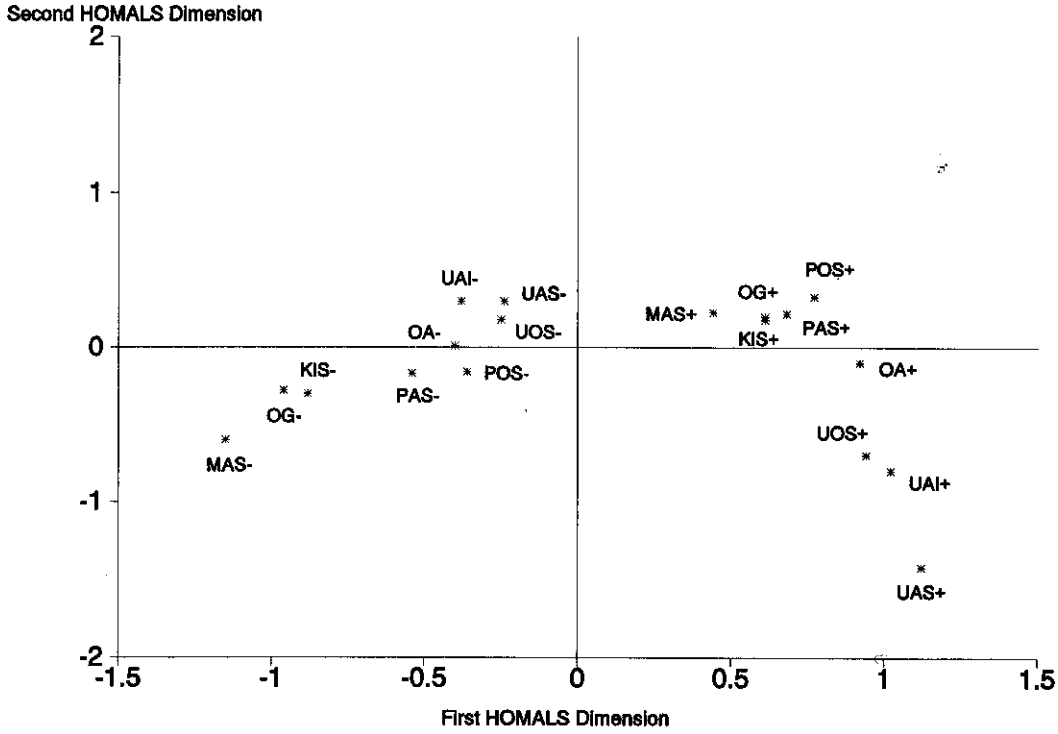

Figure 2. Category quantifications from the HOMALS computer program using data from Sample 2 (nationally recruited African American participants). Plus signs indicate reported occurrences, and minus signs indicate reported nonoccurrences. UAS = unprotected anal sex; UAI = unprotected anal insertion; UOS = unprotected oral sex; OA = oral–anal contact; OG = oral–genital contact; MAS = masturbation; PAS = anal sex with condom; POS = oral sex with condom.

sified men into three groups that appeared to vary along the single, latent dimension of HIV-related risk taking. Conditional probabilities of reported behavioral occurrences associated with each of three classes were similar for the two groups, except for behaviors associated with condom use, particularly during oral sex. Because the AIDS workshop sample was recruited 2 years earlier than the African American sample, during a time period when major gay community interventions were promoting the use of condoms, it is possible that this difference is solely due to temporal influences on condom use behavior. Only fur-

Table 2
Mean Scores on the First Two Homogeneity Analysis Dimensions by Safer Sex Guidelines Classification

Classification by safer sex guidelines[a]	Mean (and *SE*) for Sample 1		Mean (and *SE*) for Sample 2	
	First dimension	Second dimension	First dimension	Second dimension
No sexual activity	−3.96 (.00)	−0.56 (.00)	−5.16 (.00)	−0.72 (.00)
Very low risk only	−2.46 (.00)	0.23 (.00)	−3.61 (.10)	0.02 (.05)
Possible risk only	−0.24 (.12)	0.65 (.05)	−1.44 (.11)	0.74 (.04)
Condom use	1.14 (.20)	2.07 (.13)	−0.15 (.12)	1.23 (.04)
Definite risk	3.19 (.18)	0.14 (.11)	2.00 (.10)	0.43 (.05)
Extreme risk	3.93 (.43)	−2.79 (.14)	3.95 (.18)	−1.67 (.06)

Note. Sample 1 was composed of 343 homosexually active men attending an AIDS education workshop; Sample 2 was composed of 837 African American men recruited nationally.
[a] Very low risk includes masturbatory behaviors; possible risk includes sharing saliva and oral–genital contact without ejaculation; condom use includes both oral and anal sex with a condom; definite risk includes oral sex with ejaculation, anal insertion without ejaculation, and oral–anal contact; extreme risk is unprotected anal intercourse with ejaculation. Participants were categorized according to most sexually risky behavior in which they engaged in the past month.

Table 3
Model Fitting Results of Latent Class Analyses

Model and restriction	L^2	*df*	1 − E	λ	Model comparison	L^2	*df*
		One class					
M_0: Independence	3,168.80**	1,004					
		Two classes					
M_1: Unrestricted	1,028.63	984	.99	.98	M_0–M_1	2,140.17**	20
		Three classes					
M_2: Unrestricted	679.36	964	.93	.89	M_1–M_2	349.27**	20
Conditional probabilities restricted							
M_{3A}: Kissing	680.63	967	.93	.89	M_{3A}–M_2	1.27	3
M_{3B}: M_{3A} and oral contact	684.37	970	.93	.89	M_{3B}–M_{3A}	3.74	3
M_{3C}: M_{3B} and masturbation	688.26	973	.93	.89	M_{3C}–M_{3B}	3.89	3
M_{3D}: M_{3C} and ejaculatory oral sex	693.40	976	.93	.89	M_{3D}–M_{3C}	5.14	3
M_{3E}: M_{3D} and ejaculatory anal sex	700.50	979	.93	.89	M_{3E}–M_{3D}	7.10	3
M_{3F}: M_{3E} and anal insertion	704.34	982	.93	.89	M_{3F}–M_{3E}	3.84	3
M_{3G}: M_{3F} and oral–anal sex	714.29	985	.93	.89	M_{3G}–M_{3F}	9.95	3
M_{3H}: M_{3G} and anal sex with condoms	728.00	988	.93	.89	M_{3H}–M_{3G}	13.71*	3
M_{3I}: M_{3H} and oral sex with condoms	776.98	991	.92	.88	M_{3I}–M_{3H}	48.98**	3
Conditional probabilities and class membership restricted							
M_4: Completely restricted	803.74	993	.92	.89	M_4–M_{3I}	26.76**	2
		Four classes					
M_5: Unrestricted	578.54	944	.87	.80	M_2–M_5	100.46**	20

* $p < .01$. ** $p < .001$.

ther research can clarify the source of this difference, if it, indeed, still exists.

Nevertheless, the reported behavioral profiles of both groups are consistent with the existence of a single latent trait dimension underlying patterns of sexual behaviors among ethnically diverse samples of homosexually active men. Remarkably, this latent structure conforms well to standard public health guidelines regarding HIV-related sexual behavior risk reduction.

The existence of a single latent dimension to sexual behavior practices has several very important implications. First, a single latent dimension implies that many of the men who practice high-risk behaviors are also likely to be practicing other behaviors consistent with safer sex guidelines. Indeed, in this study 64% of men who reported unprotected anal intercourse to the point of ejaculation in the previous month also reported anal intercourse in the same time period where condoms were used.

Table 4
Prevalence of Reported Sexual Behaviors in Previous Month and Latent Class Analysis Conditional Probabilities for Positive Responses (Three-Class Model, M_2)

	% reporting behavior occurrence		Conditional probabilities for latent classes					
			Sample 1			Sample 2		
Sexual behaviors	Sample 1	Sample 2	1	2	3	1	2	3
Masturbation	65.0	72.3	.13	.96	.87	.12	.92	.92
Oral-genital sex without ejaculation or condom	51.0	60.9*	.01	.68	.91	.00	.74	.94
Kissing with saliva exchange	54.2	59.5	.02	.73	.92	.01	.73	.90
Anal sex with condom	27.1	44.0**	.02	.32	.54	.01	.50	.74
Oral sex with condom	12.8	32.1**	.00	.28	.08	.00	.38	.53
Oral–anal contact	16.6	30.1**	.00	.10	.46	.00	.29	.63
Oral sex with ejaculation	14.9	20.8	.00	.13	.36	.01	.19	.45
Anal sex without ejaculation or condom	16.3	27.5**	.00	.00	.59	.00	.12	.88
Anal sex with ejaculation	11.1	17.8*	.00	.00	.37	.00	.07	.60
Marginal probabilities of class membership			.34	.38	.28	.25	.51	.24

* $p < .01$. ** $p < .001$.

Table 5
Comparison of Individual Latent Class Membership Assignment With Classification by Safer Sex Guidelines

Classification by safer sex guidelines[a]	Latent classification					
	Sample 1			Sample 2		
	1	2	3	1	2	3
No sexual activity	99	0	0	172	0	0
Very low risk only	18	0	0	32	0	0
Possible risk only	2	54	0	4	67	0
Condom use	0	53	0	2	137	0
Definite risk	0	32	47	2	196	76
Extreme risk	3	0	35	0	28	121

Note. Conditional probabilities are unrestricted, Model M_2. Sample 1 was composed of 343 homosexually active men attending an AIDS education workshop; Sample 2 was composed of 837 African American homosexually active men recruited nationally.
[a] Very low risk includes masturbatory behaviors; possible risk includes sharing saliva and oral–genital contact without ejaculation; condom use includes both oral and anal sex with use of a condom; definite risk includes oral sex with ejaculation, anal insertion without ejaculation, and oral–anal contact; extreme risk is unprotected anal intercourse with ejaculation. Participants were categorized according to most sexually risky behavior in which they engaged in the past month.

Several studies have already identified inconsistent condom use when risk of HIV transmission is present as a significant concern for HIV prevention interventions (Adib, Joseph, Ostrow, Tal, & Schwartz, 1991; Ekstrand & Coates, 1990). In this context, relapse, a topic of much focus (Kelly et al., 1991), can be reframed as not necessarily abandonment of risk-reducing sexual practices by gay men but a straying into the higher risk end of the behavioral spectrum. Knowledge of the patterns of relapse can contribute to successful safer sex interventions, including an understanding of specific sexual activities or situational factors that, once identified, can serve as warning signals for relapse. Similar strategies have been used in other health risk-reducing behaviors (Leventhal & Cleary, 1980; Lichtenstein, Weiss, & Hitchcock, 1986; Marlatt & Gordon, 1980).

A second critical implication of our findings pertains to the conceptualization of possible ethnic and cultural differences among the diverse populations of men who have sex with other men. Findings from this study indicate that the latent structure of sexual behaviors may be very similar across ethnically and racially different populations, although the frequency with which such patterns are represented may differ. For systems of classification, surveillance, or data analysis in the area of sexual behaviors of homosexually active men, this is heartening. As Dressler et al. (1991) have noted, conceptual validity of cross-cultural measures in comparative research can be demonstrated by finding close similarity of factor structures across samples. Furthermore, comparisons with an a priori hierarchical categorization of behaviors according to HIV risk guidelines suggests that this simple approach provides a reasonably good ordinal approximation of this latent dimension.

However, our findings do not collaterally imply that the underlying psychological structures, including motivations and decision-making process, or social factors involved in influencing these sexual behavior patterns are also necessarily the same across ethnically and culturally diverse groups (Cochran & Mays, 1988; Mays & Cochran, 1990; Mays & Jackson, 1991). It may be that the types of sexual risk taking, in fact, have dissimilar determinants in different ethnic–racial, cultural, or socioeconomic groups.

Finally, our findings also suggest that restrictive assumptions of unidimensionality associated with latent trait analysis may be appropriate in the realm of sexual behavior. Elsewhere, we have successfully used Guttman scaling (Guttman, 1944), a long-established technique for scaling qualitative data underlaid by a unidimensional construct, to index extensiveness of lifetime sexual experiences in a study heterosexual sexual behavior among young adults (Cochran & Peplau, 1991). This study lends further support to this approach of viewing individual sexual behaviors as conditionally related. Latent variable models can be used to capture this dependency.

In the second decade of HIV research, elucidating underlying structures of behavior, explicating similarities and differences among diverse racial and ethnic groups, and developing effective models of behavior change will receive increasing focus. The statistical methods used here to optimally scale patterns of sexual behavior offer important advantages in this effort. Each technique has somewhat different strengths and limitations. For example, sample size requirements are more restrictive for latent class analysis than for homogeneity analysis and may exceed the resources of many clinical sample-based studies, particularly within psychology (Holt & Macready, 1989). However, latent class analysis offers the ability to test specific hypotheses related to the underlying structure.

The statistical techniques used here are part of a body of emerging methods in the analysis of categorical data (Heinen, 1993; Reiser & Schuessler, 1991). Both techniques permit reducing multiple, dichotomous behavioral indicators into a single score or assignment of a grouping variable without imposing a priori assumptions about the structuring of homosexually active men's sexual behaviors. Scaling behavior in this fashion permits direct measurement of "safer sex" behavioral patterns and, in the present study, provided validation for a simple a priori coding scheme. With incident data, these techniques offer a distinct advantage in that sexual risk taking within even a single sexual encounter can be scaled efficiently. Because "safer sex" (and its attitudinal and behavioral covariates) is frequently the target of both public health interventions and behavioral research, this measurement focus has the benefit of specifying more directly the construct of interest.

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